

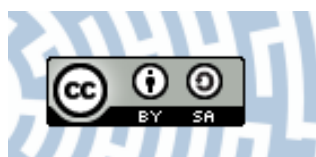


**You have downloaded a document from
RE-BUŚ
repository of the University of Silesia in Katowice**

Title: Reflection on the borders of language and speech in light of discoveries in zoosemiotics

Author: Tomasz Nowak


Citation style: Nowak Tomasz. (2021). Reflection on the borders of language and speech in light of discoveries in zoosemiotics. "Zoophilologica" T. 7, Nr 1 (2021), s. 1-53, doi 10.31261/ZOOPHILOLOGICA.2021.07.10



Uznanie autorstwa - Na tych samych warunkach - Licencja ta pozwala na kopiowanie, zmienianie, rozprowadzanie, przedstawianie i wykonywanie utworu tak długo, jak tylko na utwory zależne będzie udzielana taka sama licencja.



TOMASZ NOWAK

 <http://orcid.org/0000-0001-6044-113X>

University of Silesia in Katowice

Department of Humanities

Reflection on the Borders of Language and Speech in Light of Discoveries in Zoosemiotics

Refleksja nad granicami języka i mowy
w obliczu odkryć zoosemiotyki

Abstrakt

Głównym problemem, który poruszam w niniejszym artykule są granice języka i mowy, wytyczane wspólnie przez nauki społeczno-humanistyczne i matematyczno-przyrodnicze, zwłaszcza – fuzję semiotyki i biologii, czyli biosemiotyki. W tekście formułuję tezę, zgodnie z którą zdolności i umiejętności biokomunikacyjne zwierząt ludzkich i nie-ludzkich dzieli dystans: zarazem ilościowy i jakościowy, przy czym: (pre)adaptacje filogenetyczne i (pre)dyspozycje ontogenetyczne zwierząt ludzkich i nie-ludzkich są z jednej strony komunikacyjnie – dyskretne, z drugiej strony kognitywnie i behawioralnie – kontynualne. Wyniki badań empirycznych, które przytoczyłem i skomentowałem, pozwalają sądzić, że istnieją cechy biokomunikacyjne swoiście ludzkie.

Słowa kluczowe: granice języka i mowy, uniwersalia językowe, biolingwistyka, zoosemiotyka

Размышление о границах языка и речи
перед лицом открытий зоосемиотики

Абстракт

Основная проблема, которую автор обсуждает в этой статье, – это границы языка и речи, очерченные совместно социально-гуманитарными науками, математикой и естественными науками, особенно – слиянием семиотики и биологии, то есть био-семиотики. В работе формулируется тезис, согласно которому биокommunikационные способности и навыки человеческих существ и животных находятся на некотором расстоянии друг от друга: как количественно, так и качественно, где филогенетические (пре)адаптации и онтогенетические (пред)расположенности человеческих существ и животных, с одной стороны, коммуникативно – незаметны, с другой стороны, когнитивно и поведенчески – постоянны. Результаты эмпирических исследований позволяют предположить, что существуют специфические особенности человеческой биокommunikации.

Ключевые слова: границы языка и речи, лингвистические универсалии, биоллингвистика, зоосемиотики

1. Introduction

No disciplined and rigorous reflection on language and speech can turn a blind eye to two issues; first, How do language and speech exist? and, second, How is language and speech learned? Which together presuppose the answer to a third (and key) question: What are language and speech? In other words, it is impossible to discuss the *ontological* and *gnoseological attributes* of language and speech until attempts are made to define the *content* and *scope* of both terms (and I do not have to add here that there is no, and probably never will be, universal agreement in this regard but, nonetheless, I believe it is worth the effort to seek a consensus).

I present to the reader an article that reviews the question of the *boundaries of language and speech*. In this paper, I take the position that the expression of terms: language and speech are formulated either with the use of an *internal-linguistic* or *external-linguistic* perspective. In other words, their definitions are constructed either on the basis of linguistics (and its programs), for example, by comparing many ethnic languages with each other, or within sciences other than linguistics (both socio-humanistic and mathematical-natural), for example, by comparing one *natural language* and many *animal codes*.

The main problem I raise in this article concerns the boundaries of language and speech that are delineated both by social sciences, the humanities, mathematics, and natural sciences, especially by the fusion of semiotics and biology, or *bio-semiotics*. At the same time, I have a strong belief (a belief bordering on certainty) that the assumptions and discoveries made in the field of biosemiotics (and its sub-disciplines, including zoosemiotics) can shed new light on what the entities: language and speech are. Moreover, it is likely that these assumptions and discoveries will lead to the need for reinterpretation of the content and scope of both terms.

Biosemiotic problems are of great interest to the representatives of various scientific disciplines. It is notable that in Polish-language publications philosophical views¹ dominate, while specialists in the field of biocommunications, that is, biologists and linguists, have very little to say on the matter. This paper sets out to fill this literary gap and, as such, is an attempt at a linguistic interpretation of biological observations, also in terms of the dispute that pro- and anti-naturalistic advocates have had with each other for many years. I would like to recall that the discussion between *pro-naturalism* and *anti-naturalism* on language and speech first of all centers on the fact that advocates (anti-naturalists) are trying to show that some features of language and speech are only human, while their opponents (pro-naturalists) say that all features of

¹ Honorata Korpikiewicz, *Biokomunikacja. Jak zwierzęta porozumiewają się ze światem* (Poznań: Wydawnictwo Naukowe UAM, 2011); Łukasz Kwiatek, *Przemów, a cię ochrzczę. O małpach wychowanych przez człowieka* (Kraków: Copernicus Center Press, 2017).

language and speech are also human, where strong features, which are only human, and weak features, which are also human, have their nature: being either *stricto* communicative or *largo* communicative, including cognitive and/or behavioral (the problem with any reflection on language and speech is that it is not known whether there are phylogenetic (pre)adaptations and strictly communicative ontogenetic (pre)dispositions, which are not both cognitive and/or behavioral). Consequently, if the null hypothesis states that language and speech are phylogenetic (pre)adaptations and ontogenetic (pre)dispositions (*sui generis*) that are human-unique only, then the research I refer to is intended to confer or corroborate the null hypothesis.

2. Development

Biosemiotics, the science of the semiosphere within the biosphere, identifies signs (*semiosis*) and life phenomena (*biosis*) with each other to eventually integrate them into a single biological-semiotic process (direction) – biosemiosis, which is the reference point for biosemiotic disciplines and programs.² Biosemiotics explores the phenomenon of biocommunication, putting an emphasis on its perspectives: dynamic (the problem of ontogenesis and (its) phylogenesis) and static (the problem of structure and (its) function). In particular, biosemiotics explores the relationships between, on the one hand, the *code* (sign) and, on the other hand, between the *sender* and *receiver* (subject of the sign), between the *context* (object of the sign), *message* (construct of the sign), and *contact* (substrate of the sign). Therefore, in the following paragraphs I am going to discuss the results of the following observations: biopragmatic, biosemantic, biogrammatic, and biodiacritical, constantly bearing in mind the question of whether some (pre)adaptations and (pre)dispositions can be found in the biocommunication domain as strong, only human, traits.

Biosemiotics, as a broader field, is interested in the signaling communication of all living organisms, while zoosemiotics, which is a narrower field, specializes in the study of signaling in the animal kingdom. It is important to note that zoosemiotic reflection on the boundaries of information representation and interpretation of intentions focuses on similarities and differences in communication between representatives of, among others, two groups: mammals and birds, that is, higher animals, who are closest to humans in terms of phylogenetics (mammals) and ontogenetics (birds), cf. the search for, on the one hand, mammalian homologies in terms of language and, on the other hand, avian analogies

² Dario Martinelli, *A Critical Companion to Zoosemiotics. People, Paths, Ideas* (New York: Springer, 2010).

in terms of speech. In summation, zoosemiotics penetrates the phenomena of communication in the world of mammals and birds, where research (natural and artificial, active and passive – as discussed further on) concerns, on the one hand, bird species: (neo)gnathae and (non-)passerine, (non-)galliformes and (non-)songbirds and, on the other hand, mammal species: viviparous, placental, and primates, including Old World anthropoids and New World anthropoids, guenons and apes, gibbons, and hominidae.

Biosemiotics is currently developing in two parallel directions: natural and artificial, where natural communication and artificial communication are different in that either humans are trying to teach humans non-human communication, or humans are trying to teach non-humans human communication; more precisely, either humans are trying to communicate with non-humans using non-natural components and communication goals for humans and non-humans, or humans are trying to communicate with non-humans using components and communication goals that are natural for humans and not natural for non-humans. In practice, however, these research approaches complement each other, accompanying each other in different proportions.³

2.1. (More) natural biocommunication

2.1.1. Biopragmatic discoveries

The main research issue in biopragmatics takes the form of two alternative questions: Is the subject, associated with a sign (only), intentional or (also) inferential? Is the interaction encountered in the animal world competitive or cooperative?

2.1.1.1. Observations

Many observations have been made and many experiments have been carried out that shed some light on how (non-human) animals,⁴ especially great apes,

³ Research on animal communication in natural and artificial environments differ from each other, for instance, in terms of applied research methods: active and passive. The study of animal communication in natural conditions is carried out in such a manner that, first, (passive) observations are made to formulate hypotheses and, second, (active) experiments are carried out to test these hypotheses. Research on animal communication in an artificial environment is carried out in such a manner that, first, (active) experiments are run to formulate hypotheses, and, second, (passive) observations are made to test these hypotheses. Of course, studies using research methods like active (experiments) and passive (observations) differ from one another in that active research (experiment) supposes the active influence of the investigator on the subject, and that passive research (observation) supposes the passive observation of the subject by the investigator (observation).

⁴ In my article I try (!) to avoid the automatic opposition that is “imposed” by colloquial language, cf. *human and animal*. Therefore, I consciously use the term “non-human animals”

specifically chimpanzees, process messages at the biopragmatic level; inter alia the main questions posed by the researchers are whether animals feel compassion (decentration) and can work together (cooperation), as well as whether they are likely to cheat (deception).

Decentration

It has been found that some animals (chimpanzees) are able to share someone else's point of view and have some potential in the field of the theory of mind.

First of all, it has been observed that when an individual occupying a low position in the group sees that food is in the view of another individual occupying a higher position in the group, the lower status individual will not reach for the said food, and when the lower position individual sees that food is not in the view of another high-ranking individual, the lower status individual in the group will reach for the food.⁵

Second, an experiment was carried out in which the investigators (humans) presented to the subjects (animals) scenes that took place in a room containing two people, two containers, and one object. The animals observed a sequence of several consecutive and related situations, for instance, person1 put the object in container1; person2 saw that person1 put the object in container1; person1 went (without the object) from room1 to room2; person2 pulled the object out of container1, put the object into container2 and went (without the object) from room1 to room3 (or person2 pulled the object out of container2 and went (with the object) from room1 to room3); person1 went from room2 to room1 and began looking for the object. It is important to note, that when person1 went from room2 to room1 (when he returned) and began looking for the object, the animals focused (fixed) their eyes on person1 and on container1 (the study was conducted with the use of an eye tracker), which proves that they accepted the perspective of person1 who was looking for the object. The animals knew that, first, the object was not in the container1 and, second, that person1 did not know (because the researcher left room1) where the object was, but thought that the object was in container1 (because the researcher put it there before leaving room1). The experiment was a modification of a test. The original version was intended for people who used speech, for instance, children and adults, and the second was for those who did not talk, like human infants and animals, where the first version expected a verbal response (answers to

("zwierzęta nie-ludzkie" in Polish) borrowed from English, cf. the commonly accepted term non-human animals in the sense of "animals not being human" ("zwierzęta niebędące ludźmi" in Polish) (the hyphen is meant to emphasize the power of negation *de re*).

⁵ Josep Bräuer, Josep Call, and Michael Tomasello, "Chimpanzees Really Know What Others Can See in a Competitive Situation," *Animal Cognition* 10, no. 4 (2007): 439–448.

a question), while the second measured a physiological answer (movement of the eyes, direct of sight).⁶

It has also been found that some animals (chimpanzees) can understand someone else's intentions. First, it has been observed that in a situation when a caregiver objectively could not, even if he/she subjectively wished to, share food with the animal, the animal reacted calmly, whereas in a situation when the caregiver subjectively did not want to, even if he/she objectively could share food with the animal, the animal reacted nervously.⁷ Second, it has been observed that some animals (chimpanzees) transmit the intention of (meta) communication to each other in such a way that they absorb the attention of the recipient, for example, by hitting a rock or poking a hand, and initiate interaction with the recipient, for instance, by the raising of an arm or patting of the hand.⁸

Cooperation

It has been found that animals could not understand the essence of cooperation, but can cooperate in situations where, first, they anticipate their future profit (reward), and, second, when they receive someone's explicit request (demand).

At first, an experiment was conducted in which the researchers (humans) presented the subjects (human children and adult chimpanzees) with a scenario involving two people and two objects: a stapler and scissors. The script included several scenes, for example, person1 stapled the cards with a stapler, then put the stapler in its place1 and left the room; person2 entered the room, then put the stapler in a different place2 and left the room; person1 entered the room and, having not found the stapler in place1, began looking for it all over the room. The children, looking at how person1 was looking for the stapler, started pointing (altruistically) to show person1 the place2 where the stapler was, and stopped pointing when person1 found the stapler (interestingly, the children were not interested in the scissors, which were next to the stapler in place1). The chimpanzees, when looking at the subsequent scenes, showed no intention

⁶ Christopher Krupenye, Fumihiro Kano, Satoshi Hirata, Josep Call, and Michael Tomasello, "Great Apes Anticipate That Other Individuals Will Act According to False Beliefs," *Science* 354, no. 6308 (2016): 110–114.

⁷ Josep Call, Brian Hare, Malinda Carpenter, and Michael Tomasello, "Unwilling versus Unable: Chimpanzees Understanding of Human Intentional Action," *Developmental Science* 7, no. 4 (2004): 488–498.

⁸ Katie E. Slocombe, Tanja Kaller, Laurel Turman, Simon W. Townsend, Sarah Papworth, and Klaus Zuberbühler, "Production of Food-associated Calls in Wild Male Chimpanzees Is Dependent on the Composition of the Audience," *Behavioral Ecology and Sociobiology* 64, no. 12 (2010): 1959–1966.

of helping (sharing knowledge) and showed no intention of cooperating, for example, by giving explicit (deictic) guidance.⁹

Second, an experiment was carried out in which the researcher (human) looked for a tool (key) with which he could open a box containing food which the researcher (would) like to use either for the subject tested or for himself. In that experiment human (children) and chimpanzee (adults) individuals were test subjects. The children spontaneously pointed the researcher where the tool was even when the researcher was using it to obtain food only for himself. The chimpanzees indicated to the researcher where the tool was only when the researcher used it to get food for them alone.¹⁰

Third, an experiment was carried out, in which, on the one hand, the researcher (human) created a motivational situation and cooperative pressure on the subjects (animals), and, on the other hand, the subjects selected information and communicated their intentions with the aid of a keyboard. Two common chimpanzees, Austin and Sherman, were taught to communicate using a lexigram board (similar to a keypad with keys), whereby the connection between keys and lexigrams met two conditions: the condition of equivalence of signs and words and the condition of substitution of signs and objects. The experimental situation was such that Sherman was in one room with a container of food, and Austin was in another room with the key to the container of food. The first room and the second were connected in such a way that the objects could be freely shared between them. Austin and Sherman shared common goals and had a common means of achieving them, namely, the motivational goal of the food in the container. The means to achieve this (further) goal was the key to the container, the instrumental goal was the key to the box, and the means to achieving this (closer) goal was the keyboard for communication. Austin and Sherman, therefore, were put in such a situation that, having no other choice, they had to cooperate with each other. The communication took place in such a way that, first, Sherman sent a message to Austin (using the lexigram keyboard) asking him for the key to the container (then, Austin gave the key to Sherman, and Sherman opened the container and took the food out of it), and second, Austin sent a message to Sherman (using the lexigram keyboard) asking him for food from the container (then, Sherman divided the food, gave it to Austin, and Austin ate his share). Interestingly, the animals were better at

⁹ Ulf Liszkowski, Malinda Carpenter, Tricia Striano, and Michael Tomasello, "12- and 18-month-olds Point to Provide Information for Others," *Journal of Cognition and Development* 7, no. 2 (2006): 173–187.

¹⁰ Anke Bullinger, Juliane Kaminski, Felizitas Zimmerman, and Michael Tomasello, "Different Social Motives in the Gestural Communication of Chimpanzees and Human Children," *Developmental Science* 14, no. 1 (2001): 58–68.

solving the task when the reward was meant for them than when the reward was meant for someone else, for instance, their caregivers.¹¹

Fourth, an experiment was carried out in which two unrelated individuals were placed in two booths from where they could observe each other. The first individual had juice in a carton (within the reach of its hand) and a stick. A straw was needed to drink the juice through it (in the carton), while the second individual had juice in a bottle (beyond the reach of its hand) and a straw and needed a stick to draw the juice with it (in the bottle). It is important to note that in one version the individuals had the tools they needed on both sides, that is to say, both the first individual and the other individual had them. In the second version, the individuals had the necessary tools unilaterally, that is, one individual had them, and the other individual did not. It turned out that (in both versions), first, if one individual asked the other, for example, by extending his arm towards him, he received the tool needed: a straw or a stick, respectively, and, second, if one individual did not ask the other, he did not receive the tool needed. Animals, especially monkeys, particularly apes, in particular hominids, function socially in such a manner that observing the situation of another individual does not make them rush to help. The necessary condition is appropriate communication. In this way, helping on demand is an economic strategy, namely, inventing (on its own) may prove unnecessary, and responding (to someone's request) may be profitable.¹²

Deception

The literature provides several examples of the phenomenon of deception, with some observations resulting in numerous interpretations, both stronger and weaker.

First of all, deceptive behavior has been observed in some mammals (monkeys). For instance, it has been noted that monkeys transmit an alarm message in the context of food, that is, when a group was foraging and a predator was not hunting, which caused the group (receiver) to escape from the announced threat and the individual (sender) to obtain the abandoned food. It was noted that chimpanzees transmitted a food message in the context of good quality food in abundant quantities, but did not transmit a food message when food quality was low and in small quantities.¹³

¹¹ Sue E. Savage-Rumbaugh, *Ape Language: From Conditioned Response to Symbol* (New York: Oxford University Press, 1986).

¹² Shinya Yamamoto, Tatyana Humle, and Masayuki Tanaka, "Chimpanzees Help Each Other upon Request," *Public Library of Science* 4, no. 10 (October 2009): 1–7, <https://doi.org/10.1371/journal.pone.0007416>.

¹³ Marc D. Hauser and Richard W. Wrangham, "Manipulation of Food Calls in Captive Chimpanzees," *Folia Primatologica* 48 (1987): 207–210.

Second, deceptive behavior has been observed in some birds (hens). For instance, it has been observed that a male is more likely to transmit a food message when there was a female (partner) nearby than when there was a male (rival) nearby. It has been observed that the male is more likely to transmit an alarm message when there was a blood relative nearby than when there was non-blood relative in the proximity.¹⁴

The problem of interpreting deceptive observations is that, on the one hand, subjective and individual observations are often difficult to test with objective and repetitive experiments. On the other hand, one observation in different (weaker or stronger) formulations sometimes explains many hypotheses with different (stronger and weaker) assumptions, cf. the stronger (Machiavellian) hypothesis, which states that a male (rooster) deceives a male (rival) by sending a message that eliminates the relationship of form and content in the signal, and the weaker (legal) hypothesis, which states that the male is courting the female (partner) by transmitting a message that cultivates a relationship of form and content in the signal, with the form of the sign being of a food nature and the content of the sign being of a sexual nature (it is interesting to note, that in half of the cases when the male transmitted a food message to the female, food was unavailable to both).

I would like to recall that the methodology of biosemiotic research uses the so-called Occam's razor, which is realized as a postulate: either (neo)behavioral (Morgan's Canon) or (neo)cognitive (Martinelli's Canon). In any case, the point is that, first, in a situation where there are alternative explanations, simplification suppresses complication, and, in a situation where there are no alternative explanations, complication suppresses the simplification. In this view, the phenomenon of deception usually finds simpler expressions, for instance, something more behavioral and less cognitive.¹⁵

2.1.1.2. Interpretations

Differences in communication between human and non-human animals at the biopragmatic level are reduced to the fact that while in the human world the sender and the recipient, when communicating, cooperate with each other because the sender wants the recipient to know something from the recipient. In the animal world the sender and the recipient, when communicating, compete with each other because the sender wants the recipient to do something for the sender. In other words, animals compete more willingly and better (with each other) than they cooperate; to be more precise, they compete instinctively, but cooperate instrumentally. In the process of communication, humans *cooperate*

¹⁴ Marcel Gyger and Peter Marler, "Food Calling in the Domestic Fowl, *Gallus gallus*: The Role of External Referents and Deception," *Animal Behaviour* 36 (1988): 358–365.

¹⁵ Robert W. Mitchell and Nicolas N. Thompson, eds., *Deception: Perspectives on Human and Non-human Deceit* (New York: State University of New York Press, 1986).

informally and *altruistically*, and animals cooperate *manipulatively* and *egotistically*, cf. blood relatives and coalitions of kindred individuals. From this point of view, human communication is *collectively cooperative* (group as a goal), and animal communication is *individually cooperative* (group as a means). Let me remind you that cooperation *stricte* does not mean that someone1 does something separately for someone2, but someone2 does something separately for someone1, but rather someone1 and someone2 do something together. In this way, cooperation does not take place in the *me* and *you* mode, but in the *us* mode. Meanwhile, humans (also) conformistically take the perspective of the first plural person (*we*), and animals (only) specifically adopt the perspective of the first singular person (*I*). For instance, hunting is done in such a way that one individual chases the victim, a second individual surrounds the victim, and a third individual catches the victim. In other words, successive individuals join the hunt, cutting off the victim's escape route, while each individual wants to occupy the most convenient position in order to get food for themselves (in light of this, it can be assumed that hunting is self-organized – without a top-down scenario and division into roles, because these are born spontaneously on the foundations of selfish competition).¹⁶

Let me remind you that biocommunication is a *game of (non-)iterated prisoner dilemma*, while an evolutionarily stable communication strategy is a *tit for tat* strategy, that is, friendly strategy, in a situation when the sender begins an altruistic game with the recipient, and merciful strategy, when the sender does not continue an altruistic game with the recipient. Blood relations and mutual altruism lies at the heart of animal communication, but human communication is based on (non-)blood relations and (non-)mutual altruism, while communication based on kinship or mutual altruism becomes stable if it meets the following conditions: first (for relative altruism): $br > c$, where: r is the “relationship: genes of the sender in the genes of the recipient,” c is the “cost of the sender” and b is the “benefit of the recipient,” and the second (for mutual altruism): $bs > c$, where: s is “non-blood kinship: the sender's profit in the recipient's profit,” b is the “recipient's benefit” and c is “the sender's cost.” Animal communication assumes natural competition and is inherently evolutionarily stable. Human communication assumes natural cooperation and is not evolutionarily stable, that is to say, humans effectively exchange information with each other, even though the sender and the recipient are not (always) related by blood or just related, and the messages they transmit and receive are not (always) energy-expensive and are not necessarily true.¹⁷

¹⁶ Michael Tomasello, *Origins of Human Communication* (Cambridge: The MIT Press, 2008).

¹⁷ Robert L. Trivers, “The Evolution of Reciprocal Altruism,” *The Quarterly Review of Biology* 46 (1971): 35–57; Robert Axelrod and William D. Hamilton, “The Evolution of Cooperation,” *Science* 211 (1981): 1390–1396; Gilbert Roberts, “Cooperation through Interdependence,” *Animal Behaviour* 70 (2005): 901–908.

Human communication is based on several specifically human, cognitive, and behavioral foundations, inter alia, people share common views, knowledge, goals and actions, since by their nature they trust each other, help each other, share with each other, and punish each other for lack of reciprocity (while feeling an internal, endocrinal, reward or punishment). It is important to note that each of these features is closely related to communication. For instance, communication in the sense of helping each other by sharing trustworthy information with them, although people manifest altruistic motivations and cooperative inclinations when they learn to point, even before they begin to speak. Namely, people communicate with each other in such a way (most often) that they share knowledge with each other: either pointing someone to something (*ostensive information*), or telling something to someone (*verbal information*), cf. (co)work for (co)knowledge. In contrast, animals transmit and receive messages that perform (simultaneously) multiple functions (at most one main and at least one secondary), while animal messages perform – as the main function (primary figure) – an expressive and/or aesthetic (minimal) function or an impressive and/or a fictive (maximum) function, but not a referential and/or reflexive function, where the reference function can play the role of one of several side functions (background) in animated messages. For instance, it has been noted that chimpanzees communicate via gestures, yet they do not use declarative gestures as a referential function, but imperative gestures as an expressive function or intentional gestures as a fictive function. Moreover, it has not been observed that chimpanzees (either in a natural or artificial setting) use gestures as deictic and demonstrative functions, that is to say, they do not indicate or show anything. They just do not understand the cooperative function of gestures. For instance, it has been observed that animals compete with a caregiver for food both when an animal sees (and understands) that the caregiver wants to (selfishly) obtain food (by reaching for the unhidden food that the animal sees), and when the animal sees (but does not understand) that the caregiver wants to (altruistically) help the animal obtain food (by pointing at the hidden food that the animal does not see).¹⁸

Differences in human and non-human communication at the pragmatic level (and, consequently, at subsequent levels, inter alia, semantic, grammatical, and diacritical levels), result from human and non-human animals communicating in different ways. Namely, animals communicate *explicitly* (semantically) by means of code (signals), transmitting messages to each other, and humans communicate *implicitly* (pragmatically) by means of ostension (suggestions), suggesting interpretations to each other. In this view, human communication combines two phenomena: communication of intention and communication of information, cf. the assumptions and assertions of *implication theory* and *rel-*

¹⁸ Michael Tomasello, “Why Don’t Ape s Point?,” in *Roots of Human Sociality*, ed. Norman Enfield and Stephen Levinson (New York: Routledge, 2006), 506–524.

evance theory,¹⁹ which states that, paradoxically, people communicate more and much more effectively when they do not say what they want to say, or when they say something different (or more or less than they should in a given situation), instead of what they want to say. The sender and the receiver equally share the energy costs and information profits of the communication, cf. the sender suggests something to the receiver, and the receiver infers something via the sender, cf. the suggestion: “You know what (*q*) I mean by saying that *p*” and the inference: “I know what (*q*) you mean by saying that *p*.” In summation, there is no more than one level in animal communication: direct and literal, and in human communication, there is at least one level: (non-)direct and (non-)literal. In other words, animals communicate through *statements*, and humans communicate through *under-statements*. It is important, however, that it has turned out that some species of animals have a *theory of mind* (to an intentional degree not higher than the second degree; only humans, thanks to language and speech, can reach higher and further), that is, the capability and ability to *decentrate* (*meta-represent*), namely, they understand that others are guided not by what the world is like, but by what they think about what the world is like, and thus they are capable of reflection (reading someone’s mind), the essence of which is reflected in the formula: “I think that you (don’t) think that (\sim)*p*.”²⁰

2.1.2. Biosemantic discoveries

The main research problem of biosemantics takes the form of two alternative questions: Is the *object* which the sign is associated with is (only) *intentional* or (also) *extentional*? Is the *signaling* that can be found in the animal world *indexable* or *symbolic*?

2.1.2.1. Observations

Many observations and experiments have been made that shed light on how (non-human) animals, especially monkeys, process messages at the biosemantic level.

First, it was found that communication signaling alarm by some mammals (guenons) occurs in such a way that the sender stimulates the recipient (screams and runs away), and the recipient reacts to the sender (looks up and runs away). The observations conducted made it possible to establish that the alarm repertoire of monkeys includes at least three signals associated with a certain type (stimulus) of threat (attack by predatory animals) and with the corresponding

¹⁹ Paul H. Grice, “Logic and Conversation,” in *Speech Acts*, ed. Peter Cole and Jerry L. Morgan (London: Brill, 1975), 41–58; Dan Sperber and Deirdre Wilson, *Relevance: Communication and Cognition* (Oxford: Basil Blackwell, 1986).

²⁰ Ida Kurcz, “Communicative Competence and Theory of Mind,” *Psychology of Language and Communication*, 8(2) (2004): 5–18; Josep Call and Michael Tomasello, “Does the Chimpanzee Have a Theory of Mind? 30 Years Later,” *Trends in Cognitive Sciences*, 12(5) (2008): 189–192.

type (response) of shelter (rescue in camouflaging plants), where: the types of threats and shelters correspond to each other, cf. mammal (cat: leopard) and tree (crown), bird (eagle: warrior) and shrub (undergrowth), reptile (snake: python) and grass (wool). In other words, action and reaction are interconnected in such a manner that the communication between the sender and the recipient is connected by two (hypothetical) components, namely, information about the threat (what is it?) and a tendency to hide (what to do?). The experiments carried out consisted of screams being recorded (sound was recorded), and, second, screams were sent out (sound was played) and reactions were recorded (images were recorded). For example, the orientation of the recipient (individuals in a group) for the speaker: fast or slow, long or short. (The developed experimental technique has become a widely accepted research paradigm.) First, it turned out that the pack responds to calls not only when their sender (individual) is present (see), and not only when their context (predator) is present (remains within the reach of the senses), which clearly emphasizes their purely communicative (signal) nature. Second, it turned out that manipulating the acoustic spectrum in the expressive (affective) parameters of the message (the sender's communicative action) does not change the reference (declarative) parameters of behavior (the recipient's non-communicative response). To sum up, it was found that the variable in the message is the emotional component, and the constant is the informational component.²¹

Second, it was found in the social interaction of some mammals (monkeys) that the sender is often a younger male (mother's son), and the recipient – the eldest female (the son's mother). It was found that messages included social signals that are transmitted and received in the context of threats (antagonism in the pack), while these signals are structurally and functionally different, depending on who was attacking and how, on the one hand, the status of the aggressor, for example, the position of high or low (in relation to the pack), close or distant relationship (in relation to the victim), and, on the other hand, the scale of the conflict, for instance, physical or acoustic aggression. Social messages contain voice signals, such as undulating, noisy, sparkling, pulsating, and tonal (in short: several hundred [561] screams were recorded, and divided into several [5] classes). By the way, it turned out that if the sender (son) stimulates, then the recipient (mother) reacts, where: her reaction is proportional to the stimulation: either minimal, cf. the mother's cry distracts the aggressor from her son (absorption), or maximum, cf. the mother's action restrains the aggressor's attack on her son (retorsion), where the mother's reaction is always faster

²¹ Thomas T. Struhsaker, "Auditory Communication among Vervet Monkeys (*Cercopithecus aethiops*)," in *Social Communication Among Primates*, ed. Simon Altmann (New York: University of Chicago Press, 1967), 281–324; Robert M. Seyfarth, Dorothy L. Cheney, and Peter Marler, "Vervet Monkey Alarm Calls: Semantic Communication in a Free-ranging Primate," *Animal Behaviour* 28 (1980): 1070–1094.

and stronger when the son calls for help than when someone else calls for help. Social communication includes, on the one hand, communicative stimuli (mother-son communication) and, on the other hand, (non-)communicative reactions (mother-son response), where it is possible that social messages convey information about the stimulus (about the victim and the aggressor) and/or attitudes to the reaction (for the defender and the aggressor).²²

Third, it has been found that copulatory communication in some mammals (monkeys and macaques) occurs in such a way that a female communicates with a male (both with her partner and his rival) so that during copulation it signals whether or not sperm ejaculation has taken place. In other words, the female transmits one communication when copulation ends with ejaculation, and a second message when copulation does not end with ejaculation. Thus, the female sends a communication (about the result of mating: its success or failure), which concerns whether the copulation was successful (positive for the partner and negative for the rival) or not (negative for the partner and positive for the rival), increasing her chances of conceiving offspring (either from her partner or from his rival). Females want to mate with all males, which allows spermatozoa to compete in the sexual pathways and thus maximize the best genetic recombination. There are several hypotheses that try to explain copulatory communication (female screams), such as notification about the fertile phase, encouraging males to compete, regulating male ejaculation, signaling the right to males.²³

Fourth, it has been established that the alarm and food communication of some birds (hens) is carried out in such a way that the male transmits the message, and the female receives it. Alarm messages from hens are transmitted and received in the context of a threat of attack: from above (a bird), for example, a hawk, or from below (a mammal), for instance, a fox, where the male transmits alarm messages more often in the presence of relatives (natural selection). The food communications of hens are transmitted and received in the context of food with information about the taste. The best, for example, powdery mildew larvae or the worst, for instance, peanut shells, while the male often transmits food messages in the presence of females (sexual selection). In summary, birds communicate with each other in terms of their life needs, exchanging at least four communications, that is, two for alarm and two for food. It is important to note that signaling in birds is characterized by signal

²² Harold Gouzoules and Sarah Gouzoules, "Design Features and Developmental Modification of Pigtail Macaque, *Macaca nemestrina*, Agonistic Screams," *Animal Behaviour* 37 (1989): 383–401.

²³ Dana Pfefferle et al., "Female Barbary Macaque (*Macaca sylvanus*) Copulation Calls Do Not Reveal the Fertile Phase But Influence Mating Outcome," *Proceedings of the Royal Society B: Biological Sciences* 275, no. 1634 (2008): 571–578.

specialization (depending on the context) and relativization of communication (depending on the recipient).²⁴

Let me remind you that the main research problem in biosemantics takes the form of a question: Is signaling in the animal world indexable or symbolic? There have been several observations and several experiments that seem to shed some light on this question.

First, an experiment was conducted in which the researcher (human) presented the subject (chimpanzee) with signs (two types: small and large) and food (two portions: small and large), while the demonstration of signs and/or food assumed, first of all, that food is not a sign (primary agreement) and, second, food is a sign (secondary agreement); in any event, the sign (either non-food or food) and food entered into a relationship in which the elements of the sign remained: signified and signifier. The experiment was successful. The animal would first reach for the sign representing a larger portion of food to get a larger portion of food, and then the animal would reach for the sign representing a smaller portion of food to get a larger portion of food. In other words, the animal understood the original agreement (in both versions, cf. explanations: *a lot for a lot* and *a lot for a little*), while the animal, processing the problem, most likely, was guided by its cognitive abilities, cf. inference about the *modus ponens ponendo* scheme: “If (in the past) I chose X, I got food Y (first premise), and if (in the future) I choose X (second premise), I will get Y (output).” Second, the animal reached for a larger portion of food to get a large portion of food, and did not reach for a smaller portion of food to get a larger portion of food (the animal does not understand the secondary agreement in which the food sign is associated with food objects); the animal reached for a larger portion of food to eat it. The animal did not understand that one portion of food (resp. small or large) symbolizes (according to the secondary agreement) the second portion of food (resp. large or small), and therefore, by reaching for a smaller portion of food, it would provide itself with a larger portion of food. Other experimental animals (primates and hominids) behaved similarly. This example shows that animals (chimpanzees) do not understand the nature of the symbol.²⁵

Second, it has been observed that a linguistically trained pygmy chimpanzee, Kanzi, transmits messages that create combinations of signals (lexigrams),

²⁴ Peter Marler, Alfred Dufty, and Roberta Pickert, “Vocal Communication in the Domestic Chicken I: Does a Sender Communicate Information about the Quality of a Food Referent to a Receiver?” *Animal Behaviour* 34 (1986a): 188–194; Peter Marler, Alfred Dufty, and Roberta Pickert, “Vocal Communication in the Domestic Chicken II: Is a Sender Sensitive to the Presence and Nature of a Receiver,” *Animal Behaviour* 34 (1986b): 194–198.

²⁵ Sara T. Boysen, Gary G. Bernston, Mary B. Hannan, and John T. Cacioppo, “Quantity-based Interference and Symbolic Representations in Chimpanzees (*Pan troglodytes*),” *Journal of Experimental Psychology: Animal Behavior Processes* 22 (1996): 76–86.

where: the relationships between the message signals correspond to the relationships between the objects of the situation, namely, the order of one map (isomorphically maps) the order of others, which proves that animals can communicate using iconic messages, cf. communication: *grab pat* (\neq *pat grab*) and *pat grab* (\neq *grab grab*), in which the first lexigram denotes an earlier action, and the second – a later action. How do we know that there is an iconic (co)relation between signs and states? It turns out that when the recipient (a human) performs actions in a sequence identical to that provided in the communication, the sender (animal) reacts approvingly, and when the recipient (a human) performs actions in the opposite order to that predicted by the message, the sender (animal) reacts disapprovingly. This example shows that some animals (chimpanzees) understand the essence of icons (in any case, iconic signs are quite common in nature, cf. the phenomenon of mimicry).²⁶

Moreover, the aforementioned conclusion is supported by a newer interpretation of older observations. Let me remind you that in the first half of the 20th century, observations were made on bees, and in the second half of the 20th century, experiments were conducted on models of bees, thanks to which it was found that bees report, among other things, the distance to be overcome and the direction they should follow to find food (nectar). Food rituals occur in such a way that the bee leaves the hive, goes to investigate, finds food, takes a sample, returns to the hive and begins to dance, completing a movement(s) in its entirety and parts (wings and abdomen) of its body, so that it transmits messages in channels: tactile and acoustic. The dancing insect reports the distance (near or far) and the direction (left or right) in which the swarm should go in search of food. There are two types of dances that guarantee the bees the correct location of food: the first dance, which resembles the number zero (0), and the second dance, which resembles the number eight (8). The first dance signals that food is nearby ($0 < 100$ m) in a horizontal direction. The second dance signals that food is far away (> 100 m $> 13,000$ m) in a horizontal direction, which indicates the angle between the dance and the Sun. It is important to note that dance communication is based on at least two correlations: between the tempo of the dance individuals in the hive and distance from the hive to the food and between the corner of the dance individuals in the hive, the angle of the Sun above the hive, and the direction from the hive to food (between the rhythm of the dance of the individual in the hive and the energy spent on the flight from the hive to the food?). These correlations are *par excellence* iconic, among other things, they are based on the metaphor: “the more form, the more

²⁶ Patricia M. Greenfield and Sue E. Savage-Rumbaugh, “Imitation, Grammatical Development, and the Invention of Protogrammar by an Ape,” in *Biological and Behavioral Determinants of Language Development*, ed. Norman Krasnegor, Duane Rumbaugh, Richard Schiefelbusch, and Michael Studdert-Kennedy (Hillsdale: Psychology Press, 1991), 235–258.

content,” cf. iconic communications in human language: *He walked and walked and walked = He walked a loong way.*²⁷

It should be added that the acquisition (study) and processing (use) of symbols and non-symbols includes other brain chains, namely: symbolic (and some iconic) signs have a prefrontal location, and indicative (and some iconic) signs have a non-frontal location.²⁸

2.1.2.2. Interpretations

There is no doubt that during communication animals transmit *quantitative information* to each other, that is, information as a decrease in entropy, and probably *qualitative information*, that is, information as a representation of the situation. The results of at least several studies (observations and experiments) lead to the conclusion that there are at least several species of birds and mammals that have at least some signals that relate to at least several domains, and therefore communicate (with signals) that are transmitted and received in the context of: (for) threats, such as alarm, and (for) invitations, such as food.

From the point of view of a semantic interpretation of the communicative function, there are two hypotheses: (neo)cognitive (maximalist) and (neo)behavioral (minimalist), where: the first hypothesis is that animals in their communications (signals) represent (declaratively and informatively) some attributes of stimuli, and the second hypothesis is that animals organize (imperatively and emotionally) some aspects of the reaction in their communications (signals). It is likely that both interpretations are correct to some extent, where: in the world of non-human animals, the imperative is placed in the foreground (the goal), and the declarative is placed in the background (in the center). It is possible that people live in the world of declarations, whereas animals – in the world of demands. Sign communications sent and received by living organisms perform several functions, of which one is the main and the other is secondary. Animals communicate with each other by sending and receiving communications that have a function: on the one hand (primary), expressive or impressive, and on the other hand (secondary), referential. In this approach, the expressive (lower) or impressive (higher) function is the figure (center) of the communication, and the referential function is its background (periphery). (It is noteworthy that in human languages, unlike animal codes, there are words that perform a function: not only semantic, but also grammatical and pragmatic.) In this approach, signals and communications in the animal world are assigned the attribute (largest) of *functional reference*, namely, animals respond to the physi-

²⁷ Karl von Frisch, *The Dance Language and Orientation of Bees* (Cambridge: Belknap Press, 1967); Axel Michelsen, Wolfgang H. Kirchner, and Martin Lindauer, “Honeybees Can Be Recruited by a Mechanical Model of Dancing Bee,” *Naturwissenschaften* 76 (1989): 277–280.

²⁸ Dillion Niederhut, “Gesture and the Origin of Language,” in *Proceedings of the 10th International Conference (EVOLANG 10)*, ed. Christine Cuskley et al. (Singapore: Evolang 12 Organizing Committee, 2012), 266–273.

cal (diacritical) and mental (semantic) features of the communication (signals), so that they encode information about (i.e., the minimum) several attributes of a predator: first, the predator's *genus*, that is, the type of organisms, second, the predator's *locus*, including: direction: above or below; distance: far or near, and; in addition: *degree* and *mode*, that is, the level of alarm: high or low and the source of information: acoustic or optical. The problem, however, is that in groups of birds and mammals, it has been observed that one individual transmits an alarm or food communication, even if the second individual is in the same place as the first, and, like the first individual, perceives a threat or food and, like the first individual, sends an alarm or food signal. Evidently, in a situation where the first and second individuals know the same thing, the first one cannot have informational intentions in relation to the second individual. Thus, it is possible that, for instance, anxious communication boils down to an individual disturbing the pack (goal: concentration of forces) and/or the predator (goal: presentation of forces).²⁹

It is assumed that at least some species of bird and mammal communities have a repertoire of signals that, as part of their communications, belong to certain classes of contextual phenomena. In other words, the sender adapts the code to the context, distributing portions of information and emotions depending on many different factors. It is important to note that signals in the animal world perform the following functions: general or specific, for example, general alarms and food signals are given and received in the context of a threat or food "in general" and specific alarms and food signals – in the context of a threat or food "in particular." First, the alarms are stimuli and/or reactions that are associated with the threat, and which may threaten the recipient, and to the behavior which the recipient must follow where: information about the stimulus refers to the direction (top or bottom) and attack distance (large or small) attacking and susceptibility to response direction (up or down) of salvation and a means (fast or slow) to escape. Second, food cues refer to stimuli and/or reactions that relate to the food the recipient can find and the behavior the recipient must implement, where: information about the stimulus refers to the quantity (more or less) and quality (better or worse) of the food and the predisposition to the reaction – the direction (right or left) and distance (near and far) to the goal, cf. the famous (iconic!) dance of the bees.³⁰ In summa-

²⁹ Simon W. Townsend and Marta B. Manser, "Functionally Referential Communication in Mammals: The Past, Present and the Future," *Ethology* 119 (2013): 1–11.

³⁰ Interestingly enough, when an experiment was conducted in which bee food (nectar) was placed on a pole, it turned out that bees can neither send nor receive messages that signal the food is above the ground or not on the ground, because they have signals that relate to the horizontal, and not to the vertical dimension due to their subjective perception of the objective environment having developed in natural and not in experimental-artificial situations. Moreover, it has been observed that many populations of bees of the same species interpret signals differently: "close" and "far," "left" and "right," which is an argument for a thesis that

tion, the semantics of animal signaling includes signs that are (to each other) similar in relation: *hyponym* and *hyperonym*. In other words, the hierarchy of creatures in the sphere of animal interests has only two levels: (more) general and (more) specific.

However, the most important question that needs to be resolved from the outset is whether signals in animal communication have the status of separate units from the *co(n)text* and in the *co(n)text*. Consequently, it should be checked that signals in animal messages do not depend on the contexts in which they occur, and that they are invariant in the contexts in which they appear, where: the term *co(n)text* can refer to both situations (*context*) that accompanies the signal as an independent message, and the accompanying text (*co-text*), attached to the signal as an independent message. It is assumed that signals *A* and *B* are constant in the contexts of *X* and *Y* regardless of contexts *X* and *Y*, provided that they satisfy the proportions in terms of paradigmatics and syntagmatics: $AX/BY = AX/BY$, cf. *black crow/white sheep = white crow/black sheep*, where the words: *crow* and *sheep* are animal names, and *black crow/white sheep* \neq *white crow/black sheep*, where the words *crow* and *sheep* are not animal names (of course, in the first situation we are dealing with lexemes: *white*, *black*; *crow*, *sheep*, and in the second situation – with phraseological units: *white crow*, *black sheep*). The paradigmatic and syntagmatic relation (together): $AX/BY = AX/BY$ can be divided into (separate) proportions: paradigmatic: $AX/BX = AY/BY$ and syntagmatic: $AX/AY = BX/BY$, so we can assume that: signals: *A* and *B* are independent of contexts: *X* and *Y* as long as they correspond to the proportion in paradigmatic terms: $AX/BX = AY/BY$, and signals: *A* and *B* are invariant in contexts: *X* and *Y* as long as they satisfy proportions in the syntagmatic plane: $AX/AY = BX/BY$.

It turns out that messages (signals) sent and received by animals remain closely (inextricably) connected to the contexts (objects) in which they appear (to which they refer). For instance, while a person can relate the word *eagle* to various objects, cf. *eagle* as “a specific (one or certain) individual or abstract (set or set) species” and, accordingly, pronounces (about an eagle or eagles) different things (at different times and in different places), the animal will only use the *eagle signal* in the context of a threat from this predator (here and now).³¹ The context of human messages is abstract and unstable, and the context of animal

bees only transmit what is happening “now” and “here,” where the categories “now” and “here” can encompass human hours and kilometers.

³¹ This is somewhat similar to a situation where there are some peculiar (!) expressions of natural language. For instance, a *paremia* (proverb or saying) that is expressed only under precisely defined conditions, cf. the expression *let the cat out of the bag*, which the sender sends to the recipient only when “something (negative) that was hidden has become apparent.” From this point of view, the *paremia* is not independent on the context, but rather closely and constantly correlated with it.

messages is concrete and stable, where the variability and stability of the context are associated with (pre)adaptation and cognitive (pre)disposition, that is, the ability to *mentally travel* through time (past and future) and space (near and far), and with (pre)adaptation and communicative (pre)disposition, namely, the ability to represent a verbal mental journey unique to humans. To summarize, signaling (reference) is rigid (bony) in communication with animals and flexible (elastic) in human communication. Thanks to special linguistic means, cf. qualifier (existential and general) and operator (descriptive and abstract), humans can relate words to various objects in various ways, cf. the phenomenon of *assumption*, for example, material and normal, including personal (in relation to an individual) and universal (in relation to a species).

2.1.3. Biogrammatical discoveries

The main problem of biogrammatology research takes the form of two alternative questions: first, is the *construct* that the *sign* is associated with (only) *linear* or (also) *structural*, and second, is there a *phonotactic* or *syntactic combination* that can be found in the animal world?

There have been many observations and many experiments conducted that shed light on how animals (other than humans) process messages on a biogrammatical level.

Biogrammatology describes complex communication: internal and external, namely, built communicates: monologue, cf. one (transmitting) complex communication separately and in a dialogue mode, cf. a set (transmission and reception) of simple messages, where in a monologically complex communication the second signal changes the first signal, and in a complex dialogue communication, the first signal causes the second signal.³² In the future, the work focuses exclusively on monologically complex communications as the closest grammatical equivalents of combinations in human languages.

The results of the research show the messages that mammals and birds transmit and receive have a certain degree of internal formal complementation.

First, it has been observed that some mammals (tamarins) exchange communications that show some degree of internal complementarity, especially in a situation where two groups meet: one's own and another's. It turned out that in a situation where two groups meet each other, males and females in both groups approach and receive complex messages, a combination of simple

³² An example of dialogically complex communication is the stickleback mating ritual, which consists of several stages (adjacent pairs), parts of which are optional and non-permutable. Cf. First, the male shows the female his lower abdomen. Second, the male zigzags to the nest, and the female (in response) follows him. Third, the male raises his mouth up, and the female (in response) follows the male. Fourth, the male lets the female into the nest, and the female (in response) slips into the nest. Fifth, the male pushes the female with his mouth, and the female (in response) lays eggs. See Niko Tinbergen, *Instinktlehre* (Berlin and Hamburg: P. Parey, 1952).

signals, see the signals: “alarm” and “relaxation,” which appear (separately) in the context of approaching (alarm) and removing (relaxation) a predator. For instance, if the distance that separates both groups is large (perceptually), males and females vocalize the first communication, and if the distance that separates both groups is small (escalating), males and females vocalize the second communication. Both the first and second communication are complex; the first communication is smaller, and the second communication is larger. The first message combines two signals: anxious “emotional tension” and soothing “emotional relaxation.” The first communication is given (separately) by males and females, and: individuals of both sexes give two versions of the first communication, that is, males – the male version and females – the female version. The second communication, in turn, combines two versions of the first communication: male and female. The second communication is sent (jointly) by males and females, while individuals of both sexes transmit one version of the second communication, that is, the male-female version.³³

Second, it has been observed that some mammals (chimpanzees) formulate, on the one hand, a dozen more types of innate than individually learned (long-range) communications that resemble the following: giggling, grunting, gasping, humming, coughing, shouting, squeaking, whining, and barking, and, on the other hand, a dozen or so more individually learned than innate (short-range) messages that affect their body (kinestics) and voice (vocalist), face (facial expressions) and hands (gestures). Communications combine acoustic and optical signals in about half, with a slight predominance of optical signals, resulting in their combinations (no more than 10% of the body, cf. 375 observed messages of pygmy chimpanzees and 383 observed messages of chimpanzees). Moreover, chimpanzees modify signals in such a way that, for instance, the signal repertoire refers to activity (threat and food), and the body of communication refers to the properties (quality and quantity) of activity (threat and food).³⁴

In connection with everything that has been discussed above, it can be assumed that at least some animal species use communication that has a certain degree of internal formal complementation.

2.1.3.1. Linear Combinations: Observations and Interpretations

The results of the research conducted show the messages that mammals and birds transmit and receive have a certain degree of internal linear complementation.

First, observations and experiments were made to establish that the order of notes in syllables, syllables in motifs, and motifs in the songs of certain birds

³³ Joseph Cleveland and Charles T. Snowdon, “The Complex Vocal Repertoire of the Adult Cotton-top Tamarin (*Saguinus oedipus*),” *Zeitschrift für Tierpsychologie* 58 (1982): 231–270.

³⁴ Amy S. Pollick and Frans B. M. de Waal, “Ape Gestures and Language Evolution,” *Proceedings of the National Academy of Sciences of the USA* 104 (2007): 8184–8189.

(brown-headed cowbird) is not random, but predictive and, as such, subject to certain linear restrictions. It turned out that if the male transmits a natural communication: linear-canonical, a female, on receiving the notice, takes up a sexual position (result of observation), and if the experimenter plays the artificial communication: linear-inversive, that is, communication processed by the experimenter for research purposes, a female, after receiving this message, does not take up a sexual pose, and, moreover, does not respond to it (result of experiment).³⁵

Second, observations were made that some birds (tits) approach and receive messages that remain in connection with the contexts of threats (from a predator) and invitations (to a partner), with the male playing the role of the sender and the female playing the role of the recipient. If the sender sends a message (ABC) to the recipient that includes the first (emergency) signal, the recipient looks around the sender, and if the sender sends the recipient a message (D) containing the second (paired) signal, the recipient initiates movement in the direction of the sender. An experiment was conducted that consisted of messages containing alarms and mating signals being recorded and, first, recreated in a natural form: $ABC + D$, and, second, processed in an artificial form: $D + ABC$. It turned out that in the first situation, the recipient responded adequately to the signals, and did not respond to them at all in the second situation. Thus, it was found that there is a linear proportion between the parts of the communication and the context, between the sender's stimuli and the recipient's responses, namely: " ABC " and " D " in the communication stimulus correspond to " ABC " and " D " in the context of a response.³⁶

Hence, we can assume that at least some animal species use a linear grammar that satisfies the concatenation condition: $\sim (AB = BA)$.

2.1.3.2. Idiomatic Combinations: Observations and Interpretations

The results of the study show the messages that mammals and birds transmit and receive have a certain degree of internal idiomatic complementation.

First, observations and experiments have been made showing that some mammals (capuchins) transmit and receive communications that are inherently complex: both linearly (disjunction or signal conjunction), when two signals (A , B) transmitted in a particular context (X) are received as two messages (A and/or B), and idiomatically (signal concatenation), when two signals (A , B) transmitted in a different context (Y) are received as one communication (C). In other words, in one situation, two communication stimuli (" A " and " B ") generate (proportionally) two non-communicative responses (" A " and " B "), and in

³⁵ Laurene Ratcliffe and Ronald Weisman, "Phrase Order Recognition by Brown Headed Cowbirds," *Animal Behaviour* 35 (1987): 1260–1262.

³⁶ Toshitaka N. Suzuki, David Wheatcroft, and Michael Griesser, "Experimental Evidence for Compositional Syntax in Bird Calls," *Nature Communications* 7 (2016): 10986.

another, two communication stimuli (“A” and “B”) generate (disproportionately) one non-communicative response (“C”).³⁷

Second, it has been observed that some mammals (monkeys) transmit and receive messages that either convey a threat from a predator (from the air or from the ground), or a call to roam (in search of food or shelter), where the role of the sender is played by a higher male, and the role of the recipient – a secondary pack. More specifically, it was found the dominant subject transmits acoustic signals (*A*, *B*) that it voices in different contexts (*X*, *Y*), individually or together. In the first case, the communicators belong to an “alien” sphere and send out (on the principle: each signal separately) an alarm caused by the presence of a predator (*genus* and *locus*) that attacks from below (*A*). For instance, a mammal (cat: leopard), or from above (*B*), for example, a bird (eagle: crowned eagle). In the second case, the messages relate to one’s “own” and announce (on the principle: all signals together) movement initiated by the pack (*AB*) in search of food (at an early hour) or sleep (at a late hour). In other words, two identical signals (*A*, *B*) in different contexts (*X*, *Y*) express different content depending on whether they appear in the communications separately (in the context of a threat) or together (in the context of movement), thus: old structures (initially contradicting each other, cf. *AB* “threat from above” ^ “threat from below”) have, thanks to concatenation, new functions (in the second place consistent, cf. with *AB* the “search for food [in the morning]” or the “search for food [in the evening]”) which fully corresponds to what is called an *idiom*.³⁸

Therefore, we can assume that at least some animal species use idiomatic grammar, that is, formally combinational, but not functionally compositional, cf. condition: $AB \neq B \ \& \ "AB" \neq "A" + "B,"$ for example, *white crow* (lexical unit): *white crow* \neq *crow* & “*white crow*” \neq “*white*” + “*crow*,” but non-syntactic grammar, that is, formally combinational and functionally compositional, cf. condition: $AB = B \ \& \ "AB" = "A" + "B,"$ for example, *black crow* (grammatical construction): *black crow* = *crow* & “*black crow*” = “*black*” + “*crow*.”

2.1.3.3. Structural Combinations: Observations and Interpretations

The results of the study suggest that messages sent and received by mammals and birds have a certain degree of structural complexity, where: this complication is more morphotactic than syntactic, which seems important, since the processing of morphotactic combinations describes “finite state grammars” – FSG (with the strength of a weaker “regular grammar” – RG) and the processing of syntactic combinations – PSG – “phrase structure grammar” (with the strength of stronger CFG – “context-free grammars”).

³⁷ John G. Robinson, “Syntactic Structures in the Vocalizations of Wedge-capped Capuchin Monkeys, *Cebus olivaceus*,” *Behaviour* 90 (1984): 46–79.

³⁸ Kate Arnold and Klaus Zuberbühler, “Language Evolution: Semantic Combinations in Primate Calls,” *Nature* 441 (2006): 303.

First, it was found that some mammals (guenons) communicate in such a way that a message, which is a complex combination of simple signals, consists of a root and an affix (suffix), whereby the content of a formally fixed affix changes (generalizes) the content of a formally variable root. The study was conducted in a manner that, first, observations were made, and second, experiments were conducted, for example, researchers (people) presented the subjects (animals) with optical and acoustic stimuli, namely, a mannequin and samples of (non-)predatory (non-)mammals and (non-)birds, and then recorded their reaction. Over the course of the study, a repertoire of several signals was extracted from the body of many messages, including one autonomous signal (acoustically low and constant): [boom] and several heteronomous signals (acoustically high and variable: rise or fall): simple, such as [hok] and [krak], and complex, such as [hok-oo] and [krak-oo]. It turned out that guenons, using simple signals, send and receive complex messages in the context of larger and smaller threats, where: first, large threats are associated with physical factors, such as a falling tree or a falling branch, see [boom], and with biotic factors, such as a threat from an eagle, see [hok], or a threat flying in the air, other than an eagle, see [hok-oo], and a threat from a leopard, see [krak], or a threat running on the ground, other than a leopard, see [krak-oo]; second, less hazards are associated with the presence of other organisms: both non-marmosets and marmosets, that is, separate (contiguous) individuals and multiple (competing) groups. In other words, in messages that signal a greater threat, the affix (suffix) transforms the root (core) so that specific content, for instance, “greater threat from a (non-)predator: from above, from the air, or from below, from the ground,” see message pairs: [hok] and [hok-oo] and [krak] and [krak-oo] where the segments: [hok-] and [krak-] are special kernels, and the segment: [-oo] is a common suffix. It is important to note that the information provided by elements and affixes varies depending on which population and which (sub)species use them, see *krak* “special risk: leopard” (in the Ivory Coast) and *krak* “general risk” (in Sierra Leone), while in different countries, populations and (sub)species, different predators pose a threat: not just eagles (in the Ivory Coast for Campbell’s mona monkeys), and only eagles (in Sierra Leone, for Diana monkeys).³⁹

Second, it was found that some mammals (*Callicebinae*) encode information in their messages about the type (*genus*) of the predator and the direction of its attack (*locus*), where: information about the species is present in a message that consists of a single, and information about the direction – in a message consisting of more than one signal. The study was carried out in the following manner: observations and experiments were conducted, for example, research-

³⁹ Karim Ouattara, Alban Lemasson, and Klaus Zuberbühler, “Campbell’s Monkeys Concatenate Vocalizations into Context-specific Call Sequences,” *Proceedings of the National Academy of Sciences of the United States of America* 106, no. 51 (2009): 22026–22031.

ers (people) presented optical stimuli to subjects (animals), that is, models of predatory mammals and birds, and then recorded their reaction. First, it was observed that mammals (animals) have at least two signals (A , B) united in communications in a combination by which animals report a threat from predators: birds (A) that attack from above, from the air (a threat from the air or a tree), and mammals (B) that attack from below, from the ground (ground threat). Second, an experiment was conducted in which researchers (humans) presented the subjects (animals) with a predator dummy. In a natural situation, a bird dummy was placed in a tree and a mammal dummy on the ground, and in an artificial setting, a bird dummy on the ground and a mammal dummy in a tree. After seeing a (fictitious) bird in a tree and a (fictitious) mammal on the ground in a natural setting, the animals reacted by transmitting the following messages: An (for a bird in a tree) and Bn (for a mammal on the ground). After seeing a (fictitious) bird on the ground and a (fictitious) mammal in a tree in an artificial setting, the animals reacted by transmitting the following messages: AnB – with iteration A (for a bird on the ground) and BnA – with iteration B (for a mammal in a tree).⁴⁰

The observed facts are explained using several competing hypotheses: both quantitative and qualitative, as well as stronger and weaker.

The quantitative (statistical and probabilistic) hypothesis states that the proportion of signals in a message correlates with the severity of the attack, strictly depending on where the victim and the predator, for example, a bird in a tree (An) and a land mammal (Bn), there is a greater threat than a bird on the ground (AnB) and a mammal in a tree (BnA). In this approach, the first component, more numerous (foreground?), signals the predator's *genus*, and the second, less numerous (foreground?) the component is the predator's *locus*.

The qualitative (algebra-logical) hypothesis, in turn, has two versions: a stronger and a weaker one. *The stronger (grammatical) version* of the qualitative hypothesis states that messages sent and received by animals are formal combinations of forms and functional compositions of the signal content: A and B , which are characterized by a certain degree of structural complexity, cf. condition: $\sim (AB \neq A \neq B)$. According to this version, animals encode the *genus* and *locus* of the predator in their messages, where: information about the type of predator in relation to information about the direction of its attack is either higher or lower, cf. hypothetical construction, see: $AB = A \neq B$ or $BA = B \neq A$, or coordinates – compare the paratactic structure: $AB = A = B$ or $BA = B = A$. In the first (hypothetical) approach, the message AnB “threat from a *land-bird*” consists of the main idea A (the bird) and a subordinate one B (land), cf. $AB = A \neq B$, and the communication BnA “threat from a *mammal on a tree*”

⁴⁰ Philippe Schlenker, Emmanuel Chemla, Cristiane Cäsar, Robin Ryder, and Klaus Zuberbühler, “Titi Semantics: Context and Meaning in Titi Monkey Call Sequences,” *Natural Language and Linguistic Theory* 35 (2017): 271–298.

consists of the main idea B (mammal) and a subordinate one A (on a tree), cf. $BA = B \neq A$. Unfortunately, it is difficult to find other convincing facts that support this very strong hypothesis. In the second (paratactic) approach, the communication $A \ n \ B$ “large threat (if) *above* and smaller (if) *on the ground*” consists of the previous A part (large threat (if) *above*) and the subsequent B part (smaller threat (if) *land*); see $AB = A = B$, and the communication BnA “large threat (if) *on the ground* and lesser threat (if) *from above*” consists of the preceding B part (large (if) threat *on land*) and subsequent A part (lesser threat (if) *from above*), cf. $BA = B = A$). We may note that paratactic constructs are within the computational capacity of animals. It has been observed that Kanzi, a linguistically trained bonobo, transmits communications that coordinate combinations of signals (lexigrams), where relationships between communicative signals correspond to relationships between objects in a situation based on conjunction, cf. communications: *grab pat* (“first grab me, then pat me”) and *pat grab* (“first pat me, then grab me”), in which the first part denotes an earlier action and the second denotes a later action. Therefore, it is possible that paratactic structures (coordinations) in the communication of non-human animals may be comparable due to their equal degree of complication. Finally, a weaker (lexical) version of the qualitative hypothesis states that messages sent and received by animals are neither grammatical combinations of forms, nor semantic compositions of the content of the signals A and B . Specifically, in an artificial situation, for example, a bird dummy on the ground and a mammal dummy on a tree, animals that are unable to recognize and/or name the type of threat (decision conflict regarding the choice of a semantically adequate signal: A or B) alternate between signaling a threat from a bird and from a mammal. It is possible that “new situations” for “old signals” act as evolutionary catalysts, as new functions emerge from old structures. The observed conflict may be an artificial simulation of a natural process.

Regardless of which hypothesis, in actuality, best explains the facts, grammatical combinations arise from strong selective pressure on them, cf. first, the advantage of acoustic messages over optical messages (for example, due to the fact that it is easier to hear in the forest than to see), and, second, the advantage of complex messages over simple ones (for example, due to wide variety in the number and types of predators). The combination, first of all, enhances the informational power of the code. In particular, it makes information more abundant and accurate. Moreover, a combination is a grammatical tool, using which mammals and birds, with a small repertoire of semantic signals, form a large number of pragmatic communications. Specifically, the connection between the signal in the code and the signal in the communication is that the signal in the code (for abstract species) refers to a state in context in a rigid manner, and a signal in a message (for a particular person as sender and/or recipient) refers to a state in context in a flexible manner.

Consequently, it is possible to formulate a hypothesis according to which at least some species of animals use a morphotactic grammar (its certain primitive form), that is, something in between phonotactic and syntactic grammars.

2.1.3.4. Iterative Combinations: Linear and Structural

This study's results show that messages that mammals and birds transmit and receive have an iterative-linear (reduplicative) complication, but do not have an iterative-structural (recursive) complication (or, at least, this has not yet been convincingly proven).

Among other things, it has been observed that some birds (tits) transmit and receive messages that are characterized by at least a certain degree of formal complication, and, moreover, the recorded complication of messages has signs of linear iteration. Thus, first, a corpus was formed: several thousand (3,500) communications were recorded, of which several hundred (362) combinations were extracted. Second, the code was restored. It includes vocabulary – several (4) segments, cf. four notes: *A*, *B*, *C*, *D*, and grammar – two patterns, cf. two rules: $A(n)D(n)$ and $B(n)C(n)$, where diagrams define the sequence of segments, including their quality and quantity. Above all, however, rule schemas imply a potentially infinite repetition of the notes in syllables and therefore a potentially infinite amount of information in sequences. The term information refers here to quantity, not quality.⁴¹

Although they have a small number of signals in their repertoire, animals create a large number of messages in the corpus, especially combinations that include at least two signals, and, in particular, sequences that order at least two signals. However, there are critical differences in the combinatorial domains of human and non-human animals. In particular, humans transmit and receive messages that are grammatical (syntactic) combinations and semantic (propositional) compositions, cf. a sentence consists of words, where a sentence refers to the state of affairs and words refer to things, while animals transmit and receive messages that are grammatical (phonotactic and possibly morphotactic, but not syntactic) combinations, but not semantic (propositional) compositions, cf. sounds, where a word refers to the state of affairs, but sounds do not refer to things. However, above all, man is capable of transmitting and receiving a finite number of signals (words and their meanings), which can carry an infinite amount of information (proposals and judgments about them). The communicative, mathematical and psychological basis of infinite operations is *recursion*, or structural iteration (inclusive iteration). It is realized only in the syntactic area (for example, *grandfather (whom – grandfather)...n* and *grandmother (whom – grandmother)n...*; *grandfather knows that (grandmother knows*

⁴¹ Jack P. Hailman, Millicent S. Ficken, and Robert W. Ficken, "The 'chick-a-dee' Call of *Parus atricapillus*: A Recombinant System of Animal Communication Compared with Written English," *Semiotica* 56 (1985): 191–224.

*that grandfather knows...)*n p; grandfather, *who (knows grandmother, who knows grandfather, ...)*n p.

Mathematical and linguistic studies demonstrate that *phonotactic and morphotactic processing* – for example, of sounds in particles and particles in words – requires a grammar that is no weaker or stronger than RG: for example, FSG. Meanwhile *syntactic and transphrastic processing* – for example, words in sentences and sentences in texts – require grammars that are no weaker or stronger than CFG: for example, PSG. Consequently, it is assumed that the critical difference (which outweighs the other factors) in the field of the grammatical combinatorics of humans and animals is (the absence of) the existence of syntax (recursion). Thus, experimental studies seek to strengthen or weaken the hypothesis of the uniqueness of syntax and recursion in human communication. Experimental research is focused on two issues in particular.

The first issue lies in the fact that animals (more precisely, some mammals and birds) process messages that generate: either ordinary grammars (RG), for example, finite state grammars (FSG), which describe linear relationships between predecessors and successors in sequences, or contextual free grammars (CFG), such as the phrase structure grammar (PSG), which describe structural relationships between the principal and subordinate elements in constructions. In other words, the first problem deals with the question of whether the respondent follows linear or structural, phonotactic, or syntactic clues when processing the messages presented by the researcher, that is, whether he takes into account only the perceptual forms and positions (ante- and post-) of segments in the sequence (the local relationships of concrete elements), which are subject to, for example, duplication, or also takes into account understandable functions and the dominance of (hypo- and hyper-) segments in the structure (global relations of abstract classes), which, for example, are subject to recursion.

The second problem lies in the fact that animals (more precisely, some mammals and birds) process messages that contain elements (segments) and their sets (classes), which are subject to the following operations: (only) duplication (linear iteration), see $Z \rightarrow (XY)^n$ or $Z \rightarrow XnYn$, or (also) recursion (structural iteration), see $Z \rightarrow (Z)XY(Z)$ or $Z \rightarrow X(Z)Y$, where both operations generate (for segments A and B), combinations that are, in the first sequence, identical, and in the second sequence, distinct. See, on the one hand, AB and $ABAB$, ... for: $Z \rightarrow (XY)^n$ and $Z \rightarrow (Z)XY(Z)$, and, on the other hand, AB and $AABB$, ... for: $Z \rightarrow XnYn$ and $Z \rightarrow X(Z)Y$?

The research being conducted should provide an answer to the following question: Does the animal extract the schema from the training corpus (*mastery of the grammar*), and does it apply the schema to the test (*grammatical extrapolation*)? In other words, does the animal generalize the pattern? That is, does it transfer the learning pattern (old) to the testing pattern (new) as follows: different segments, like ABA and BAB , CDC and DCD , but an identical pattern,

such as *XYX*, where the schemas must follow the rules of competing formal grammars – FSG and PSG? In order to answer these questions, research is being carried out, which, in terms of methodology, fits into the AGL paradigm.

The AGL (*artificial grammar learning*) paradigm was created to make it possible to diagnose the grammatical (combinational) (pre)dispositions of (non-) speaking beings, including their computational basis, that is, either algebraic-logical constraints or statistical-probabilistic transitions.⁴² In experimental studies carried out in the AGL paradigm, the researcher presents stimuli to the person being studied, where one stimulus correlates with a reward and the other does not. The research records the reactions that the person experiences, depending on what he knows (is able to do) and what he does not know (is unable to do). Experimental studies in the field of zoosemiotics deal, in particular, with the fact that the researcher (person) demonstrates messages to the subject (animal), which contain segments and diagrams. The message is formed in such a way that a diagram, for example, *XYX*, begins the corresponding positions, and the corresponding segment, such as *A* and *B*, ends them, such that some messages, such as *ABA* and *BAB*, are correct (grammatical), while others, such as *AAB* and *BBA*, *ABB* and *BAA*, are incorrect (not grammatical). However, first and foremost, research consists of two stages: training and testing. The researcher presents to the subject, on the one hand (in the training stage), old messages containing old segments and old patterns, and, on the other hand (in the testing stage), new messages containing new segments and old patterns (or vice versa). Messages can include segments in either a random order (no pattern), that is, a non-grammatical order, or in a predictive order (with a template), that is, in a grammatical order and, moreover, one that is compatible with one of the few formal grammars, for example, FSG or PSG. In other words, at the training stage, the researcher teaches the subject, and, at the testing stage, the researcher checks the subject. Specifically, it is checked whether a tested pattern is discovered in the input data (old) and whether the pattern is carried over to the output data (new). It is important that one type of stimulus (message)

⁴² The AGL model was developed on the basis of psycholinguistics as a method to experimentally detect the implicit assimilation of an artificial grammar in laboratory conditions. The research conducted has revealed that respondents (that is, language and speech users who do not receive any instructions from examiners and rely only on their intuition), first, memorize sequences of letters in a predictable order (in a non-random order), which is generated by a certain formal grammar, and, second, they classify correct sequences generated by a particular formal grammar more accurately than incorrect ones (note: “better” and “more accurate” mean, roughly, being above the threshold of a “perfect coin toss”). Research in the AGL paradigm has demonstrated the primacy of the role of long-term procedural memory over declarative memory in the grammatical area of syntactic combinatorics, and confirms the existence of a mechanism for grammatical assimilation. See George A. Miller, “Free Recall of Redundant Strings of Letters,” *Journal of Experimental Psychology* 56, no. 6 (1958): 485–491; Arthur S. Reber, “Implicit Learning of Artificial Grammars,” *Verbal Learning and Verbal Behavior* 5, no. 6 (1967): 855–863.

correlates with a reward (food), while the other does not. For example, any message containing the scheme *XYX* is a rewarded stimulus. We may compare: the messages *ABA* and *BAB* are used at the training stage, while *CDC* and *DCD* are used at the testing stage. If the animal answers correctly, that is, indicates (in some way) a stimulus, which is rewarded in anticipation of a (food) reward, such as drooling or moving towards the food they are expecting, it has found a pattern in the input data (detection) and passed it to the output (generalization). Moreover, the researcher predicts that the subject will not respond to old stimuli (habituation), but will respond to new stimuli (dishabituation) – provided that the subject recognizes and differentiates both of them, of course. Thus, by presenting stimuli and registering reactions, one can learn something about what the subject already knows (is able to do) and what he does not yet know (is unable to do), especially in the grammatical (syntactic) area.⁴³

The AGL paradigm has assumed an important place in research on the potential mental representation of formal grammars in the animal kingdom.⁴⁴ Therefore, the research problem undertaken in the field of zoosemiotics takes the form of a question: What grammar can be found in the brain of humans and animals (and in its many minds): a weaker or stronger one – for example, FSG or PSG?

Formal grammars: FSG and PSG occupy different positions in the *hierarchy of formal languages (grammars and automata)*. FSG, like RG, occupies a lower position, and PSG, like CFG, occupies a higher one. Clearly, this is related to the degree of complexity of their rules with regard to, among other things, their quality and the quantity of symbols used in them.⁴⁵ The research being conducted seeks to establish which rung of this grammatical ladder is occupied by people, and which by animals.⁴⁶ This research fits into the AGL paradigm, especially with regard to the application of the (dis)habituation technique.

The *(dis)habituation* procedure, that is, habituation and dishabituation, is conducted such that, first, habituation to a simpler stimulus (for example, a message generated by FSG) and dishabituation from a more complex stimulus (for example, a message generated by PSG) are carried out. Then, habituation to a more complex stimulus (such as a PSG-generated message) and dishabituation from a simpler stimulus (such as a FSG-generated message) are carried out. In other words, the researcher (dis)habituates the subject. If (dis)habituation is successful in both directions, that means that the researcher has trained

⁴³ Emmanuel M. Pothos, “Theories of Artificial Grammar Learning,” *Psychological Bulletin* 133 (2007): 227–244.

⁴⁴ Murphy A. Robin, Esther Mondragon, and Victoria A. Murphy, “Rule Learning by Rats,” *Science* 319 (2008): 1849–1851.

⁴⁵ John Hopcroft, Rajeev Motwani, and Jeffrey Ullman, *Wprowadzenie do teorii automatów, języków i obliczeń* (Warszawa: Wydawnictwo Naukowe PWN, 2005).

⁴⁶ Noam Chomsky, “Three Models for the Description of Language,” *IRE Transactions on Information Theory* (1956): 113–123.

and tested a subject who recognizes/knows the stimuli: both the simpler and the more difficult one. This study has found that humans differentiate in both directions, while animals differentiate in either one or both ways. For example, on the one hand, mammals (tamarins) that are habituated to the (previously disclosed) messages generated by PSG did not respond to the (later disclosed) messages generated by FSG. On the other hand, birds (starlings) that were accustomed to the (previously disclosed) messages generated by a PSG responded to the (later disclosed) messages generated by an FSG.⁴⁷

How can the results of the experiment be interpreted? The experimental results can be interpreted in two ways: more weakly or more strongly. The weaker hypothesis is that the subject (an animal) processes the messages presented by the researcher (a human) as guided by their cognitive features (related to their cognitive (pre)dispositions, for example, arithmetic ones), cf. duplication as a linear iteration, such as $(A(n)B(n))(n)$. The stronger hypothesis is that the subject (an animal) processes the messages presented by the researcher (a human) as guided by their linguistic characteristics (related to their linguistic (pre)dispositions, for example, grammatical ones), cf. recursion as a structured iteration, such as $C \rightarrow (C)A(C)B(C)$. Here we may remember that the general methodology of science (logic) formulates a postulate called Occam's Razor, which has been interpreted in various ways based on the detailed methodology of science (biosemiotics). For example, Martinelli's Canon postulates that if one hypothesis, a weaker one, does not explain a fact, the stronger hypothesis is accepted, and Morgan's Canon postulates that if two hypotheses, one stronger and one weaker, explain one fact, then the weaker hypothesis is accepted. The results of the research that I have presented and commented are covered by Morgan's Canon, which requires the weaker hypothesis to be accepted. Therefore, it is possible, and we may even state with a high degree of probability, that birds use not grammatical (lingual) strategies, but arithmetic (cognitive) strategies, when processing experimental messages. That is, they count segments (up to several at a time): A and B on both extreme sides of the original sequence AB , cf. $A|B$, $AA|BB$, $AAA|BBB$, $AAAA|BBBB$. The situation is somewhat reminiscent of that with the horse Clever Hans. That is, animals have once again surprised people with their cunning, which allows them to resolve language problems with non-linguistic strategies. Regardless of the results obtained and the interpretations adopted, this research should be continued: first, using pygmy chimpanzees (as the animals most similar to humans) as experimental subjects, and, second, by attempting to show that animals exceed the limit of several repetitions. Until

⁴⁷ Tecumseh W. Fitch and Marc D. Hauser, "Computational Constraints on Syntactic Processing in a Nonhuman Primate," *Science* 303 (2004): 377–380; Timothy Q. Gentner, Kimberly M. Fenn, Daniel Margoliash, and Howard C. Nusbaum, "Recursive Syntactic Pattern Learning by Songbirds," *Nature* 440 (2006): 1204–1207; Michael C. Corballis, "Recursion, Language, and Starlings," *Cognitive Science* 31 (2007): 697–704.

this goal is achieved, we may claim that syntactic recursion is a strong, purely human, and specifically linguistic trait.

The research problem arising in connection with the results of this study concerns the genesis of recursion as a defined phylogenetic (pre)adaptation and an ontogenetic (pre)disposition that is inherent to the natural world. There exist at least two hypotheses that attempt to explain the selection pressure that can lead to the adaptation of cumulative recursion, where the first hypothesis signals the relationship of recursion with the manipulation of objects (tools), and the second suggests the relationship of recursion with the affinity of individuals (kinship). Both of these hypotheses are based on the results of observations and experiments, and confirm the emphatic uniqueness of recursion in syntax and syntax in the language.

First, it has been observed that humans and animals perceive relationships between objects that are generally related to each other. One example is a set of cups – small (*A*), medium (*B*) and large (*C*) – where *A* is contained in *B*, and *B* is contained in *C*. There exist several possible (combinations) of relationships between the three cups of different sizes. Manipulation of the cups allows a larger or smaller number of more or less complex operations to be performed. We may compare the following strategies: strategy1 – from *B* to *C* without *A* (one operation), strategy2 – *B* to *C* and from *A* to *B* (two operations), strategy3 – from *A* to *B* and from *B* to *C* (two operations). The first strategy is used by adult monkeys and human children under 12 months of age, the second strategy is used by children under 24 months of age, and the third strategy is used by children over 24 months of age and adults. The results of this research show that recursive thinking – that is, inclusive iteration (which is potentially infinite) – is a purely human domain.⁴⁸

Second, it has been observed that both humans and animals perceive relationships between humans who are related to each other: ancestors (parents, grandparents) and descendants (child, grandchild). It turns out that only humans are aware of the potentially infinite ladder of existence, cf. affinities as iterations of inclusions, for example, on the one hand, (*grand-*)*n* father and (*grand-*)*n* mother, and, on the other hand, (*grand-*)*n* child and (*grand-*)*n* daughter. In the animal kingdom, the status of a grandparent (the father or mother of someone's father or mother), or of a grandson or granddaughter (the child of someone else's child), does not exist, and there are few other roles (degrees of kinship) like those performed by relatives in human communities.⁴⁹

⁴⁸ Patricia M. Greenfield, "Strategies Used to Combine Seriated Cups by Chimpanzees (*Pan troglodytes*), Bonobos (*Pan paniscus*), and Capuchins (*Cebus apella*)," *Journal of Comparative Psychology* 113 (1999): 137–148.

⁴⁹ Dorothy L. Cheney and Robert M. Seyfarth, *How Monkeys See the World: Inside the Mind of Another Species* (Chicago: University of Chicago Press, 1990); Dorothy L. Cheney and Robert M. Seyfarth, *Baboon Metaphysics* (Chicago: University of Chicago Press, 2007).

It is possible that human and non-human animals transform simple units into complex ones in different ways (in the synthesis and analysis mode). Specifically, animals combine simple units to form complex ones by virtue of the concatenation relation (non-recursive), and people combine simple units to form complex ones by virtue of the dominance relation (recursive).

Thus, it is possible to formulate the hypothesis that no known animal species uses a structurally and syntactically recursive grammar (in any case, no one has yet managed to prove this convincingly).

2.1.4. Bio-diacritical discoveries

The main problem of the study of diacritical marks takes the form of two alternative questions: Is the *substrate* that the *sign* is associated with (only) *segmental* or (also) *prosodic*? Does there exist an *impulsive* or *volitional transmission* that can be found in the animal kingdom?

2.1.4.1. Observations

There have been many observations and many experiments conducted that shed light on how animals (other than humans) process messages on a biodiacritical level.

Let us compare the operations and processes. Transmission (synthesis) and reception (analysis) in human and non-human animals demonstrate that there are structural (anatomical) and functional (physiological) differences between them. Such differences are greater in the range of (more innate) transmission and less in terms of (more learned) perception. Differences come to the fore depending, more or less, on the stage and/or level of processing, cf. cerebral, nervous, and organic. Synthesis and analysis are classes of operations and processes that involve speech circuits (generators and analyzers), the processing of cognitive patterns and impressions, speech pathways (nerves) (motor and sensory), the processing of electrical impulses, speech organs (effectors and receptors), motion processing, and acoustic vibrations.

There are at least several methods used to detect neural circuits involved in the processing of (neuro)motor and (neuro)sensory messages, inter alia, on one (transmitting) side, observing cerebral stimulation and (absence) motor response, or recording the correlation of the corresponding lesions and aphasia, and on the other (receiving) side, observing acoustic stimulation and (in) the presence of a sensory response or recording the correlation of the corresponding lesions and agnosia.⁵⁰

In mammals and birds, (*neuro*)*sensory processing* of acoustic messages is carried out such that animals, like humans, have neural circuits responsible for receiving acoustic stimuli. This involves, first, all sounds (common circuits)

⁵⁰ Charles T. Snowdon, "Language Capacities of Nonhuman Animals," *Yearbook of Physical Anthropology* 33 (1990): 215–243.

and, second, some specific sounds (special chains) – specifically, species-specific voice signals. In this respect, *lateralization of the left hemisphere* and *superior temporal localization* are observed in communication between birds and mammals. It turns out that the left hemisphere (through the right ear) recognizes sounds faster and more correctly than the right hemisphere (through the left ear), and lesions in the left hemisphere are more likely to cause (neuro)sensory dysfunction than lesions in the right hemisphere.

(Neuro)motor processing of acoustic messages in mammals and birds is carried out in such a way that animals, like humans, have neural circuits responsible for the transmission of acoustic stimuli, where: structures and functions correspond to each other in such a way that the hypothalamus is responsible for motivational functions, cerebellum – for control-respiratory functions, cingulate gyrus – for control-resonance functions and (pre)motor cortex – for control-modulating and control-articulatory functions, where: the anterior cingulate gyrus controls vocalization in the non-human animal kingdom and the inferior frontal gyrus – vocalization in the human animal world, so it is assumed that animal vocalization is more impulsive, and human vocalization is more volitional, where: it has been observed that chimpanzee message transmission includes volitional gestures and impulsive vocalizations in addition to the sounds of lips and teeth.

In fact, both hemispheres are more or less equally involved in biodiachritical processing. For example, human left hemisphere processes more precisely (in the analysis and synthesis mode) the segmental features of sounds, see example of a “left hemisphere” opposition: consonant *kura : góra : hura : tura* and vowel *kara : kora : kura*, and human right hemisphere processes more precisely (in analysis and synthesis mode) prosodic features of sounds, cf. example of the “right hemisphere” intonational opposition: *You are coming : Are you coming? : You’re coming!*⁵¹

Transmission

Humans, unlike other animals, have two circuits responsible for transmitting messages, namely, an evolutionarily older circuit that remains under *paleocortical* (*limbic*) control, that is, screaming, including laughter and crying, and an evolutionarily newer circuit that remains under *neocortical* (*frontal*) control, that is, speech. Therefore, people, when speaking, control the movements of organs: respiratory, resonant and articulatory, which makes their vocal behavior more flexible and innovative both on an individual (psycho- and idiolectal) and populational (socio-dialectal) scale compared to the vocal behavior of (other)

⁵¹ Marc D. Hauser, Noam A. Chomsky, and Tecumseh W. Fitch, “The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?” *Science* 298 (2002): 1569–1579; Stephen Pinker and Ray Jackendoff, “The Faculty of Language: What Is Special about It?” *Cognition* 95, no. 2 (2005): 201–236.

animals. Of course, speech developed due to anatomical structures and physiological functions, which, first of all, performed the functions of breathing and swallowing (adaptation), and second, were used for speaking (exaptation).

Phonation, or sound synthesis, includes (at least) three stages: *breathing*, *resonance* and *articulation*, while at each stage, there are some differences between animals: human and non-human; namely, several critical structures were discovered, (un)availability of which determines the functions of human speech.⁵²

First, an animal moves and breathes in such a way that there is synchronization between the breathing rate and movement (inhalation and exhalation are approximately the same length), while a man speaks and breathes in such a way that there is no synchronization between the frequency of breathing and speech (exhalation is much longer than breathing); moreover, speech determines breathing, and its prosodic characteristics are especially active in this respect.⁵³

Second, an animal has a larynx with a different structure and function, namely, the larynx in both mammals and birds in passive state is high and is low if active, while human larynx is located low (lower in comparison with all mammals and birds) both in the passive state (silence) and in the active state (speaking), also humans are born with a high larynx, then, starting from the third month to the third year, the larynx moves down. It is important to note that there are vocal cords in the larynx that are involved in the synthesis of voiced/voiceless sounds.⁵⁴

Third, an animal has a vocal tract in the shape of the Greek letter iota, which means that the entire tongue is in the mouth, while in humans, the vocal tract is in the shape of the Greek letter gamma, which allows the human to regulate the size of the oropharyngeal cavities with the help of the muscles of the hyoid bone and tongue, as a result of which the tongue is fully or partially located in the mouth and pharynx. In addition, the soft palate is involved in the synthesis of nasal sounds, and loss of air sacs present in (other) animal anatomy allows vowel sounds to be synthesized at the expense of the importance of vocalization.⁵⁵

⁵² Terrence Deacon, *The Symbolic Species: The Coevolution of Language and the Brain* (New York: W.W. Norton & Company, 1997); Terrence Deacon, "Language Evolution and Neuromechanismus," in *A Companion to the Cognitive Science*, ed. William Bechtel and George Graham (Oxford: Blackwell, 1998), 2012–2225.

⁵³ Ann M. MacLarnon and Gwen P. Hewitt, "The Evolution of Human Speech: The Role of Enhanced Breathing Control," *American Journal of Physical Anthropology* 109, no. 3 (1999): 341–363.

⁵⁴ Philip Lieberman, "Motor Control, Speech, and the Evolution of Human Language," in *Language Evolution*, ed. Morten H. Christiansen and Simon Kirby (New York: Oxford Scholarship Online, 2003), 255–271.

⁵⁵ Tecumseh Fitch, "The Evolution of Speech: A Comparative Review," *Trends in Cognitive Sciences* 4, no. 7 (2000): 258–267.

It is important to note that auditory transmission has been observed in birds and mammals, namely, a strong relationship (significant correlation) between the communicative activity of the sender and the communicative presence of the recipient. The point is that the sender transmits only if or mainly when the sender knows that the recipient is receiving, otherwise, that is, when the sender knows that the recipient is not receiving or does not know whether the recipient is receiving, the sender does not transmit. It is obvious that the sender communicates with the recipient: arbitrarily or specifically, for example, due to the (non-)presence of some biotic and/or social feature. For example, first, it has been observed that some birds (hens) are more likely to transmit food messages more often when a female (partner) is nearby than when a male (competitor)⁵⁶ is nearby; second, it has been observed that certain mammals (guenons) are more likely and willing to transmit disturbing messages when a blood relative is nearby than when there is a related individual in the proximity.⁵⁷

Auditorium observations can be interpreted in different ways, namely, they can constitute a pre-condition that determines whether animal transmissions are volitional (as a result of a flexible decision) or impulsive (as a result of a rigid reaction). However, it is possible that they fall between the first and the other.

Reception

Human and non-human animals process physical waves (substances) – in terms of psychic sensations (forms) and communication signals (functions) – in terms of their characteristics (compare, on the one hand, the spectrum of sound and, on the other hand, its vibration, intensity and duration). Sound processing in the brain is carried out in such a way that, first, the (*projective*) *primary cortex* bilaterally (separately) analyzes the physical (acoustic) features, that is, more continual values, for example sounds: tones and noises, and, second, the *secondary (associative) cerebral cortex* analyzes (together) language features, that is, more discrete (phonetic) values, including segmental (more left hemispheric) values: consonants (\pm), syllable (\pm) and sonorous (\pm), as well as prosodic (more right hemispheric): high (\pm), loud (\pm), long (\pm). Naturally, each species has a specific set of code features that differentiate between message functions.⁵⁸

There are at least two thresholds of animal auditory processes: first, the (*non-hearing threshold*), and second, the *threshold of (in)acute hearing*, where each threshold has two boundaries – lower and upper, which refer to the species (primary) and individual (secondary). Animals perceive acoustic ($> 20 < 20,000$

⁵⁶ Marcel Gyger and Peter Marler, "Food Calling in the Domestic Fowl, *Gallus gallus*: The Role of External Referents and Deception," *Animal Behaviour* 36 (1988): 358–365.

⁵⁷ Dorothy L. Cheney and Robert M. Seyfarth, "Vervet Monkey Alarm Calls: Manipulation through Shared Information," *Behaviour* 94 (1985): 150–166.

⁵⁸ Stephen Pinker and Paul Bloom, "Natural Language and Natural Selection," *Behavioral and Brain Sciences* 13, no. 4 (1990): 707–784.

Hz), infrasonic (< 20 Hz) and ultrasonic (> 20,000 Hz) messages. Infrasound messages (in the communicative function) are better perceived by non-human animals than by human ones (and more often by larger than smaller, by sea than land animals), while ultrasonic messages (in communication function) are better received by non-human animals – more often by smaller than larger ones and better by terrestrial than marine ones. Second, a man perceives sounds in the range (16) 20–20,000 Hz, including: sounds (speech) in the range (500) 1000–3000 Hz. It is important to note that the auditory ossicles in the middle ear are responsible for the sharp hearing of speech sounds, where the limits are 2,000–4,000 Hz, that is, the range required for acute hearing of sounds, which corresponds to the high hearing acuity of humans and the low hearing acuity of chimpanzees. Therefore, it is assumed that the structure: auditory cortex and its function: acute hearing constitute linguistic adaptation.⁵⁹

2.1.4.2. Interpretations

Anatomical and physiological differences between human and non-human animals result in human synthesizing and analyzing several hundred (motor and sensory) voice samples, cf. (allo)phone(s), that represent from -teen to -ty (motor and sensory) voice types, cf. phoneme(s) (for comparison: chimpanzees do not produce, for example, high vowels and back consonants).

First, animals (human and non-human) send signals in codes in strict dependence on the function (goals) and structures (components) of messages, that is, depending on what (the purpose) is and to whom (component) the signal is sent. It also depends on where and when they emit signals. In other words, the sender adapts the message to the recipient by distributing portions of information and emotions, for example, due to the (un)availability of certain (biotic and/or social) characteristics of the recipient. Second, animals (human and non-human) transmit and receive messages in such a way that they tune to each other, namely, on the one hand, the sender adjusts the physical characteristics of the message for a specific recipient (normalization), on the other hand, the recipient identifies the physical characteristics of the message of a particular sender (discrimination). Third, animals (human and non-human) perceive sounds (segmental and prosodic) in a categorical way, that is, they assign one mental unit, for example, (phone)mic to many physical units, for example, (phone)etic.⁶⁰

Therefore, it can be assumed that the differences in diacritical transmission between humans and non-human animals are associated with the fact that cog-

⁵⁹ Ignacio Martinez et al., “Auditory Capacities in Middle Pleistocene Humans from the Sierra de Atapuerca in Spain,” *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 27 (2004): 9976–9981.

⁶⁰ Bridget Samuels, Marc Hauser, and Cedric Boeckx, “Do Animals Have Universal Grammar? A Case Study in Phonology,” in *The Oxford Handbook of Universal Grammar*, ed. Ian Roberts (Oxford: University Oxford Press, 2011), 1–23.

nitiv (pre)adaptations are older, and behavioral (pre)adaptations are younger. Therefore, for example, non-human animals are better recipients than senders, which means that the representation (the sender's synthesis) is more rigid in the imitative sense, and the interpretation (the recipient's analysis) is more flexible in the creative sense, inter alia, non-human animals do not have some typically human (pre)adaptations, cf. weaker coverage of theory of mind, lower working memory, and especially lower degree of vocalization control.

2.2. (More) Artificial Biocommunication

From the beginning of the 20th to the beginning of the 21st century, a number of individuals, representatives of several species of mammals and birds, namely, non-apes, including dolphins, such as bottlenose *Pho*, and parrots, such as African gray parrot *Alex*, and monkeys, including non-chimpanzees, for example, gorilla *Koko* and orangutan *Chantek*, and chimpanzees including non-common chimpanzees, such as *Kanzi* and *Panbanisha*, and common chimpanzees, such as *Gua* and *Viki*, *Washoe* and *Nim*, *Sarah* and *Lana*, *Austin* and *Sherman*, were taught language and speech under strictly laboratory conditions.⁶¹

Of course, *talking animals* are not limited by just these few representatives. However, research has primarily focused on the *hominid family*, cf. orangutan: Bornean and Sumatran, gorillas: Eastern and Western, mountain and lowland, chimpanzee: common and pygmy. The studies of artificial communication in animals included teaching artificial communication, that is, in English, first, through acoustic (oral) contact, and second, via optical (manual) contact, and: first of all, elderly individuals in the field of sign gestures, and second, younger individuals in terms of symbolic lexes. It is important to note that the changes in the curriculum were the responses of teachers (educators) to the failures (to a greater extent) and successes (to a lesser extent) of their students ('boarders').

⁶¹ Winthrop N. Kellogg and Donald A. Kellogg, *The Ape and the Child: A Study of Environmental Influence Upon Early Behavior* (New York: McGraw-Hill Book Co., 1933); Cathy Hayes, *The Ape in Our House* (New York: Harper & Brothers Publishers, 1951); Duana M. Rumbaugh, *Language Learning by a Chimpanzee: The LANA Project* (New York: Columbia University Press, 1977); Herbert S. Terrace, *Nim: A Chimpanzee Who Learned Sign Language* (New York: Columbia University Press, 1979); Francine G. Patterson and Eugene Linden, *The Education of Koko* (New York: Holt, Rinehart & Winston, 1981); David Premack and Ann J. Premack, *The Mind of an Ape* (New York: Norton, 1983); Sue E. Savage-Rumbaugh, *Ape Language: From Conditioned Response to Symbol* (New York: Oxford University Press, 1986); Allen R. Gardner, Beatrice T. Gardner, and Thomas E. Van Cantfort, *Teaching Sign Language to Chimpanzees* (Albany: State University of New York Press, 1989); Sue T. Parker, Robert W. Mitchell, and Lyn H. Miles, *The Mentality of Gorillas and Orangutans* (Cambridge, 1999); Sue E. Savage-Rumbaugh and Roger Lewin, *Kanzi: The Ape at the Brink of the Human Mind* (Wiley: John Wiley & Sons, 1996).

Studies on communication (pre)adaptations and (pre)dispositions of (non-human) animals were conducted, taking into account their “linguistic abilities” and “speech skills” at four levels: pragmatic, semantic, grammatical, and diacritical. Therefore, training of animals, especially those closest to humans, chimpanzees (first common, then pigmy ones) in the field of linguistic presentation of information and verbal interpretation of intentions went through four successive stages: diacritical (30–40s), for example, Gua and Viki, semantic (60–70s) – Washu and Nim, grammatical (70 and 80s) – Sarah and Lana, and pragmatic (80–90s) – for example, Austin and Sherman, Kanzi and Panbanisha.⁶²

2.2.1. Observations

The study of animal artificial communication has resulted in some interesting observations (facts) and interpretations (hypotheses) that can be summarized in several points, organized into several domains.⁶³

Biopragmatic domain. First, when communicating with humans, animals show communicative-behavioral congruence, that is, there is a correlation between the cognitive (meaning) and behavioral aspects of communication, that is, between what they communicate first, and what they do afterwards. Second, animals transmit and receive messages that perform either at least an expressive function or at most an impressive function, but do not perform a referential (higher) function in the message. In other words, animal messages, directed at humans, are always imperatives, and never declaratives. Third, animal-human communication is largely based on monological messages, and to a lesser extent – on dialogical messages. Fourth, animals do not initiate communication with humans and do not exhibit communicative inventiveness in their relationship with humans, namely, the longer they learn from humans, the more they imitate them.

⁶² Two methods were used in the research: (1) animals were taught grammatical-semantic representations of information (specific to human language); (2) animals were taught pragmatic-diacritical interpretation of intentions (specific to human speech).

⁶³ Allen R. Gardner and Beatrice T. Gardner, “Teaching Sign Language to a Chimpanzee,” *Science* 165 (1969): 664–672; Herbert S. Terrace, Laura Ann Petito, Roger Saunders, and Thomas G. Bever, “Can an Ape Create a Sentence?,” *Science* 206 (1979): 891–902; Francine P. Patterson, “The Gestures of a Gorilla: Language Acquisition in Another Pongid,” *Brain Lang.* 5 (1978): 72–97; Lyn H. Miles, “Apes and Language: The Search for Communicative Competence,” in *Language in Primates: Perspectives and Implications*, ed. Judith De Luce and Hugh T. Wilder (New York: Springer, 1989), 43–61; Patricia M. Greenfield and Sue E. Savage-Rumbaugh, “Imitation, Grammatical Development, and the Invention of Protogrammar by an Ape,” in *Biological and Behavioral Determinants of Language Development*, 235–258; Patricia M. Greenfield and Sue E. Savage-Rumbaugh, “Grammatical Combination in Pan Paniscus: Processes of Learning and Invention in the Evolution and Development of Language,” in *Language and Intelligence in Monkeys and Apes: Comparative Developmental Perspectives*, ed. Sue T. Parker and Kathleen R. Gibson (Cambridge: Cambridge University Press, 1990), 540–578.

Biosemantic domain. First, animals understand the relationship between a word and a thing. Second, they understand the relationship between one word and another word, for example, they can provide verbal equivalence and generalization for a given word. Third, animals learn and use words with a semantic function, namely: static words, names of things and names of their properties, cf. specific and abstract nouns, and dynamic words, names of actions and names of their characteristics, cf. subjective and objective verbs, that is, with an active subject, compare attribute (action) of a subject, or with a passive object, compare attribute (location) of an object, in the main role. Fourth, animals do not learn and use words with grammatical function. Compare, for example, conjunctions (relators), and pragmatics, cf. partitions (modifiers), so the units of language and speech, which are sentences and texts (*par excellence*), are beyond their capabilities. So are the phenomena that are key to human languages: prediction and proposition, as well as metalanguage and metatext.

Biogrammatic domain. First, grammatical combinations are either someone else's imitations (human, including European: English), cf. SVO order, or their own inventions (chimpanzees, including African: Bushmen?), compare OVS order. Second, animal combinations tend to have linear stabilization and iconization. Third, animals construct grammatical combinations, the elements of which are bound by a (non-)recursive concatenation operation rather than a non-recursive dominance operation; ergo: animals do not (trans)form structures: neither obligatory nor optional, namely, they do not build lexical phrases, for example, NP and VP, and functional phrases, for example, IP and CP, nor do they form sentences: first, negative and passive, second, interrogative and imperative. Fourth, grammatical combinations make up no more than a dozen or so per cent of the messages corpus, with combinations usually consisting of two lexemes or two gestures. It is important to note that animals do not use logical functors (although their combinations may appear to resemble paratactic constructions).

2.2.2. Interpretations

The history of research of artificial communication in the hominid family has fewer successes and more failures. They both allow us to hypothesize the boundaries separating communication types between on the one hand, *Homo*, and on the other hand, *Pan*, *Lord*, *Gorilla*, *Pongo*. In the 20th century, there have been attempts to show that (non-human) animals under artificial conditions can master human language and speech within the following limits: *pragmatically cooperative*, *semantically symbolic*, *grammatically syntactical*, *diacritically-volitional*. In the 21st century, attempts have been made to show that (non-human) animals cannot master human language and speech and reach in natural and/or artificial conditions at least *pragmatically competitive*, *semantically indexed*, *grammatically phonotaxic*, *diacritically impulsive* level, and

at most achieving *pragmatically instrumental, semantically iconic, grammatically idiomatic, diacritically auditory* degree. The attempts of the 20th century failed and the attempts of the 21st century were successful for several reasons, where each reason determined the limits (negative for failure and positive for success) of the abilities and skills of animals (non-human), that is, phylogenetic (pre)adaptations and ontogenetic (pre)dispositions: first, communicative, second, cognitive and behavioral. Now the research results support the hypothesis that at best animals reach the *proto-language* and *proto-speech* threshold, but do not achieve the representation of information at the *universal grammar* (UG) level and interpretation of intention at the *theory of mind* (TM) level.⁶⁴

3. Conclusion

The contribution of scientific disciplines to the reflection on the boundaries of language and speech is different, namely, in the field of formal sciences, the a priori problem of *what language cannot be* is considered, and in the field of empirical sciences, a posteriori question of *what language can be* is considered. Moreover, formal linguistics estimates that there is potentially an infinite (uncountable) number of languages (formal codes). On the other hand, empirical linguistics states that there is (and will be) a finite (countable) number of languages (empirical codes). Material linguistics asserts that there are several (-thousand or -hundred and -ty or -teen) ethnic languages (phenotypic codes), while theoretical linguistics assumes that there is one natural language (genotype code) as a generalization of the expansion and abstraction of the intensification of the terms *language* and *speech*.⁶⁵

Therefore, in my opinion, linguistic and speech universals can include, on the one hand, immanent features, that is, features common to (many) ethnic languages compared to each other (from an intra-linguistic perspective), and

⁶⁴ Tomasz Nowak, "Przyczynek do studiów nad biologiczną ewolucją komunikacji. Na tropie pewnej hipotezy," *Zoophilologica. Polish Journal of Animal Studies* 1 (2015): 133–147; Tomasz Nowak, "Czy język mógł powstać samorzutnie? O pewnej koincydencji w ewolucji języka," in *Biological Turn. Idee biologii w humanistyce współczesnej*, ed. Dobrośława Wężowicz-Ziółkowska and Emilia Wieczorkowska (Katowice: Wydawnictwo Uniwersytetu Śląskiego, 2016), 130–145; Tomasz Nowak, "Przetwarzanie języka/mowy w umyśle/mózgu na tle wyników wybranych eksperymentów neurolingwistycznych," *Logopedia Silesiana* 5 (2016b): 54–80; Tomasz Nowak, "W kręgu modeli neurolingwistycznych: wybrane propozycje i wstępne interpretacje," *Logopedia Silesiana* 5 (2016a): 31–53; Tomasz Nowak, "Studia nad filogenezą języka i mowy jako zwierciadło, w którym przeglądamy się nowoczesne koncepcje lingwistyczne," *Teksty z Ulicy. Zeszyt memetyczny* 18 (2017): 81–115.

⁶⁵ Jerzy Pogonowski, "Ile jest języków?," *Investigationes Linguistica* XIV (2016): 1–12.

transcendent features, that is, features specific to (one) natural language compared to the communicative abilities and skills of non-human animals (from an external-linguistic perspective). In this paper, I consciously follow the second of the outlined paths.

3.1. Universals

Biosemiotics, like any other field of knowledge at some stage of its development, seeks generalizations, that is, *universals* – first, local universals common to all individuals of one species, and, second, global universals common to all individuals of each species.

Biosemiotic universals are communicative meanings: *stricte* or *largo* (cognitive and/or behavioral) phylogenetic pre-adaptations and ontogenetic predispositions, active in specific domains: functional, cf. pragmatic interaction and diacritic transmission, and structural, cf. semantic signaling and grammatical combination, that is, abilities and communication skills, common to all specimens of all species, cf. some mammals respond to the alert messages of some birds, and some birds respond to the alert messages of some mammals, for example, guenons can fall prey to eagles and leopards and the yellow-billed hornbill can fall prey of the eagle, but not of the leopard, therefore the hornbill actively reacts to the sounds, on the one hand, of the eagle, and, on the other hand, to the cries of guenons when they see an eagle.

Biolinguistic universals, a subset of biosemiotic universals, are features of every human being (always and everywhere), in contrast to features that neither human has (never and nowhere), whereas the features of every human being (always and everywhere) are the features of only humans or the characteristics of humans, that is, features that partially belong (at the same time) to some non-humans (separately) and to all people as a whole (together) as a result of synergistic and emerging joint evolution.⁶⁶

Biolinguistic universals form the foundation of an abstract *natural language* (in the singular) as a generalization of specific *ethnic languages* (in the plural), and in each case, two values are distinguished (like the obverse and the reverse), that is, *language and speech*. In this article, when using the terms language and speech, I take (and will take) into account only their biological interpretation. In other words, when I ask about the limits of language and speech, I am also asking about their biolinguistic universals.⁶⁷

⁶⁶ Charles F. Hockett, "The Origin of Speech," *Scientific American* 203 (1960): 68–111; Charles F. Hockett, "The Problem of Universals in Language," in *Universals of Language*, ed. Joseph Greenberg (Cambridge: The MIT Press, 1966), 1–29.

⁶⁷ The terms *language* and *speech* have different contents and scopes, depending on the accepted point of view: psychological, sociological or biological, for example, first, *language*

3.2. Boundaries

Biosemiotics penetrates the sign communication of living organisms, assigning itself, on the one hand, semiotic phenomena, for example, pragmatic, semantic, grammatical, diacritic, and, on the other hand, biological phenomena, for example, interaction, signaling, combination, transmission.

The main question that I formulate in my work is the following: Is there a boundary, a demarcating impassable line between the biological and semiotic activity of human and (other) animals? I suggest that in order to find an answer to the question posed we should combine the abilities and biosemiotic skills of human and non-human animals, taking as the basis for the comparison a matrix of intersecting, alternative to each other, biological and semiotic attributes, because the comparison of human and non-human animals in terms of biocommunication abilities and skills, phylogenetic (pre)adaptation and ontogenetic (pre)disposition, necessarily presupposes the existence of a certain comparative base (Latin *tertium comparationis*). Therefore, I propose a theoretical interpretation grid (correlates of signs and areas of phenomena), which will allow, or at least facilitate interpretation of the results of empirical observations:

Biocommunicational correlates

1. Biopragmatic correlate:
 - 1.1. (only) intentional subject
 - 1.2. (also) inferential subject
2. Biosemantic correlate:
 - 2.1. (only) intentional object
 - 2.2. (also) extentional object
3. Biogrammatic correlate:
 - 3.1. (only) linear construct
 - 3.2. (also) structural construct
4. Bioacritical correlate:
 - 4.1. (only) segmental substrate
 - 4.2. (also) prosodic substrate

and *speech* are a mental entity (mental representation), at the individual level, cf. approaches: generative *competence* – *performance* and cognitive *schematization* – *elaboration*, second, *language* and *speech* are a social entity (social institution), at the population level, cf. the approaches: structural *system* – *usus* and communicative *ideation* – *discourse*, third, *language* and *speech* are a biotic entity (life instinct), at the species level, cf. *linguistic abilities* and *speech skills* as (pre) *phylogenetic adaptations* and (pre) *ontogenetic dispositions for the representation of information* (knowledge in a sentence) and the *interpretation of intention* (volition in a text).

Biocommunication domains

1. Biopragmatic domain:
 - 1.1. (only) competitive and (at most) instrumental interaction
 - 1.2. (also) cooperative interaction
2. Biosemantic domain:
 - 2.1. (only) indexable and (at most) iconic signaling
 - 2.2. (also) symbolic signaling
3. Biogrammatic domain:
 - 3.1. (only) phonotactic and (at most) idiomatic combination
 - 3.2. (also) syntactic combination
4. Biodiacritical domain:
 - 4.1. (only) impulsive and (at most) auditorium transmission
 - 4.2. (also) volitional transmission

In my work, I formulate a hypothesis stating that biocommunication abilities and skills of human and non-human animals are separated by a certain distance: both quantitative and qualitative. The research results that I have quoted and commented on, allow us to conclude that there are strong, only human, biocommunication features, and weak, also human, biocommunication features, whereby strong features are present (only!) in human communication, while weak features – (also!) in animal communication.⁶⁸

First, the communicatively strong, only human features are:

1. Biopragmatic features:
 - 1.1. domain: cooperative interaction
 - 1.2. correlate: inferential subject
2. Biosemantic features:
 - 2.1. domain: symbolic signaling
 - 2.2. correlate: extensional object
3. Biogrammatic features:
 - 3.1. domain: syntactic combination
 - 3.2. correlate: structural construct
4. Biodiacritical features:
 - 4.1. domain: volitional transmission
 - 4.2. correlate: prosodic substrate

⁶⁸ Naturally, although human communication seems to be more advanced than non-human communication, this does not mean that older, atavistic structures and functions do not come to the fore in human communication, cf. The meaning of the alternative elements: “only” (for animals other than humans) and “also” (for human animals).

Second, communicationally weak features, also human, are:

1. Biopragmatic features:
 - 1.1. correlate: intentional subject
 - 1.2. domain: interaction:
 - 1.2.1. rivalry (at least)
 - 1.2.2. instrumental (at most)
2. Biosemantic features:
 - 2.1. correlate: intensional object
 - 2.2. domain: signaling:
 - 2.2.1. indexable (at least)
 - 2.2.2. iconic (at most)
3. Biogrammatic features:
 - 3.1. correlate: linear construct
 - 3.2. domain: combination:
 - 3.2.1. phonotactic (at least)
 - 3.2.2. idiomatic (at most)
4. Biodiacritical features:
 - 4.1. correlate: segmental substrate
 - 4.2. domain: transmission
 - 4.2.1. impulsive (at least)
 - 4.2.2. auditorium (at most)

It is important to note that the biological and semiotic abilities and skills of non-human animals are subject to assessment: weak and strong, depending on the place where the observations were made: whether in the natural environment or in the artificial environment, since non-human animals achieve better results in an environment that is artificial for them rather than natural, compare the degree above the minimum in the field of natural communication and the degree below the maximum in the field of artificial communication.⁶⁹

3.3. Conclusion

In the field of biosemiotics, questions are formulated and answers are sought that relate to the extent to which the biocommunication abilities and skills of humans and non-humans are achieved in several of the most important areas.

⁶⁹ The brain of animals (human and non-human) has a high potency, which actualizes to a minor extent: less – in the natural environment (context of passive observation) and more – in the artificial environment (context of active experiment). Therefore, the communicative performance of some animals, especially monkeys, especially hominidae, is ascribed the status of *proto-linguistic* and *proto-speech traits*, or even *quasi-linguistic* and *quasi-speech* features.

To put it mildly, biosemiotics deals with how living organisms orient themselves in the world of human equivalents: texts, sentences, words and sounds, that is, how signs are used, marked, constructed and emitted.

In contrast to the biocommunication of non-human animals, the biocommunication of human animals, is, first, *pragmatically interpersonal, semantically informative, grammatically verbal*, and *diacritically indifferent*, second, in each of its domains, it is *multi-layered* (potentially infinite) and *multi-dimensional* (innovatively innovative),⁷⁰ see:

1. Pragmatically polylogical communication:
 - 1.1. see pragmatic decentration
 - 1.2. cf. metatext and its texts
2. Semantically poly-referential communication:
 - 2.1. see semantic implication
 - 2.2. cf. hyperonym and its hyponyms
3. Grammatically polistratal communication:
 - 3.1. see grammatical recursion
 - 3.2. cf. the functor and its arguments
4. Diacritically polymodal communication:
 - 4.1. see diacritical innovation
 - 4.2. cf. contrast and its components

The biocommunication of human and non-human animals differs as far as finiteness and infinity are different, with differences in (in)finity coming to the fore in every biocommunication domain, which makes a human open to infinity, while others animal species are closed in their two-dimensional and two-level horizon, namely, in the domains of pragmatic decentration, semantic implication, grammatical recursion, and diacritic innovation, where non-human animals reach the second degree at best. To summarize, it can be stated that phylogenetic (pre)adaptations and ontogenetic (pre)dispositions of human and non-human animals are, on the one hand, communicatively-discreet, and, on

⁷⁰ Naturally, the differences in the human and non-human communication are a consequence of differences: genetic, cf. gene: FOX P2, and systematic ones, cf. taxon: HSS vs LCA, anatomical, cf. organ: DP2: BA 44/BA 22, and physiological, cf. process: (E)LAN. I have covered these topics in several other publications, therefore I will not devote more space to them in this study. See Tomasz Nowak, "Przyczynek do studiów nad biologiczną ewolucją komunikacji. Na tropie pewnej hipotezy," *Zoophilologica. Polish Journal of Animal Studies* 1 (2015): 133–147; Tomasz Nowak, "Czy język mógł powstać samorzutnie? O pewnej koincydencji w ewolucji języka," 130–145; Tomasz Nowak, "Przetwarzanie języka/mowy w umyśle/mózgu na tle wyników wybranych eksperymentów neurolingwistycznych," 54–80; Tomasz Nowak, "W kręgu modeli neurolingwistycznych: wybrane propozycje i wstępne interpretacje," 31–53; Tomasz Nowak, "Studia nad filogenezą języka i mowy jako zwierciadło, w którym przeglądamy się nowoczesne koncepcje lingwistyczne," 81–115.

the other hand, cognitively and behaviorally-continual, which leads to significant changes in the point of view of the direction of research, namely, nowadays they are increasingly looking for common features, that is, those that could be points of exit (LCA) and arrival (HSS) in the biotic and cultural (co)evolution of language and speech, in the areas of cognition and behavior, not communication.

Biosemiotics studies the biological and semiotic activity of living organisms; and inevitably the spectrum of issues it deals with is immeasurably vast. As it is impossible to say/write everything about everything, in my work I limited myself to only a few, key issues from the point of view of the goal that I set for myself. However, one thing that interested me most of all is the following: Are there any existing and knowable features (predispositions and pre-adaptation) that make up the border between the biological and semiotic competences of humans and (other) animals? (In my work, I formulate certain theses and look for arguments for them; unfortunately, due to the extensive area of research and the considerable volume of the text, I do not present or analyze counter-arguments, leaving this issue to my opponents or to readers interested in the issue.) I am well aware of the fact that it has not been possible (and probably will not be in the near future) to find a satisfactory answer to the question posed; nevertheless, I have made my own attempt to draw this demarcation line based on the results of (the most recent) empirical observations. At the same time, I think that we live on the (un)known planet. We know very little. So far, we have probably learned a few percent of human languages and an even smaller proportion of animal species languages at most. Therefore, it should be expected that subsequent discoveries will change, perhaps radically, our worldview, not only in the field of biocommunication.

Translated by Dmitry Kozhevnikov

Bibliography

- Arnold, Kate, and Klaus Zuberbühler. "Language Evolution: Semantic Combinations in Primate Calls." *Nature* 441 (2006): 303.
- Axelrod, Robert, and William D. Hamilton. "The Evolution of Cooperation." *Science* 211 (1981): 1390–1396.
- Boysen, Sara T., Gary G. Bernston, Mary B. Hannan, and John T. Cacioppo. "Quantity-based Interference and Symbolic Representations in Chimpanzees (*Pan troglodytes*)." *Journal of Experimental Psychology: Animal Behavior Processes* 22 (1996): 76–86.

- Bräuer, Josep, Josep Call, and Michael Tomasello. "Chimpanzees Really Know What Others Can See in a Competitive Situation." *Animal Cognition* 10, no. 4 (2007): 439–448.
- Bullinger, Anke, Juliane Kaminski, Felizitas Zimmerman, and Michael Tomasello. "Different Social Motives in the Gestural Communication of Chimpanzees and Human Children." *Developmental Science* 14, no. 1 (2001): 58–68.
- Call Josep, Brian Hare, Malinda Carpenter, and Michael Tomasello. "Unwilling versus Unable: Chimpanzees Understanding of Human Intentional Action." *Developmental Science* 7, no. 4 (2004): 488–498.
- Call, Josep, and Michael Tomasello. "Does the Chimpanzee Have a Theory of Mind? 30 Years Later." *Trends in Cognitive Sciences*, 12(5) (2008): 189–192.
- Cheney, Dorothy L., and Robert M. Seyfarth. "Vervet Monkey Alarm Calls: Manipulation through Shared Information." *Behaviour* 94 (1985): 150–166.
- Cheney, Dorothy L., and Robert M. Seyfarth. *How Monkeys See the World: Inside the Mind of Another Species*. Chicago: University of Chicago Press, 1990.
- Cheney, Dorothy L., and Robert M. Seyfarth. *Baboon Metaphysics*. Chicago: University of Chicago Press, 2007.
- Chomsky, Noam. "The Models for the Description of Language." *IRE Transactions on Information Theory* (1956): 113–123.
- Cleveland, Joseph, and Charles T. Snowdon. "The Complex Vocal Repertoire of the Adult Cotton-top Tamarin (*Saguinus oedipus*)." *Zeitschrift für Tierpsychologie* 58 (1982): 231–270.
- Corballis, Michael C. "Recursion, Language, and Starlings." *Cognitive Science* 31 (2007): 697–704.
- Deacon, Terrence. *The Symbolic Species: The Coevolution of Language and the Brain*. New York: W.W. Norton & Company, 1997.
- Deacon, Terrence. "Language Evolution and Neuromechanismus." In *A Companion to the Cognitive Science*, edited by William Bechtel and George Graham, 2012–2225. Oxford: Blackwell, 1998.
- Fitch, Tecumseh. "The Evolution of Speech: A Comparative Review." *Trends in Cognitive Sciences* 4, no. 7 (2000): 258–267.
- Fitch, Tecumseh W., and Marc D. Hauser. "Computational Constraints on Syntactic Processing in a Nonhuman Primate." *Science* 303 (2004): 377–380.
- Frisch, von Karl. *The Dance Language and Orientation of Bees*. Cambridge: Belknap Press, 1967.
- Gardner, Allen R., and Beatrice T. Gardner. "Teaching Sign Language to a Chimpanzee." *Science* 165 (1969): 664–672.
- Gardner, Allen R., Beatrice T. Gardner, and Thomas E. Van Cantfort. *Teaching Sign Language to Chimpanzees*. Albany: State University of New York Press, 1989.
- Gentner, Timothy Q., Kimberly M. Fenn, Daniel Margoliash, and Howard C. Nusbaum. "Recursive Syntactic Pattern Learning by Songbirds." *Nature* 440 (2006): 1204–1207.
- Gouzoules, Harold, and Sarah Gouzoules. "Design Features and Developmental Modification of Pigtail Macaque, *Macaca nemestrina*, Agonistic Screams." *Animal Behaviour* 37 (1989): 383–401.

- Greenfield, Patricia M. "Strategies Used to Combine Seriated Cups by Chimpanzees (*Pan troglodytes*), Bonobos (*Pan paniscus*), and Capuchins (*Cebus apella*)." *Journal of Comparative Psychology* 113 (1999): 137–148.
- Greenfield, Patricia M., and Sue E. Savage-Rumbaugh. "Grammatical Combination in *Pan paniscus*: Processes of Learning and Invention in the Evolution and Development of Language." In *Language and Intelligence in Monkeys and Apes: Comparative Developmental Perspectives*, edited by Sue T. Parker and Kathleen R. Gibson, 540–578. Cambridge: Cambridge University Press, 1990.
- Greenfield, Patricia M., and Sue E. Savage-Rumbaugh. "Imitation, Grammatical Development, and the Invention of Protogrammar by an Ape." In *Biological and Behavioral Determinants of Language Development*, edited by Norman Krasnegor, Duane Rumbaugh, Richard Schiefelbusch, and Michael Studdert-Kennedy, 235–258. Hillsdale: Psychology Press, 1991.
- Grice, Paul H. "Logic and Conversation." In *Speech Acts*, edited by Peter Cole and Jerry L. Morgan, 41–58. London: Brill, 1975.
- Gyger, Marcel, and Peter Marler. "Food Calling in the Domestic Fowl, *Gallus gallus*: The Role of External Referents and Deception." *Animal Behaviour* 36 (1988): 358–365.
- Hailman, Jack P., Millicent S. Ficken, and Robert W. Ficken. "The 'chick-a-dee' Call of *Parus atricapillus*: A Recombinant System of Animal Communication Compared with Written English." *Semiotica* 56 (1985): 191–224.
- Hart, Stephen. *The Language of Animals*. New York: Henry Holt & Co., 1996.
- Hauser, Marc D., Noam A. Chomsky, Tecumseh W. Fitch. "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?" *Science* 298 (2002): 1569–1579.
- Hauser, Marc D., and Richard W. Wrangham. "Manipulation of Food Calls in Captive Chimpanzees." *Folia Primatologica* 48 (1987): 207–210.
- Hayes, Cathy. *The Ape in Our House*. New York: Harper & Brothers Publishers, 1951.
- Hockett, Charles F. "The Origin of Speech." *Scientific American* 203 (1960): 68–111.
- Hockett, Charles F. "The Problem of Universals in Language." In *Universals of Language*, 1–29, edited by Joseph Greenberg. Cambridge: The MIT Press, 1966.
- Hopcroft, John, Rajeev Motwani, and Jeffrey Ullman. *Wprowadzenie do teorii automatów, języków i obliczeń*. Warszawa: Wydawnictwo Naukowe PWN, 2005.
- Kellogg, Winthrop N., and Donald A. Kellogg. *The Ape and the Child: A Study of Environmental Influence Upon Early Behavior*. New York: McGraw-Hill Book Co., 1933.
- Korpikiewicz, Honorata. *Biokomunikacja. Jak zwierzęta porozumiewają się ze światem*. Poznań: Wydawnictwo Naukowe UAM, 2011.
- Krupenye, Christopher, Fumihiro Kano, Satoshi Hirata, Josep Call, and Michael Tomasello. "Great Apes Anticipate That Other Individuals Will Act According to False Beliefs." *Science* 354, no. 6308 (2016): 110–114.
- Kwiatek, Łukasz. *Przemów, a cię ochrzczę. O małpach wychowanych przez człowieka*. Kraków: Copernicus Center Press, 2017.
- Kurcz, Ida. "Communicative Competence and Theory of Mind." *Psychology of Language and Communication*, 8(2) (2004): 5–18.
- Lieberman, Philip. "Motor Control, Speech, and the Evolution of Human Language." In *Language Evolution*, edited by Morten H. Christiansen and Simon Kirby, 255–271. New York: Oxford Scholarship Online, 2003.

- Liszkowski, Ulf, Malinda Carpenter, Tricia Striano, and Michael Tomasello. "12- and 18-month-Olds Point to Provide Information for Others." *Journal of Cognition and Development* 7, no. 2 (2006): 173–187.
- MacLarnon, Ann M., and Gwen P. Hewitt. "The Evolution of Human Speech: The Role of Enhanced Breathing Control." *American Journal of Physical Anthropology* 109, no. 3 (1999): 341–363.
- Marler, Peter, Alfred Dufty, and Roberta Pickert. "Vocal Communication in the Domestic Chicken I: Does a Sender Communicate Information about the Quality of a Food Referent to a Receiver?" *Animal Behaviour* 34 (1986a): 188–194.
- Marler, Peter, Alfred Dufty, and Roberta Pickert. "Vocal Communication in the Domestic Chicken II: Is a Sender Sensitive to the Presence and Nature of a Receiver?" *Animal Behaviour* 34 (1986b): 194–198.
- Marler, Peter. "Animal Communication: Affect or Cognition?" In *Approaches to Emotion*, edited by Klaus R. Scherer and Paul Ekman, 345–365. Hillsdale: Psychology Press, 1984.
- Martinelli, Dario. *A Critical Companion to Zoosemiotics. People, Paths, Ideas*. New York: Springer, 2010.
- Martinez Ignacio, et al. "Auditory Capacities in Middle Pleistocene Humans from the Sierra de Atapuerca in Spain." *Proceedings of the National Academy of Sciences of the United States of America* 101, no. 27 (2004): 9976–9981.
- Michelsen, Axel, Wolfgang H. Kirchner, and Martin Lindauer. "Honeybees Can Be Recruited by a Mechanical Model of Dancing Bee." *Naturwissenschaften* 76 (1989): 277–280.
- Miles, Lyn H. "Apes and Language: The Search for Communicative Competence." In *Language in Primates: Perspectives and Implications*, edited by Judith De Luce and Hugh T. Wilder, 43–61. New York: Springer, 1983.
- Miller, George A. "Free Recall of Redundant Strings of Letters." *Journal of Experimental Psychology* 56, no. 6 (1958): 485–491.
- Mitchell, Robert W., and Nicolas N. Thompson, eds. *Deception: Perspectives on Human and Non-human Deceit*. New York: State University of New York Press, 1986.
- Niederhut, Dillion. "Gesture and the Origin of Language." In *Proceedings of the 10th International Conference (EVLANG 10)*, edited by Christine Cuskley et al., 266–273. Singapore: Evolang 12 Organizing Committee, 2012.
- Nowak, Tomasz. "Przyczynek do studiów nad biologiczną ewolucją komunikacji. Na tropie pewnej hipotezy." *Zoophilologica. Polish Journal of Animal Studies* 1 (2015): 133–147.
- Nowak, Tomasz. "Studia nad filogenezą języka i mowy jako zwierciadło, w którym przeglądamy się nowoczesne koncepcje lingwistyczne." *Teksty z Ulicy. Zeszyt memetyczny* 18 (2017): 81–115.
- Nowak, Tomasz. "Czy język mógł powstać samorzutnie? O pewnej koincydencji w ewolucji języka." In *Biological Turn. Idee biologii w humanistyce współczesnej*, edited by Dobrosława Wężowicz-Ziółkowska and Emilia Wieczorkowska, 130–145. Katowice: Wydawnictwo Uniwersytetu Śląskiego, 2016.
- Nowak, Tomasz. "W kręgu modeli neurolingwistycznych: wybrane propozycje i wstępne interpretacje." *Logopedia Silesiana* 5 (2016a): 31–53.

- Nowak, Tomasz. "Przetwarzanie języka/mowy w umyśle/mózgu na tle wyników wybranych eksperymentów neurolingwistycznych." *Logopedia Silesiana* 5 (2016b): 54–80.
- Nowak, Tomasz. "Małpia gramatyka? Porównanie potencjału kombinatorycznego ludzi i szympansov (studium przypadku)." *Zoophilologica* 3 (2017): 109–127.
- Ouattara, Karim, Alban Lemasson, and Klaus Zuberbühler. "Campbell's Monkeys Concatenate Vocalizations into Context-specific Call Sequences." *Proceedings of the National Academy of Sciences of the United States of America* 106, no. 51 (2009): 22026–22031.
- Parker, Sue T., Robert W. Mitchell, and Lyn H. Miles. *The Mentality of Gorillas and Orangutans*. Cambridge: Cambridge University Press, 1999.
- Patterson, Francine G., and Eugene Linden. *The Education of Koko*. New York: Holt, Rinehart & Winston, 1981.
- Patterson, Francine P. "The Gestures of a Gorilla: Language Acquisition in Another Pongid." *Brain Lang* 5 (1978): 72–97.
- Pfefferle, Dana et al. "Female Barbary Macaque (*Macaca sylvanus*) Copulation Calls Do Not Reveal the Fertile Phase But Influence Mating Outcome." *Proceedings of the Royal Society B: Biological Sciences* 275, no. 1634 (2008): 571–578.
- Pinker, Stephen, and Paul Bloom. "Natural Language and Natural Selection." *Behavioral and Brain Sciences* 13, no. 4 (1990): 707–784.
- Pinker, Stephen, and Ray Jackendoff. "The Faculty of Language: What Is Special about It?" *Cognition* 95, no. 2 (2005): 201–236.
- Pogonowski, Jerzy. "Ile jest języków?" *Investigationes Linguistica* XIV (2016): 1–12.
- Pollick, Amy S., and Frans B. M. de Waal. "Ape Gestures and Language Evolution." *Proceedings of the National Academy of Sciences of the USA* 104 (2017): 8184–8189.
- Pothos, Emmanuel M. "Theories of Artificial Grammar Learning." *Psychological Bulletin* 133 (2007): 227–244.
- Premack, David, and Ann J. Premack. *The Mind of an Ape*. New York: Norton, 1983.
- Ratcliffe, Laurene, and Ronald Weisman. "Phrase Order Recognition by Brown Headed Cowbirds." *Animal Behaviour* 35 (1987): 1260–1262.
- Reber, Arthur S. "Implicit Learning of Artificial Grammars." *Verbal Learning and Verbal Behavior* 5, no. 6 (1967): 855–863.
- Roberts, Gilbert. "Cooperation through Interdependence." *Animal Behaviour* 70 (2005): 901–908.
- Robin, Murphy A., Esther Mondragon, and Victoria A. Murphy. "Rule Learning by Rats." *Science* 319 (2008): 1849–1851.
- Robinson, John G. "Syntactic Structures in the Vocalizations of Wedge-capped Capuchin Monkeys, *Cebus olivaceus*." *Behaviour* 90 (1984): 46–79.
- Rumbaugh, Duana M. *Language Learning by a Chimpanzee: The LANA Project*. New York: Academic Press, 1977.
- Samuels, Bridget, Marc Hauser, and Cedric Boeckx. "Do Animals Have Universal Grammar? A Case Study in Phonology." In *The Oxford Handbook of Universal Grammar*, edited by Ian Roberts, 1–23. Oxford: Oxford University Press, 2011.
- Savage-Rumbaugh, Sue E. *Ape Language: From Conditioned Response to Symbol*. New York: Oxford University Press, 1986.
- Savage-Rumbaugh Sue E., and Roger Lewin. *Kanzi: The Ape at the Brink of the Human Mind*. New York: John Wiley & Sons, 1996.

- Schlenker, Philippe, Emmanuel Chemla, Cristiane Cäsar, Robin Ryder, and Klaus Zuberbühler. "Titi Semantics: Context and Meaning in Titi Monkey Call Sequences." *Natural Language and Linguistic Theory* 35 (2017): 271–298.
- Seyfarth, Robert M., Dorothy L. Cheney, and Peter Marler. "Vervet Monkey Alarm Calls: Semantic Communication in a Free-ranging Primate." *Animal Behaviour* 28 (1980): 1070–1094.
- Slocombe, Katie E., Tanja Kaller, Laurel Turman, Simon W. Townsend, Sarah Papworth, and Klaus Zuberbühler. "Production of Food-associated Calls in Wild Male Chimpanzees is Dependent on the Composition of the Audience." *Behavioral Ecology and Sociobiology* 64, no. 12 (2010): 1959–1966.
- Snowdon, Charles T. "Language Capacities of Nonhuman Animals." *Yearbook of Physical Anthropology* 33 (1990): 215–243.
- Sperber, Dan, and Deirdre Wilson. *Relevance: Communication and Cognition*. Oxford: Basil Blackwell, 1986.
- Struhsaker, Thomas T. "Auditory Communication among Vervet Monkeys (*Cercopithecus aethiops*)." In *Social Communication Among Primates*, edited by Simon Altmann, 281–324. New York: University of Chicago Press, 1967.
- Suzuki, Toshitaka N., David Wheatcroft, and Michael Griesser. "Experimental Evidence for Compositional Syntax in Bird Calls." *Nature Communications* 7 (2016): 10986.
- Terrace, Herbert S. Nim. *A Chimpanzee Who Learned Sign Language*. New York: Columbia University Press, 1979.
- Terrace, Herbert S., Laura Ann Petito, Roger Saunders, Thomas G. Bever. "Can an Ape Create a Sentence?" *Science* 206 (1979): 891–902.
- Tinbergen, Niko. *Instinktlehre*. Berlin und Hamburg: P. Parey, 1952.
- Tomasello, Michael. "Why Don't Apes Point?" In *Roots of Human Sociality*, edited by Norman Enfield and Stephen Levinson, 506–524. New York: Routledge, 2006.
- Tomasello, Michael. *Origins of Human Communication*. Cambridge: The MIT Press, 2008.
- Tomasello, Michael. *Why We Cooperate*. Cambridge: The MIT Press, 2009.
- Townsend Simon W., and Marta B. Manser. "Functionally Referential Communication in Mammals: The Past, Present and the Future." *Ethology* 119 (2013): 1–11.
- Trivers, Robert L. "The Evolution of Reciprocal Altruism." *The Quarterly Review of Biology* 46 (1971): 35–57.
- Wilson, Edward O. *Socjobiologia*. Poznań: Wydawnictwo Zysk i S-ka, 2000.
- Yamamoto, Shinya, Tatyana Humle, and Masayuki Tanaka. "Chimpanzees Help Each Other upon Request." *Public Library of Science* 4, no. 10 (October 2009): 1–7. <https://doi.org/10.1371/journal.pone.0007416>.

Tomasz Nowak – doktor habilitowany nauk humanistycznych w zakresie językoznawstwa, autor prawie 100 publikacji naukowych i dydaktycznych. Przedmiot jego dociekań stanowi gramatyka i semantyka współczesnego języka polskiego, zwłaszcza następujące zagadnienia: formalny opis polszczyzny i eksplikowanie znaczeń wybranych jednostek języka. Szczególną wagę przywiązuje w opisie do kwestii metodologicznych, m.in. na podstawie zgromadzonego materiału językowego testuje różne modele lingwistyczne.

Obecnie jego zainteresowania ogniskują się wokół kognitywistycznych badań nad językiem i mową. Od lat żywo interesuje się zagadnieniami z dziedziny biosemiotyki.

Tomasz Nowak – holds a post-doctoral degree in humanities (linguistics); is author of almost 100 scientific and didactic publications; conducts research on the grammar and semantics of contemporary Polish, and specifically on the formal description of Polish and the explication of the meanings of selected linguistic units; in his descriptions attaches particular importance to methodological issues, for example, tests various linguistic models on the basis of the collected language material; recently his interests have focused on cognitive studies of language and speech; for many years now has been keenly interested in aspects of biosemiotics.