**Evolution of syntax and semantics from psycholinguistic and neurolinguistic perspectives:
a working paper**

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1. INTRODUCTION

In the present paper, I shall provide a narrative review of selected scientific studies and discussions dealing with the evolution of semantics and syntax. The aim of the present paper is not to provide a complete review. The number of studies and discussions on language evolution has exploded recently and the studies stem from various scientific disciplines, impeding my ability to review and understand the entire literature. The focus of this paper will be on psycholinguistic and neurolinguistic literature which has, however, only sporadically tested hypotheses on language evolution. Independently of this obstacle, I shall search in these studies for potential implications for the evolution of semantics and syntax. The aim of this paper is to acquaint Croatian scientists with the topics of the evolution of semantics and syntax and offer them an interdisciplinary view of different approaches and problems which will provide basic information on the topic to the interested reader.

In the second chapter, I shall briefly describe language evolution in the context of contemporary evolutionary sciences and address some studies which putatively show that animals may display both semantic and syntactic behaviors in their communication. In the third chapter, I shall introduce psycholinguistic and neurolinguistic studies which suggest that semantics and syntax are embodied in perceptuo-motor system. In the fourth chapter, I shall portray the protolanguage model of language evolution and the accompanying theory of language fossils.

2. EPISTEMOLOGY AND SOME FUNDAMENTAL ASSUMPTIONS IN LANGUAGE EVOLUTION

2.1. Language evolution and human evolution

Evolution of semantics and evolution of syntax are objects of research within language evolution¹, i.e., in the broad sense, evolution of human cognition. Evolution of language and evolution of human cognition can be understood as topics within human evolution. Due to many unanswered questions, human evolution remains a controversial topic in the scientific realm, with different scientists not seldomly fiercely criticizing and attacking each other: “It would appear that the modern-human-origins debate is not for the faint of heart.” (Lindly & Clark 1990: 251). Theories of human evolution have been criticized outside of the scientific realm as well, perhaps most notably by advocates of creationism. However, the main assumption of creationism appears circular: humans did not evolve but were created by a deity because there is no doubt that humans were created by a deity² (cf. Wyn Davies 2001³: 38ff.).

Language evolution is a highly interdisciplinary area and isolated findings from individual scientific disciplines cannot answer key questions in language evolution: “This is an interdisciplinary game, played by biologists, neurologists, anthropologists, archaeologists, computer scientists, philosophers, and more—as well as, or maybe I should say a good deal more than, by linguists.” (Bickerton 2007: 510). As Bickerton suggests, it can be observed that linguists have only modestly been involved in debates on language evolution. Linguistic research which would test hypotheses on language evolution is found few and far between, with, on the other hand, a relatively larger proportion of theoretical and/or introspective discussions. Because language is believed to represent a human-specific feature (Everett 2016: 7–8; Faust 2012: xxvi;

¹ Some also use the term *evolutionary linguistics* (e.g., Fujita 2009; Gong & Shuai 2013; McMahon & McMahon 2013). However, Croft (2008) uses that term in the meaning of applying models of evolutionary biology in the research of language change. Terminology in both linguistics and cognitive science in general is heterogeneous, but terminology is not the topic of this paper and I shall thus aim to avoid terminological discussions.

² In 2018, the American actress and model Megan Fox also participated in the criticism of archaeology and similar disciplines, allegedly accusing archaeologists of “narrow-mindedness” and “only giv[ing] us a one-sided view of the truth”, announcing thus her then new documentary series which was to “delve into some of the greatest mysteries of time, including whether Amazon women really existed or if the Trojan War was real” (Megan Fox thinks archaeologists are too narrow minded to understand history, 2018).

³ For the original in English, see Wyn Davies (2000).

Levelt 2018: 128; Pagel 2017: 5), the question of language and speech origins has been a longstanding one in human evolution research. So, it does not wonder that a large part of empirical research on language evolution has been conducted by palaeoanthropologists and archaeologists. However, the proposed implications of this research for language evolution are mostly speculative and not seldomly linguistically controversial. For example, Henshillwood et al. (2004) and d’Errico et al. (2005)⁴ describe the findings of perforated *Nassarius kraussianus* shells from the sites Blombos and Die Kelders in the South African Republic dated to ~75 000 BP. Based on archaeological analyses, the authors conclude that these findings were likely perforated by human hands and used as beads of a necklace-like object. The authors then claim that this assumption is “evidence for symbolic behaviour”. Following the logic of the authors, because these objects were “symbolic” (what ever that may mean⁵), the population using these objects had a “fully syntactical language”: „Since syntactical language is the only means of communication bearing a built-in meta-language that permits creation and transmission of other symbolic codes (Aiello 1998), beadwork represents a reliable proxy for the acquisition of language and fully modern cognitive abilities by southern African populations 75,000 years ago.” (d’Errico et al. 2005: 19–20). It is beyond the scope of the present paper to comment on conclusions of this type, but see Botha (2009) for fierce (and justified) criticism. Everett (2016: 8–9) brings forward a convincing thought experiment questioning our ability to infer the presence of modern language in a given population based on their material culture:

What if all eighty remaining speakers of Banawá died out suddenly and their bones were discovered only 100,000 years hence? Forgetting for now the fact that linguists have published grammars, dictionaries and other studies of the Banawá language, would their material culture leave any evidence that they were capable of language and symbolic reasoning? Arguably it would leave even less evidence of language than has been found for neanderthalensis or erectus. Banawá art [...] and their tools [...] are biodegradable. So their material culture would disappear without a trace in much less than the 800,000 to 1,500,000 years that have passed since the appearance of the earliest cultures. [...] It is known that current populations of Amazonians have fully developed human languages and rich cultures, so care must be taken not to conclude prematurely that the absence of evidence about language or culture in the prehistoric record indicates that ancient human populations lacked these essential cognitive attributes.

⁴ The same duo of first authors recapitulated this hypothesis in a hefty number of other published papers.

⁵ Cf. “Neandertals show cultural innovations such as burials, pigment use and, at a later stage, personal ornaments suggesting their ability to create symbolic cultures.” (d’Errico et al. 2005: 20).

2.2. Language evolution and genetics

Key discoveries about language evolution should come from genetic research since evolutionary mechanisms act on genes, i.e., the genotype: “[M]utation and selection take place in the genotype.” (McMahon & McMahon 2013: 10). Hence, the origins and evolution of language should be associated with specific mutations on specific genes or gene groups. However, genetic research of language functions remains scarce (Konopka & Roberts 2016b: 1272; Newbury & Monaco 2010: 316). Furthermore, previous research has mostly focused on the relationship between individual mutations on individual genes and developmental language disorders, and have thus far failed to offer a clear picture of the relationship between genetics and language:

Genetic analysis of specific language disorders is of major interest for both clinical research and linguistic theory. However, the results of this analysis almost always do not show any univocal and compulsory relationships between particular gene mutations and particular disorders or a casual link between the genotype and the phenotype. (Benítez-Burraco 2012: 225)

Recently, many authors have emphasized the role of the so-called cumulative culture in language evolution. Cumulative culture stands for cultural features, i.e., technological products, skills, and knowledge which cannot emerge during the lifetime of a single individual, but are a result of successive accumulation of changes through generations of individuals and groups (Reindl & Tennie 2018: 1). In general words, the concept of cumulative culture implies that cultural phenomena act similar to the structures of living beings, i.e., they evolve. In this context, culture and social learning are understood as factors which change a population’s ecological niche which then demands new adaptations of cognitive features (Lotem et al. 2017). Since cultural factors likely played an important role in language evolution, language evolution might have been a case of gene-culture co-evolution⁶. Everett (2016), on the other hand, finds that genetics cannot help

⁶ This is the manner in which mutations which in combination with specific cultural factors enabled the functioning of the lactase enzyme in human adults, i.e., enabled relatively painless drinking of milk (Curry 2013). Gene-culture co-evolution phenomena have been described in non-human animals as well: “[E]vidence suggests strongly that animal culture plays an important evolutionary role, and we encourage explicit analyses of gene–culture coevolution in nature.” (Whitehead et al. 2019: 1).

much in unveiling the secrets of language evolution and is specifically sceptical of the putative role of mutations in language evolution:

Could the entry of complex sentences⁷ into human language have been a mutation, spreading via the Baldwin effect or some other mechanism, such as sexual selection? This is unlikely. Language presents a different case than genes for physical skills. (Everett 2016: 31)

[M]utations for language are superfluous because language evolution can be explained without them. [...] In fact, the idea of language as a mutation simply offers no insights at all that help to understand the evolution of language. That is to say that language evolution can be explained without mutations, based instead on gradual, uniformitarianist assumptions, rendering superfluous proposals of language-specific genes or language-specific mutations. [...] Even if language ability were a mutation, it could only have produced an ability to learn language at a time when, ironically, there was no language. (Everett 2016: 70–71)

As already stated above, evolution of language (and any other feature for that matter) begins with mutations: „First, there is mutation. [...] Without mutation, there could be no evolution”⁸ (McMahon & McMahon 2013: 8). Rejection or neglect of mutations’ role in language evolution seems thus highly problematic. Furthermore, genetics and palaeogenetics in combination with palaeoanthropology and archaeology likely have the best chances among the scientific disciplines to decipher in which hominins, when, and where language, i.e., some kind of a productive symbolic system, originated. It must be, however, noted that when writing about genetics Everett (2016) mostly refers to the Universal Grammar theory and other variations of Chomskyan linguistics. Chomsky (2002), briefly, assumes that an individual mutation on an individual gene led to the emergence of language, i.e., syntax, i.e., recursion. Such assumptions are biologically nonsensical: „[T]he original mutation will typically have had only a small effect, and that subsequent development of the trait in question will have to wait for further relevant mutations to arise.” (McMahon & McMahon 2013: 9); „[S]ince genes operate in vast interacting networks affected by both each other and the environment, the concept of ‘the gene for ...’ is at best oversimplified and at worst fundamentally flawed.” (McMahon & McMahon 2013: 178).

⁷ It is not clear to me why Everett writes of “complex sentences” here and “language” in other places. Everett’s view of language is not syntactocentric, so I assume Everett is discussing language independently of its components here. Besides, it is unclear what kind of sentences are “complex sentences”.

⁸ “However, although mutation necessarily comes first, it is only an enabling step in the evolutionary story that follows.” (McMahon & McMahon 2013: 8).

Everett (2016: xvii) advocates “cultural” origins of language: “Language gradually emerged from a culture, formed by people who communicated one another via human brains. *Language is the handmaiden of culture.*”⁹ However, Everett (2016) does not clearly define the term *culture*, while other animals display variations between populations which can be interpreted as “cultural” differences. Describing culture in wild common chimpanzees (*Pan troglodytes*), Whiten et al. (1999: 682) write:

As an increasing number of field studies of chimpanzees (*Pan troglodytes*) have achieved long-term status across Africa, differences in the behavioural repertoires described have become apparent that suggest there is significant cultural variation. [...] We find that 39 different behaviour patterns, including tool usage, grooming and courtship behaviours, are customary or habitual in some communities but are absent in others where ecological explanations have been discounted. Among mammalian and avian species, cultural variation has previously been identified only for single behaviour patterns, such as the local dialects of song-birds. The extensive, multiple variations now documented for chimpanzees are thus without parallel. Moreover, the combined repertoire of these behaviour patterns in each chimpanzee community is itself highly distinctive, a phenomenon characteristic of human cultures but previously unrecognised in non- human species.

2.3. Exaptation as a language evolution model

A longstanding question in linguistics has been whether language can be understood as a modular cognitive domain independent of other cognitive domains (Chomsky 1976) or if language should be understood as a system which shares its mechanisms with other cognitive domains. If we assume the latter, the potential implication for language evolution is that language and its neural substrate phylogenetically developed, i.e., “exapted” from pre-existing brain structures and cognitive functions. In evolutionary biology, exaptation denotes a process of structure and/or function emergence from pre-existing structures and/or functions (Gould & Vrba 1982)¹⁰. For example, studies suggest that exaptation had a crucial role in the evolution of parts

⁹ Emphasized in the original.

¹⁰ Gould & Vrba (1982) actually focus on physical structures not including the brain and cognitive domains, and further note that the pre-existing structures from which other structures (or new functions) are developed are non-adaptable in the “pre-exaptation” stage. However, the non-adaptability of the pre-existing structures is not a criterium systematically used in exaptation descriptions in evolutionary biology, while in theorizing about the

of the human muscular system enabling bipedality, tool use, and vocal and facial communication:

Each and every muscle that has been long accepted to be “uniquely human” and to provide “crucial singular functional adaptations” for our bipedalism, tool use and/or vocal/facial communication, is actually present as an intra-specific variant or even as normal phenotype in bonobos and/or other apes. (Diogo 2018: 1)

In the context of language evolution, it is believed that language exapted from pre-existing cognitive domains which, above all, include perceptuo-motor processing (Pulvermüller 2018), different components of working memory (Fedorenko et al. 2006), and declarative and procedural memory (Hamrick et al. 2018):

More recently, increasing attention has been paid to the possibility that language is “domain-general”, that is, that aspects of language rely on substrates with more general functions that may predate the emergence of this domain, such as categorization, associative learning, working memory, or learning and memory. Indeed, it has been argued that because the reuse of preexisting mechanisms for new functions is expected under biological and evolutionary principles, one should expect domain-general mechanisms for language. (Hamrick et al. 2018: 1487)

For example, the capacity for sequential and hierarchical processing of goal-directed actions, in the broad sense also associated with visuospatial processing and executive functioning, could have served for the development of some aspects of semantics and syntax (Kemmerer 2012), but also discourse pragmatics¹¹ (Adornetti 2014). A possible evolutionary context for this might have been the emergence and maintenance of stone-tool-related behaviors (Gabrić et al. 2018; Lotem et al. 2017; Ruck 2014). Exaptation theories of language evolution are numerous and most of them are focused on some specific phenomena, be they specific cognitive domains, specific human evolutionary scenarios, etc.:

[A] particularly fruitful way to account for the origin of language is to analyze the systems and cognitive skills involved in its actual functioning. We suggested that a key role in the advent of human language

evolution of language and cognition, there would be no sense to assume the pre-existing structures and/or functions were non-adaptable.

¹¹ Some readers might object that discourse pragmatics is actually syntax. Be that as it may, differences between syntax and discourse pragmatics can already be observed in the lateralization patterns: while syntactic functions are typical left-lateralized, discourse functions appear to be much more associated with right-hemisphere processing (Mildner 2015: 209–212).

was played by the executive functions involved in the processing of a specific pragmatic property: discourse coherence. Through the results from cognitive archeology, we showed that these systems have evolved in the course of human phylogeny in the context of the making of stone tools and the operations requested to produce these tools overlapping with those requested to process coherence. On the basis of these considerations, we have hypothesized that our ancestors developed forms of proto-discursive communication governed by a principle of coherence. (Adornetti 2014: 235)¹²

The mirror system hypothesis suggests that evolution expanded a basic mirror system for grasping, in concert with other brain regions first to support simple imitation (shared with the common ancestor of humans and great apes) and thence to complex imitation (unique to the hominin line), which includes overimitation, the apparent drawbacks of which are in fact essential to human skill transmission. These advances in praxis supported the emergence of pantomime and thence protosign and protospeech. (Arbib 2011: 257)¹³

Not, of course, that such evolved [brain] structures need necessarily be completely specialised for language: it goes without saying that we use elements of the vocal tract for non-linguistic functions (most obviously breathing), and language may well also involve more generally applicable cognitive systems. We are simply suggesting at this stage that there may be physical and neurological structures which have a partial specialisation for language, perhaps among other things. Looking at this from an evolutionary viewpoint, the development of a capacity to analyse patterns might initially have been beneficial in hunting or predicting the availability of water in different places at different seasons; but it might subsequently have facilitated aspects of language and therefore have been co-opted for these purposes too. (McMahon & McMahon 2013: 24)

Not looking specifically at semantics and syntax, there is an abundance of arguments for exaptation theories of language evolution from experimental studies which suggest functional associations between language and other cognitive functions. For example, a number of studies have observed the decisive role of perceptuo-motor brain areas in different aspects of speech and language functioning. It is clear that motor areas are involved in speech production via, among others, activation of motor plans and muscle articulators, and movement coordination:

¹² See also Adornetti et al. (2018); Ferretti et al. (2018).

¹³ Arbib has become known through his theory of the role of mirror neurons in language evolution (see also Arbib 2005; 2006; 2012; 2015; 2016a; 2016b; 2017). See also Kemmerer (2015). For criticisms of the role of mirror neurons in language evolution see Hickok (2014), Hurford (2004). For a review of early studies of mirror neurons on macaques and humans, as well as their importance in action understanding see Rizzolatti & Craighero (2004).

Actions are planned on the basis of available perceptual data, experience and goals, with the help of the cerebellum and basal ganglia. Tertiary areas are responsible for very complex movements (e.g., speech) and they control primary and secondary motor areas. Secondary areas control and coordinate several muscle groups. The commands are relayed to lower levels until they reach the neurons in the primary motor cortex (Brodmann's area 4) that will activate individual muscles or small muscle groups in order to fulfill the set goal—executing the desired movement. The execution is controlled by motor neurons in the brainstem and the spinal cord by means of commands that reach effector organs, that is, muscles. (Mildner 2015: 30)

What is more, many have proposed that speech reception also depends on activity in the perceptuo-motor areas, yet theories on this topic are numerous and experts' opinions are divided. One influential theory has been the motor theory of speech perception (Liberman et al. 1967; Liberman & Mattingly 1985; cf. Skipper et al. 2017) which in its essence proposes that the brain analyzes the form of incoming speech by “translating” the segments of the verbal stimulus into motor instructions needed for the production of the same speech segments:

Cortical stimulation studies have revealed that the mouth and face muscles are represented at the points that are responsible for phoneme identification. This supports the motor theory of speech perception—one of the best known and most extensively discussed theories of speech perception (Liberman [et al.] 1967) according to which speech is perceived by means of movements necessary to produce the heard sounds, not by means of the sounds themselves. (Mildner 2015: 34–35)¹⁴

Furthermore, research has yielded correlations between motor immaturity and specific language impairment (Bishop 2001). While it appears that there is a considerable genetic overlap between the two syndromes, it would appear that this association is the strongest in speech production quality. Perceptuo-motor areas are also involved in other language functions (other than speech). As I will aim to show in the next chapter, it is believed that the brain areas involved in action processing contain crucial information for semantic processing which is why they can be understood as part of the wider semantic brain network. These same areas, it would appear, display a marked role in syntactic processing as well, at least from the perspective of syntactical transitive coding.

¹⁴ See also Mildner (2015: 93–94) for a short review of arguments for and against the motor theory of speech perception.

As I have already hinted, mechanisms of other cognitive systems apart from perceptuo-motor processing are crucial for language functioning as well. De Beni et al. (2005) investigated the role of verbal and visuospatial working memory on the reception of “spatial” and “non-spatial” verbal auditory stimuli. Subjects actively listened to two texts, one with instructions for arriving at a specific destination and the other describing wine production. During listening, subjects performed on one of two concurrent tasks designed to increase the demands for either verbal (articulatory suppression) or spatial working memory (spatial tapping). Performing on the concurrent task of articulatory suppression resulted in worse reception of both types of texts, while concurrent performing on spatial tapping resulted in worse reception of only the spatial text:

Results support the hypothesis that verbal and spatial components of working memory are differentially involved in the comprehension and memory of spatial and nonspatial texts, with a selective interference effect of the spatial concurrent task on both the spatial and nonspatial texts. These effects emerged for recall, sentence verification, and response times. Our findings confirm previous results showing that the verbal component of working memory is involved in the process of text comprehension and memory. In addition, they show that visuospatial working memory is involved, in so far as the text conveys visuospatial information. (De Beni et al. 2005: 77)

Van Beilen et al. (2004) reported positive correlations between performance on semantic fluency (naming as many animals in 60 seconds) and the aggregate result on an executive functioning test battery (Wisconsin Card Sorting Test, Trail Making Test, and Stroop Color Word Test)¹⁵¹⁶¹⁷. Hamrick et al. (2018) conducted a meta-analysis of studies investigating the associations between declarative and procedural memory, and first language grammar acquisition and second language grammar learning. They found that first language grammar acquisition correlated with procedural memory, while second language grammar learning correlated with declarative memory in low-experience subjects and with procedural memory in high-experience subjects: “The findings yielded large effect sizes and held consistently across languages, language

¹⁵ In the same study these correlations were not significant in the group of patients with schizophrenia, schizophreniform disorder, or schizoaffective disorder.

¹⁶ Cf. Rinaldi et al. (2013) who found in healthy subjects only significant correlations with letter fluency, while in the patients with schizophrenia the correlations were significant for both semantic and letter fluencies. Still, the two studies used different test batteries for assessing executive functioning.

¹⁷ See Botting et al. (2017) for the relationship between language and executive functioning from a developmental perspective. See Thoma et al. (2009) for the relationship between proverb perception and executive functioning in patients with schizophrenia or alcoholism.

families, linguistic structures, and tasks, underscoring their reliability and validity.” (Hamrick et al. 2018: 1487). Ruiz et al. (2018) replicated these results by demonstrating a similar relationship between declarative memory and artificial language grammar learning. These studies show that language acquisition and learning depend on mechanisms of declarative and procedural memory which is contrary to modular language models and specifically those models which assume an independent module for language acquisition.

Be that as it may, these discussions and studies do not (necessarily) indicate that language evolutionarily emerged via exaptation. In the next chapter, however, I will come out with some arguments which will suggest that language likely evolutionarily emerged via exaptation from general frontotemporoparietal functions.

Hauser et al. (2002) propose in their introspective discussion on language evolution the fundamental difference between the *faculty of language in the broad sense* (FLB) and *faculty of language in the narrow sense* (FLN): „FLB includes a sensory-motor system, a conceptual-intentional system, and the computational mechanisms for recursion, providing the capacity to generate an infinite range of expressions from a finite set of elements. We hypothesize that FLN only includes recursion and is the only uniquely human component of the faculty of language.” (Hauser et al. 2002: 1569). The description of FLB is in line with the exaptation model of language evolution which would according to the authors include, approximately, perceptuo-motor processing, semantic memory, and executive functioning. The authors further suggest that FLN, under which they mean recursion, potentially firstly evolutionarily emerged for the needs of “number, navigation, and social relations” and was subsequently reused for the needs of communication, i.e., language. Thus, FLN is also described in line with the exaptation model or at least the exaptation model is considered as a valid possibility. In any case and with no disrespect, it is difficult to comment on the paper by Hauser, Chomsky, and Fitch. Firstly, the assumptions are highly introspective and not clearly founded on data from experiments or nature. Secondly, it is not clear why they propose recursion to be “the only uniquely human component of the faculty of language”. Thirdly, recursion is never defined in the paper (!): „It is regrettable that any intellectual battle should be fought over loosely defined terms.” (Hurford 2012: 390). Enigmatically, in the conclusion of their paper, Hauser et al. (2002: 1578) criticize “linguists, biologists, psychologists, and anthropologists” for “unproductive

theoretical debate[s]” on language evolution. Hauser et al. (2002) have not been spared from fierce criticisms, but not all are ready to criticize: „[Hauser et al.] (2002) is an ambitious paper, written by a well-known and interdisciplinary team of authors, and published in a very prominent scientific journal.” (McMahon & McMahon 2013: 199). Hauser et al. (2002) are often cited as advocating a nativist, modular model of language evolution¹⁸: „Recursion, often undefined except in the loosest of senses, has been seen by some as a symbolic last-ditch stand for a domain-specific innatist view of human uniqueness. This is how Hauser et al. (2002) have been interpreted, and indeed possibly how their paper was intended.” (Hurford et al. 2012). Based on what I have written above and not taking into consideration the history of the authors, I do not see much reason why their paper should be described as such or why their assumptions would be generalized in such a way, especially since the authors find it possible that recursion is extant as a modular component in non-human animals, but that in humans it somehow functionally linked to other cognitive components:

One possibility, consistent with current thinking in the cognitive sciences, is that recursion in animals represents a modular system designed for a particular function (e.g., navigation) and impenetrable with respect to other systems. During evolution, the modular and highly domain-specific system of recursion may have become penetrable and domain-general. This opened the way for humans, perhaps uniquely, to apply the power of recursion to other problems. (Hauser et al. 2002: 1578)

If Hauser et al. (2002) really had a strictly modular model of language evolution in mind when writing their paper, I must have gravely misunderstood them.

2.4. Continuity as a language evolution model

Another hot debate in language evolution has revolved around the question of whether language is an “upgraded” form of communication that was present in extinct hominins (the ones which did not have language, which ever they may be) and potentially extinct non-human primates, and

¹⁸ Matasović (2012: 60) also includes the paper by Hauser et al. as representing the so-called separatist theories which correspond to modular theories: “Separative theories emphasize that language ability differs from all other human cognitive abilities and that there is no reason to believe that language emerged with the other abilities or as a consequence of their phylogenesis.” (Matasović 2012: 58).

is today present in living non-human primates and potentially other animal taxa¹⁹; or is language so much different from animal communication that we cannot say that there is any parallel between language evolution and animal communication. As I have cited Lindly & Clark (1990) at the beginning of the paper who suggested that human evolution is not for the faint of heart, it would appear that the continuity and discontinuity discussion is not for linguists with a faint heart. Due to the strong Cartesian (and similar) heritage in the humanities (including linguistics), it has long been strictly believed that there are fundamental differences in cognition²⁰ between humans and non-human animals. Indeed, continuity is not seldomly rejected by linguists²¹:

Much of the resistance to attributing concepts to animals comes from philosophers and other scholars in the humanities. Until quite recently, the detailed workings of the brain have been terra incognita, and introspection by humans about their own mental activity was the main source of theorizing about concepts. Thinkers for whom their own mental activity is the foundation of all knowledge have some distance to travel before they can be convinced that other people have minds, let alone that animals have them, and let alone that the contents of animal minds include entities like our own concepts. The Cartesian tradition emanating from cogito ergo sum still has a strong grip. The main objection to solipsism is that it flies in the face of common sense. [...] Besides radical scepticism, another aspect of Cartesianism, dualism, is sometimes implicit in debates over animal concepts. ‘A certain Cartesian residue might be detected here: if we have an associative “mechanism” we can avoid attributing (unsubstantiated) rational thought’ (Allen 2006, p. 181). In a philosopher’s essay on the mental lives of non-human animals, Dupré (1996, p. 323) writes of the ‘powerful and pernicious influence [of] Cartesian assumptions’. (Hurford 2007: 9)

Before any discussion on the validity of the continuity assumption for language evolution, it should be kept in mind that the human (*Homo sapiens*) is a member of the superfamily of apes (*Hominoidea*) to which gibbons, orangutans, gorillas, and chimpanzees are included as well. With the chimpanzees, humans build the hominin tribe (*Hominini*)²². The taxonomical link

¹⁹ Controversially, Bickerton (1990: 77ff.) is comfortable with ascribing “protorepresentations” to plants. Writing introspectively of sundews (genus *Drosera*), carnivorous plants which, approximately, fold their leaves when a potential prey lands on them, Bickerton (1990: 79) comments: “So, to call the firing of cell A a kind of protorepresentation of the state ‘assumed presence of potential prey’ should not seem altogether unreasonable.”

²⁰ I.e., the *mind*, how *cognition* is often called in the humanities.

²¹ Lakoff & Johnson (1999) also discuss the Cartesian heritage in linguistics, focusing, however, on Chomskyan linguistics.

²² According to the up until recently valid taxonomical organization, the mentioned “hominins” (in that case, the subfamily of *Homininae*) are not the same as “hominins” (the tribe *Hominini*) which appear after the last common ancestor of humans (i.e., “hominins”) and chimpanzees (Janković & Karavanić 2009: 51). However, according to the most recent taxonomical organization of apes, the tribe *Hominini* now includes the chimpanzees (genus *Pan*) as

between humans and other apes and primates is evidenced in a number of aspects, including anatomy, longer periods of postnatal dependency which enables longer periods for behavior acquisition, “complex social organization”, diverse nutrition, and a disproportionate ratio of the number of offspring and time which the parents can invest into their offspring (Janković & Karavanić 2009: 49; see also Street et al. 2018; Whiten et al. 1999). It would thus be difficult to assume that there are no similarities in the communication systems of different apes and that some aspects of non-human ape communication are present in language²³. Following this line of thought, Heesen et al. (2019: 1) write:

Studies testing linguistic laws outside language have provided important insights into the organization of biological systems. For example, patterns consistent with Zipf’s law of abbreviation (which predicts a negative relationship between word length and frequency of use) have been found in the vocal and non-vocal behaviour of a range of animals, and patterns consistent with Menzerath’s law (according to which longer sequences are made up of shorter constituents) have been found in primate vocal sequences [...]. Both laws have been linked to compression—the information theoretic principle of minimizing code length.

Bickerton (1990: 75) agrees that language must have originated from a pre-existing communication system, but rejects the possibility that this type communication can be found in wild non-human animals:

[L]anguage was first and foremost a system of representation. It was therefore, like all other such systems, a mechanism that to a large extent created its own output—rather than merely replicating, in another mode,

well, gorillas (tribe *Gorillini*) are now part of the *Homininae*, while there is now also the subtribe *Hominina* which includes exclusively species after the “hominin”-chimpanzee split. The terminology of ape taxonomy appears to be a horror-story. See Groves (2018) for help in orienting oneself in the new ape taxonomy (cf. Prado-Martinez et al. 2013). Later in the text, I shall use the term “hominins” exclusively with the meaning of the subtribe *Hominina*, i.e., according to the now retired taxonomy, with the meaning of the tribe *Hominini*. It is currently unclear how *Hominina* should be called in Croatian.

²³ Besides, the mere fact that a number of primatological and other studies are painstakingly looking for differences between humans and other primates (e.g., Buxhoeveden et al. 2001; Donahue et al. 2018; Kanton et al. 2019; Li et al. 2018; Watzek et al. 2019) suggests that in some other sciences apart from linguistics, philosophy, etc., continuity is more frequently axiomatically assumed rather than rejected. This is observed by Hurford (2007: 9) as well: “Neuroscientists and animal researchers have their own more advanced common sense, and most start from a common assumption of continuity between animal and human minds. It can be added that many workers in another modern field, Artificial Intelligence, also have no qualms about attributing mind-like properties even to machines, as the name of the discipline implies.” Furthermore, continuity is a necessary assumption for human biomedical and other studies which use animal models, often in exchange for the unethical testing of humans. These studies include studies of language and speech disorders (French & Fisher 2014; Konopka & Roberts 2016a). Additionally, in his book *The Primate Origins of Human Nature*, van Schaik (2016) discusses humans as primates in 27 different chapters from diverse perspectives of evolutionary biology and anthropology.

what was fed into it. Precisely because of this, language was able to increase, by several orders of magnitude, not just the things but the kinds of thing that creatures could communicate about. No mere communicative mechanism could ever have done this. Thus, if we are to seek for the ultimate origins of language, we cannot hope to find those origins by looking at the means by which other creatures communicate with one another.

Thus, Bickerton (1990) proposes that because animal communication putatively lacks productivity, language is not phylogenetically associated with animal communication. Bickerton (1990: 8) names this problem *the paradox of continuity*:

[T]here are subtler but equally far-reaching differences between language and animal communication that make it impossible to regard the one as antecedent to the other. But the net result of all this is the Paradox of Continuity: language must have evolved out of some prior system, and yet there does not seem to be any such system out of which it could have developed.

Bickerton's arguments are problematic from several perspectives. Based on the fact that a specific feature is present in language but putatively not present in animal communication, Bickerton assumes that there is no phylogenetic relationship between language and animal communication. Firstly, it is crucial to note that lack of observations of the presence of a phenomenon in a given sample does not imply the phenomenon's inexistence in the sample, let alone in nature (!)²⁴. Secondly, as I shall aim to show in the next part of this chapter, some animals also might exhibit some kind of "productivity". For example, vervets have alarm calls for predators including leopards, martial eagles, African pythons, baboons, and unfamiliar humans (Seyfarth et al. 1980). Assuming these alarm calls are not a relatively recent phylogenetic phenomenon in vervets, it is plausible that vervets had alarm calls before they had a chance to encounter modern humans. This suggests that specific vervet populations at some point formed the concept UNKNOWN HUMAN, categorized it as a member of the category PREDATORS, and linked it to a new vocalization expression. Although this is a very limited example compared to productivity in language, this and some other examples in this paper show that it is potentially problematic to discuss "productivity" as a uniquely human trait and as if it were a categorical phenomenon²⁵. Thirdly, it is unclear why eventual qualitative and/or quantitative differences or

²⁴ *Contra* Hauser et al. (2002: 1572): "[T]he human uniqueness claim must be based on data indicating an absence of the trait in nonhuman animals".

²⁵ Admittedly, this is a potentially problematic example if we understand language productivity as a capacity for the production and reception of an "infinite" number of constructions or utterances based on a finite set of structures.

the distinctiveness of language compared to animal communication represent an argument for the non-existence of a phylogenetic relationship between language and animal communication. Matasović (2012: 57) writes:

It is wrong to look for analogies of language in the animal world at any cost; one should accept the zoological fact that some species sometimes develop unique morphological or behavioral features. Examples include the sonar which is used for navigation by bats, or the trunk which is used as a hand by elephants; neither the bat's sonar nor elephant's trunk have direct analogies in other mammals, but are unique adaptations which emerged due to specific conditions in which the members of the given species live.

Depending on how we define language and how we define an analogy, we can and cannot search for analogies of language in animal communication. It is difficult to define analogy in this context. If language is a representational system, then there are analogies in animals and they can be studied. If language is recursion and if animals do not exhibit recursion, then there are no direct analogies in animals and they cannot be investigated, etc. It would appear that the argumentation of strict discontinuity is the following: language is phylogenetically independent of animal communication because language is “special”, and language is “special” because it appears to the naked linguist's eye²⁶ that language has certain features which are not present in animal communication. It is unclear within which evolutionary model would such argumentation be valid. Compare with Darwin:

“He who wishes to decide whether man is the modified descendant of some pre-existing form, would probably first enquire whether man varies, however slightly, in bodily structure and in mental faculties; and if so, whether the variations are transmitted to his offspring in accordance with the laws which prevail with the lower animals; such as that of the transmission of characters to the same age or sex. Again, are the variations the result, as far as our ignorance permits us to judge, of the same general causes, and are they governed by the same general laws, as in the case of other organisms; for instance by correlation, the inherited effects of use and disuse, &c.? Is man subject to similar malconformations, the result of arrested development, of reduplication of parts, &c., and does he display in any of his anomalies reversion to some former and ancient type of structure? It might also be naturally enquired whether man, like so many other

However, the capacity to make new concepts and words could be understood as one of the prerequisites which evolutionarily enabled language productivity.

²⁶ Linguists rarely discuss animal communication and when they do, they typically refer to studies of captive apes learning language and, in that case, to studies with the bonobo Kanzi. From an empirical perspective, linguists rarely, if ever, investigate animal communication.

animals, has given rise to varieties and sub-races, differing but slightly from each other, or to races differing so much that they must be classed as doubtful species? How are such races distributed over the world; and how, when crossed, do they react on each other, both in the first and succeeding generations?” (Darwin 2013: 9)

“[M]an bears in his bodily structure clear traces of his descent from some lower form; it may be urged that, as man differs so greatly in his mental power from all other animals, there must be some error in this conclusion. No doubt the difference in this respect is enormous [...] If no organic being excepting man had possessed any mental power, or if his powers had been of a wholly different nature from those of the lower animals, then we should never have been able to convince ourselves that our high faculties had been gradually developed. But it can be clearly shewn that there is no fundamental difference of this kind. We must also admit that there is a much wider interval in mental power between one of the lowest fishes, as a lamprey or lancelet, and one of the higher apes, than between an ape and man; yet this immense interval is filled up by numberless gradations. [...] *[T]here is no fundamental difference between man and the higher mammals in their mental faculties.*”²⁷ (Darwin 2013: 29–30)

Just as Darwin points out at the end of the second citation, there is little if any reason to propose that all animal communication systems are somehow similar, but only language is unique. It would appear that we have entered the Cartesian waters once again. Furthermore, the sonar and trunk examples are problematic as well²⁸. Firstly, sonar has been observed not only in bats, but also dolphins (Pilleri 1983), whales (André 2009), and some birds (Brinklöv et al. 2013). Secondly, structural and functional similarities between a trunk and nose are clear to the naked eye, while trunk is indeed described as “a fusion of the nose and upper lip”: „The proboscis or trunk, a combination of nose and upper lip, is the most distinguishing feature of these mammals.” (Shoshani 1998: 480).

2.4.1. Semantics in animal communication

Although they do not communicate as much as humans, other animals also have their communication systems and some of these animals also display vocal and gestural modalities of

²⁷ Emphasized by me.

²⁸ Matasović (2012) cites Pinker (1994, 1999) for these examples.

communication²⁹. Seyfarth et al. (1980) convincingly showed that vervets³⁰ (*Chlorocebus pygerythrus*) have semantic memory, i.e., concepts. Struhsaker (1967) had already showed that vervets have alarm calls for at least three different predators: the leopard (*Panthera pardus*), martial eagle (*Polemaetus bellicosus*), and African python (*Python sebae*)³¹: “The acoustical features of the calls were such that (i) they could be assigned unambiguously to one type, both by sound spectrography in the laboratory and by ear in the field, and (ii) they were distinct from the nonalarm vocalizations that they most closely resembled.” (Seyfarth et al. 1980: 802). Both Struhsaker (1967) and Seyfarth et al. (1980) observed that the perception of every alarm call type was associated with specific behaviors. When vervets were on the ground and would hear a leopard call, they would escape into the tree branches; when they would hear the martial eagle call, they would look up to the sky and subsequently hide in the bushes; when they would hear the African python call, they would scan the surrounding ground: “Such responses suggested that each alarm call effectively represented, or signified, a different class of external danger. Alternatively, the different responses might have occurred not because of the alarm calls, but because the presumed respondents actually saw the different predators, either independently or cued by other alarmists.” (Seyfarth et al. 1980: 802). To test these two hypotheses, Seyfarth et al. hid loudspeakers from which they played recordings of the different alarm calls, while controlling for the calls’ length and loudness. After playing the alarm calls, the vervets would look toward the loudspeaker, scan their surroundings, and then display the specific alarm call behavior. The results thus suggest that vervets do not react to predatory objects or events, but that they react to the auditory stimulus whose features are more or less in an automatized functional relationship with the given concept in the vervet’s semantic memory. Based on this, we can

²⁹ For more on primate communication see Cheney & Seyfarth (2018), Deshpande et al. (2018), Gustison & Bergman (2016), Hewes (1973), Hostetter et al. (2001), Katsu et al. (2019), Melis & Tomasello (2019), Saffran et al. (2008), Takahashi et al. (2017). See Wich et al. (2012) for the existence of dialects in orangutans’ communication. See Crockford et al. (2018) for contextually dependent differences in the acoustical properties of pant-hooting in chimpanzees. For studies comparing human speech and primates’ vocal capacities see Boë et al. (2017), Christison-Lagay & Cohen (2018), Clay et al. (2015), Fitch & Hauser (1995), Gustison & Bergman (2017), Hammerschmidt & Fischer (2019), Hauser & Fowler (1992), Jarvis (2019), Kee Loh et al. (2017), Lameira (2017), Lameira et al. (2015a, 2015b, 2017), Pomberger et al. (2018), Ravignani & Norton (2017). See Prat et al. (2017) for dialects in the vocal communication of bats.

³⁰ Vervets are primates belonging to the parvorder *Catarrhini* and the superfamily of Old World monkeys (*Cercopithecoidea*); the other superfamily of the parvorder *Catarrhini* encompasses the apes (*Hominoidea*). It is believed that Old World monkeys and apes diverged before approximately 23 million years (Stauffer et al. 2001).

³¹ “Two other vocalizations, given to baboons and to unfamiliar humans, also seemed to be discrete call types, but they were not recorded often enough for statistical comparison.” (Seyfarth et al. 1980: 802). Seyfarth et al. also investigated the baboon alarm calls, but not the unfamiliar human alarm calls.

conclude that vervet alarm calls are semantic and symbolic (in the Saussurean sense; Hurford 2007: 225ff.; McMahon & McMahon 2013: 76; Seyfarth et al. 1980). McMahon & McMahon (2013: 76) add that these alarm calls are also arbitrary, but it is perhaps too early for such discussions³². There is a discussion whether these alarm calls are referential (Hurford 2007: 228ff.). After a comprehensive review of the literature on indexical pointing and vocalizations in primates and other animals, Hurford (2007: 229–230) concludes that these alarm calls are not referential, but they are denotative, i.e., semantic:

The vervet's bark, considered as a type of call that vervets can make, may be considered to denote the class of leopards. [...] When a vervet barks, it does not have the same effect as finger-pointing towards a particular predator. The bark is not aptly paraphrased in English as the single demonstrative word that. A better paraphrase (remembering always that such paraphrases are rough and ready, and the vervet's representation of the world is only partially similar to ours) would be 'There's a leopard round here!' I am prepared to say that vervet, chicken, and Diana monkey alarm calls and the like do denote, in the sense that they systematically bring to mind representations of quite specific categories of predators.

Possible examples of linguistic analogies of vervets' alarm calls are *Fire!*, *Help!*, *Thief!*, *Murderer!*, etc. Based on introspection, it can be concluded that both the examples above and vervets' alarm calls are one-element utterances with which the caller diverts the attention of the listeners to a specific object or event and with which the listeners are imperatively instructed to rapidly change their behavior.

Seyfarth et al. also observed that young vervets produced alarm calls for a wider range of animals (i.e., they made "errors"), while the adults normally produced the alarm calls in the presence of the actual predator that is being denoted with the alarm call. The authors add: "More than 100 species of mammals, birds, and reptiles were seen regularly by the monkeys without eliciting alarm calls." (Seyfarth et al. 1980: 803). Furthermore, "[e]ven for infants, however, the relation between type of alarm call and the stimulus that it elicited was not arbitrary. Infants gave leopard alarms primarily to terrestrial mammals, eagle alarms to birds, and snake alarms to snakes or long objects." (Seyfarth et al. 1980: 803). This suggests that, despite the "errors", young vervets likely have concepts within the category PREDATORS similar to adult vervets, but

³² If some linguistic components may be non-arbitrary (cf. Blasi et al. 2016, ali i Chen et al. 2016; Fort et al. 2015; Fryer et al. 2014; Maurer et al. 2006; Peiffer-Smadja & Cohen 2019; Sakamoto & Watanabe 2018; Tamariz et al. 2018; Winter et al. 2017), then it is certainly a plausible hypothesis for vervets as well, especially from the perspective of continuity.

they appear to be more schematic and are potentially based on a smaller number of conceptual features. Additionally, the fact that young vervets have to learn the alarm calls suggests that this communication system cannot be completely innate³³, which is unsurprising given its relative complexity. Other non-human animals have similar alarm calls:

Digweed et al. (2005) describe two such calls in white-faced capuchin monkeys: one call for bird predators, and one more general call for a range of snakes and mammals. Writing of the pale-winged trumpeter, an Amazonian bird, Seddon et al. (2002, p. 1331) write: ‘On detection of danger, trumpeters gave two acoustically different calls, one for aerial predators, and another for terrestrial predators or conspecific intruders. They also produced distinct calls on detection of large prey items such as snakes. These (alarm and snake-finding) call types seemed to evoke different responses by receivers and therefore appeared to be functionally referent.’ Domestic chickens also have alarm calls differentiated for aerial and ground predators (Karakashian et al. 1988; Evans et al. 1993). (Hurford 2007: 226)

2.4.2. Syntax in animal communication

Language learning experiments with captive apes have also demonstrated the existence of semantic concepts, as well as their relative flexibility, i.e., capacity for the change of the concept’s extension by learning. Savage-Rumbaugh et al. (1993: 112ff.) published a corpus of simple instructions in English which were given in experimental settings to Kanzi, a captive bonobo (*Pan paniscus*), and Alia, a two-year old human. Adult captive bonobos clearly have a capacity for learning different semantic concepts and categories, and understanding them in different lexical and syntactical contexts. Some examples of these instructions include *Can you put your shirt on your ball?*, *I think we need to give the balloon to Kelly.*, *Can you put some toothpaste on your ball?*, etc. Majority of the instructions include transfer of an object to a location associated with another object. All nouns were concrete, verbs syntactically transitive, and there was a small number of proper nouns. The most frequent verbs in the clauses containing the instructions were *put*, *give*, and *get*, but there were other verbs as well; e.g., *slap*, *show*, and *open*, while there were also more exotic examples such as the periphrastic causative construction with the verb *make*: *See if you can make your doggie bite your ball*. Both Kanzi and Alia correctly responded to the last instruction. One interesting example demonstrates that Kanzi

³³ For more on vervets’ alarm calls from a developmental perspective see Seyfarth & Cheney (1986). Cheney & Seyfarth (1988) write about the processing of unreliable alarm calls in vervets.

understands the meaning of individual words (an alternative hypothesis would be that Kanzi has learned the propositional meanings of the entire sentences):

When asked to „Put some water on the carrot”, he responded by tossing the carrot outdoors; since it was raining heavily at the time, his action resulted in water getting on the carrot even though he applied the water indirectly. This method of “putting water on the carrot” appeared to be deliberate on Kanzi’s part. At no other time during the test did he toss food or other items outdoors. It is also noteworthy that no one could recall ever demonstrating this behavior to Kanzi as a means of putting water on any item. Moreover, at other times during the test, and when it was not raining, he readily used both the hose and the faucet at the sink as a means of obtaining water if a request required him to do so, indicating that he knew how to obtain water. The novel solution of throwing the carrot into the rain is indicative of the flexibility that characterized the behavior of both subjects throughout the test. Kanzi and Alia’s “solutions” were often surprising even to those who had worked with them from infancy. (Savage-Rumbaugh 1993: 81–82)

Thus, not only do wild primates exhibit limited use of something we might call “lexical” units, captive primates can understand individual lexical units (words) from human languages and can potentially understand to some degree the syntactical relations in human sentences. Admittedly, in the case of noun phrases such as *your ball* (i.e., conceptually *my ball*), it is possible that Kanzi learned all noun phrases as separate lexical units, i.e., *yourball*, *yourdoggie*, etc. However, because Kanzi managed to acquire the separate lexical units which together with *your* build these noun phrases, it seems likely that Kanzi indeed acquired the lexical unit *your* and, perhaps based on some linear rule, interpreted these expressions as two-element utterances (compare *Can you give the collar to Kelly?* and *Take your collar to the bedroom.*). Thus, Kanzi might understand some elements of human language syntax (or the syntax of English?³⁴), but this is not yet completely clear from this study. In the study Kanzi’s language reception was investigated without examining production (which would be impossible in the vocal modality) and Kanzi acquired a communication system which he would have not acquired in the wild: “Natural

³⁴ There is very little morphology in the examples; only several examples of plural, possessivity, and perhaps something else. This extensive publication should be analyzed in greater detail to try to determine whether Kanzi acquired some of these words only in the plural form (pluralia tantum so to say). It is also possible that the experimental design was such that Kanzi did not need to differentiate between singular and plural. In other words, if Kanzi was instructed to perform an action on several objects of the same type at once, without being offered at least two groups of objects (one with one object, another with two objects, etc.), it would be very difficult to discuss possible differentiation between singular and plural in Kanzi. Also, it is possible that the examples in the publication do not semantically express plural but collection. In the case of possessivity (e.g., *Matata*’s), it is possible that Kanzi ignored or inhibited the last segment [z].

animal communication systems need to be kept distinct from attempts to teach signs to apes based on human languages.” (Aitchison 2003: 12). Still, it does appear that some wild primates and other animals exhibit in their communication systems some form of syntax, i.e., combining structures according to rules, but it is currently unclear whether these animals also display semantic compositionality. Hurford (2012: §1) offers an extensive review of studies on animal syntax³⁵:

Birds sing in combinations of notes, but the individual notes don’t mean anything. A very complex series of notes, such as nightingale’s, only conveys a message of sexual attractiveness or a threat to rival male birds. So birdsong has syntax, but no compositional semantics. It is the same with complex whale songs. Despite this major difference from human language, we can learn some good lessons from closer study of birds’ and whales’ songs. They show a control of phrasal structure, often quite complex. The songs also suggest that quantitative constraints on the length and phrasal complexity of songs cannot be naturally separated from their structure. (Hurford 2012: 1)

Suzuki et al. (2016) explored vocalizations in Japanese tits (*Parus minor*)³⁶:

Tits have over ten different notes in their vocal repertoire and use them either solely or in combination with other notes. Experiments reveal that receivers extract different meanings from ‘ABC’ (scan for danger) and ‘D’ notes (approach the caller), and a compound meaning from ‘ABC–D’ combinations. However, receivers rarely scan and approach when note ordering is artificially reversed (‘D–ABC’). (Suzuki et al. 2016: 1)

The meanings ascribed to these vocalizations do not exhibit the lexical-semantic character which was shown by primates. Nevertheless, the results of this study suggest that (1) Japanese tits have a capacity for conjunctive combinations of very schematic propositions and (2) that they potentially have a linear rule or linear rules for this conjunctive compositionality. Suzuki et al. analyze ABC-D as a “single meaningful unit”. If we assume that the conjunctive meaning emerges from the linear rule *ABC before D*, then it is potentially problematic to analyze ABC-D as a “single meaningful unit” in the sense of compounds, as suggested by the authors. However, ABC-D potentially represents a two-element utterance. Furthermore, if we are to judge according to the presented data, the components ABC and D (or one of them) pass the movement test for syntactic constituents.

³⁵ For syntax in primate communication see Conway & Christiansen (2001) and Milne et al. (2016).

³⁶ For a review of bird and other animal syntax see Suzuki et al. (2018).

These results indicate that the tits perceive ABC–D calls as a single meaningful unit but not as two separated meaningful units (ABC and D calls) simply produced in close proximity. As ABC and D convey unique meanings and can be used alone [Suzuki et al. 2014], the combination of these two notes does not meet the criteria for phonology [Marler 1998; Hurford 2012]. In addition, unlike call combinations reported in several non-human primates [Ouattara et al. 2009a, 2009b; Arnold & Zuberbühler 2006, 2008, 2012], the combination of ABC and D calls conveys a compound meaning that originates from both of the note units. Thus, we conclude that the combination of ABC and D calls in the Japanese great tit obeys semantically compositional syntax. (Suzuki et al. 2016: 4)

3. ARGUMENTS FOR EXAPTATION IN THE EVOLUTION OF SEMANTICS AND SYNTAX

3.1. Exaptation of lexical semantics

A limited review of the literature has thus far demonstrated that non-human primates and some other animals have semantic concepts comparable to those in humans. Nevertheless, it would be difficult to say these animals have semantic systems because that would imply the presence of different semantic categories, interconceptual relations (antonymy, hypernymy/hyponymy, metonymy, etc.), and functional connectivity between different concepts based on the presence of certain semantic features or other factors. Further empirical research is needed to determine whether such phenomena are present in non-human animals and to investigate the full extent of semantic memory in individual taxa. Seyfarth et al. (1980) demonstrated that vervets have the concepts LEOPARD, MARTIAL EAGLE, and AFRICAN PYTHON, yet that does not imply vervets do not have other concepts. Indeed, from the Cartesian point of view, the vervets likely have a large number of concepts in their semantic memory: “We have seen a picture of apes with quite a lot going on their heads.” (Hurford 2007: 331). The examples of concepts from the studies I have reviewed were limited to animate and concrete concepts. As I shall aim to demonstrate, animacy and concreteness are semantic categories which likely reflect phylogenetically ancient systems of general cognition.

From the perspectives of psychosemantics and neurosemantics (but also the syntactic-semantic interface), one hotly debated question is whether meaning is embodied, i.e., how much does semantics depend on perceptuo-motor processing. For example, if a healthy human sees a table, based on the visual stimulus, their brain will define that stimulus as a token of the concept TABLE. The brain recognizes specific visual properties of the stimulus which correspond to the semantic features of the concept TABLE, e.g., it is four-legged, square- or circle-shaped, of hard materials, within a specific size range, etc. According to the embodiment theories, beside semantic memory, perceptuo-motor areas which contain systematized perceptual information based on the individual’s repeated perceptual experience with the objects of the TABLE type are also needed to

identify the type of a stimulus. Embodiment theories are contrary to modular theories, which in the context of semantics assume that there is a “linguistic” semantic system alongside the general semantic system and that conceptual meanings are amodal or “abstract” (e.g., Anderson 1985), and not based on “concrete” information from the sensory experiences:

According to the traditional amodal approach, concepts are couched in a symbolic format that bears no structural similarity to perceptual states [Fodor 1975, 1998]. According to the modal or grounded approach, in contrast, concepts are couched in perceptual representations that become stored during perception and action, and can be later reenacted in absence of the stimuli that originally produced them [Barsalou 1999; Prinz 2002]. (Haimovici 2018: 1)

After reviewing the literature on amodal and modal approaches to semantic processing, Haimovici (2018: 10) concludes: “[T]here is not a general consensus on the specific properties that distinguish modal and amodal representations, and different authors adopt different criteria, which leads to a cross classification of certain representations depending on the chosen criterion.” In any case, the theory of meaning embodiment has already fortified itself so much within psycholinguistics and neurolinguistics, that the question whether semantics is embodied or not has practically become passé: “[T]he debate should move away from an “embodied or not” focus, and rather aim to characterize the functional contributions of sensorimotor systems to language processing in more detail.” (Mollo et al. 2016: 262).

Embodiment and exaptation are, of course, no synonyms. However, synchronic embodiment might suggest diachronic, i.e., evolutionary exaptation³⁷. If we assume that language or some of its components are embodied, we can assume relying on the Occam’s razor that language evolved via exaptation. The alternative hypothesis would be that language somehow originated as a modular phenomenon and was then later embodied. The latter hypothesis is highly problematic. Firstly, it would imply that there were at least two phases of language evolution, i.e., that there was first modular language and that it subsequently somehow got embodied. This would further imply that language could not have arisen approximately 90 000 BP as suggested by Berwick & Chomsky (2016). The date of 90 000 BP³⁸ would be reserved for the embodiment

³⁷ For more on embodiment theories, see Barsalou (2008), Chatterjee (2010), Wilson (2002). For more on the embodiment of semantics, see Barsalou (2009), Hauk & Tschentscher (2013), Mahon & Caramazza (2009), Meteyard et al. (2012), Pulvermüller (1999, 2013b), Simmons et al. (2008).

³⁸ This date should be taken with caution as it is controversial. What one wants to say with the “90 000 BP” is that this is the latest moment for the development of universal human features since after that date, there are migrations out of Africa and the Middle East into other parts of the globe where the newly come populations will in this or that

of language, while the origins of language would have to be pushed back in time (and phylogenetic history). Secondly, this would imply that there was a considerable brain reorganization in the wake of various mutations which would have occurred sometime between language emergence and language embodiment. Thirdly, such a hypothesis does not explain why some linguistic phenomena are more embodied than others. Fourthly, it is unclear how a brain supporting modular language would have functioned, thus appearing that we have somehow managed to exit the Cartesian waters and enter directly into the mysterious waters of cryptozoology, which offers additional support for the exaptation hypothesis via the Occam's razor.

3.1.1. Animacy

Linguistic animacy is a lexical-semantic category which assumes that a semantic concept denotes something which is in reality perceived as a living being. Animacy is in some languages, including Croatian, a grammatical category as well. Animacy is in Croatian structurally expressed in the accusative singular when masculine nouns denoting animate entities receive the inflectional suffix *-a*, while masculine nouns denoting inanimate entities do not receive a morpheme (on a structural level) compared to the neutral nominative form (Barić et al. 2005: 104). Hurford (2007: 41ff.) associates semantic animacy with the ability to detect biological motion:

‘Biological motion’ is a label attached to a kind of motion typical of an animal; it is distinct from trees waving in the wind, rocks tumbling down a cliff, waves in the sea, or eddies in a stream. Recognizing biological motion is not just a matter of certain sensors being excited. There has to be a quite complex calculation of the temporal and spatial relations among the moving parts. (Hurford 2007: 41)

Hurford (2007: 43) defines animacy as “potential biological movement”, noting that the differentiation between animate and inanimate entities is key for survival, i.e., that there were strong selective pressures on animals to detect animacy among the objects around them: “[C]learly almost all species have solved the problem quite well.” (Hurford 2007: 43). It appears that the ability of biological motion detection is at least partly innate:

manner replace the autochthon populations. This is why it is nonsensical to assume that language emerged some 50 000 years ago in Europe within the so-called Upper Palaeolithic revolution (e.g., Gell-Mann & Ruhlen 2011): “No contributor to this volume still defends the notion of a mutation for syntax triggering language a mere 50,000 years ago.” (Knight 2009: 2); “The Andaman Islanders in the Indian Ocean have been genetically isolated for at least 65,000 years—and no one doubts that these humans have full capacity for language.” (Knight 2009: 8).

Here we report that newly hatched chicks, reared and hatched in darkness, at their first exposure to point-light animation sequences, exhibit a spontaneous preference to approach biological motion patterns. Intriguingly, this predisposition is not specific for the motion of a hen, but extends to the pattern of motion of other vertebrates, even to that of a potential predator such as a cat. The predisposition seems to reflect the existence of a mechanism in the brain aimed at orienting the young animal towards objects that move semi-rigidly (as vertebrate animals do), thus facilitating learning, i.e., through imprinting, about their more specific features of motion. (Vallortigara et al. 2005: 1312)

It has been shown that humans also exhibit the ability of biological motion detection in early development and that it might be associated with visuospatial processing in modern humans:

The biological motion studies take off from a paper by Johansson (1973), who showed that human babies attend preferentially to mobile patterns generated by lights attached to the joints of moving animals. Biological motion is a basic component of higher-level perceptual judgements. Jokisch and Troje (2003) showed that in human subjects the particular stride frequency of an example of biological motion (in a simulated dog) was used as a clue to size and distance from the observer. (Hurford 2007: 42)

In linguistic literature, it has been suggested that lexical-semantic units denoting animate entities possess more perceptual semantic features compared to those denoting inanimate entities which, on the other hand, possess more functional semantic features (Bonin et al. 2014; Caramazza & Shelton 1998; Nairne 2010; Nairne & Pandeirada 2010a, 2010b; Tyler et al. 2000; Warrington & Shallice 1984). These assumptions are based on clinical studies of mostly neurological patients exhibiting category-specific semantic deficits:

[T]he sensory/functional dimension provides the fundamental organizing principle of the semantic system. Since [...] sensory and functional properties are differentially important in determining the meaning of the members of different semantic categories, selective damage to the visual or the functional semantic subsystem will result in a category-like deficit. [...] For example, J. B. R. defined briefcase as “small case used by students to carry papers” but responded “don’t know” to the word parrot; similarly, S. B. Y. deaned towel as “material used to dry people” but responded “bird that flies” to the word wasp. (Caramazza & Shelton 1998: 1)

For example, the concept ELEPHANT is determined by perceptual semantic information such as EARS, TAIL, LEGS and FEET, TRUNK, etc., while the concept scissors is determined by functional-associational features such as CUT, SHEAR, BLADE, METAL, etc. Råling et al. (2017) investigated the role of animacy during lexical animacy decision but found no significant

interactions with other linguistic phenomena: “Response times were influenced by the independent main effects of each parameter: typicality, age of acquisition, semantic domain, and frequency. However, there were no interactions.” (Räling et al. 2017: 2094).

The animacy effect is a prominent phenomenon in non-linguistic cognitive domains as well. The focus of previous research has been on perception and memory. Bonin et al. (2014) reported from three experiments that words denoting animate entities and visual stimuli depicting animate concepts are remembered better than inanimate words and concepts: “This finding suggests that animacy enhances not only the quantity but also the quality of memory traces, through the recall of contextual details of previous experiences (i.e., episodic memory).” (Bonin et al. 2014: 370). Similar results were obtained by Nairne et al. (2013). Li et al. (2016) observed the animacy effect in metamemory processes as well. In the study, subjects gave higher ratings in judgement of learning for animate words compared to inanimate words. Judgement of learning refers to subject’s attitude about how well he learnt or remembered something (metamemory), without necessarily measuring whether the subject actually performed in that manner on the memory task.

3.1.1. Concreteness and abstractness

Linguistic concreteness is a semantic category which assumes that some semantic features of a concept are more or less founded on sensory information³⁹ (Tušek & Peti-Stantić 2018). Concreteness and abstractness are gradual, not categorical measures (Peti-Stantić et al. 2018). Concrete words are recognized faster and recalled easier compared to abstract words (Kroll & Merves 1986; Marschark & Paivio 1977; James 1975). Many have suggested that abstract semantics emerges from concrete semantics via mechanisms of metaphors or image schemas (Croft & Cruise 2004; Geld 2006; Evans & Green 2006; Lakoff 1987; Lakoff & Johnson 1999; Taylor 2003). Following this line, Raffaelli & Kerovec (2017), for example, show the role of the conceptual domain TASTE in the construal of the Croatian and Turkish lexicon (cf. Sweetser 1990; Viberg 1984; see also Raffaelli 2009, Raffaelli & Kerovec 2015).

³⁹ There are numerous discussions on the relationship between concreteness/abstractness and imageability into which I will not enter. Tušek & Peti-Stantić (2018: 317) define imageability as the “easiness with which a visual or auditory image [of a concept] is created”. See Paivio (1969, 1971, 1986, 2010) for the dual coding theory which assumes differential roles of different cognitive processes during processing of highly and lowly imageable words. See Pexman et al. (2007) for criticism of imageability from a neurophysiological perspective.

Some readers of this paper may have already sensed that there is a degree of misunderstanding between different experts and fields within the interdisciplinary cognitive sciences. The topics of concreteness and abstractness are no exception. Most studies which deal with concrete semantics focus on action semantics. The two terms are, it would appear, often understood as synonyms. One example is Hauk (2016) who reviews experimental studies on the embodiment of lexical semantics. Devoting the section 62.4.1. of the paper to “concrete lexical semantics”, Hauk (2016: 782–783) reviews only studies of lexical action semantics (which is the topic of the next section in this paper).

Pexman et al. (2007) analyzed the performance on a semantic categorization task while subjects were scanned by fMRI. They concluded that in comparison to concrete words, abstract words were associated with a broader activation in frontotemporoparietal areas, including a number of areas associated with semantic processing: “Our results are consistent with those of a number of other studies showing that there were no cortical areas with greater activation for concrete relative to abstract words (Noppeney & Price 2004; Grossman et al. 2002; Kiehl et al 1999; Perani et al. 1999).” (Pexman et al. 2007: 1407). Binder et al. (2005) also used fMRI while subjects were performing on lexical decision. There were no significant differences in activity in the left lateral temporal lobe between concrete and abstract words. Concrete words were associated with higher activation, among others, in the bilateral angular gyrus and left dorsolateral prefrontal cortex. Abstract compared to concrete words were associated with higher activation in the left inferior frontal gyrus, premotor cortex, and dorsal temporal pole. Binder et al. (2005: 3) add: “[A]lthough the concrete word activations were bilateral with a modest leftward asymmetry, the abstract activations [...] were almost entirely confined to the left hemisphere.” However, concrete and abstract words did not significantly differ in individual areas of the left hemisphere. Compared to pseudowords, both concrete and abstract words showed higher activation in the angular gyrus, middle and inferior temporal gyri, and dorsal prefrontal cortex. The authors suggest the relationship between abstract words and activity in the left inferior frontal gyrus and superior temporal gyrus implies that the retrieval of abstract words does not depend as much on information from semantic memory:

To accept an abstract item as a word requires holding its phonological form in working memory while retrieving words associated with the item in question. Hence, in the case of abstract words, the lexical decision response depends less on retrieval of conceptual information and more on retrieval of associated

words, resulting in greater activation of left perisylvian areas subserving phonological working memory and lexical retrieval. (Binder et al. 2005: 6)

Pulvermüller (2013: 465) believes that the key difference between concrete and abstract words is in the variability of the perceptuo-motor patterns involved in the construal of a particular concept. Pulvermüller takes the word *eye* as an example of a concrete word and *beauty* as an example of an abstract word. The semantic knowledge about the concept EYE is based on an individual's experience with the denoted object type (in this case, visual experience above all). An individual acquires the concept EYE based on different and shared features which all eyes the individual has experienced have. Lesser variability in perceptuo-motor information implies here that all eyes the individual has experienced share a considerable number of qualitatively similar pieces of perceptuo-motor information, e.g., all eyes are round, all are of similar sizes, all have a specific color, all display relatively large white surfaces, all are located on a specific part of the body, etc.: "At the neurocognitive level, this leads to exemplar representations that strongly overlap in their sensorimotor semantic feature neurons, possibly dominated by a frequently processed prototype." Pulvermüller is not only concerned with concepts but with words in general as well. Because the word *eye* with its distinct form denotes a type of object whose tokens are not particularly variable from the perspective of perceptuo-motor information, then the form *eye* is repeatedly brought into a functional relationship with specific perceptuo-motor information. Thus, concrete word forms are functionally connected to the perceptuo-motor system. The stimuli based on which the individual has acquired the abstract concept BEAUTY considerably vary in quality. An individual might relate the concept BEAUTY to a particular person, the sunset, landscapes, music, etc. Thus, a robust relationship between the form *beauty* and the perceptuo-motor information associated with the concept BEAUTY cannot be established:

The low correlation of activations of neuronal circuits for word forms and for each exemplar representation results in weak links between neural representations of sensorimotor knowledge (in modality-preferential areas) and those of verbal symbols (in perisylvian cortex). Abstract semantic connections can draw on partial-overlap neurons [...] and indirect connections by way of neurons in multimodal cortex that happen to link to several sensorimotor instantiations of an abstract meaning ([...] [Pulvermüller 2012, 2013]).

Several studies have suggested that abstract word processing is associated with emotional brain areas. Moseley et al. (2012) conducted an fMRI study in which subjects passively read verbs.

Experimental words were divided into three groups: emotional (e.g., *dread*, *spite*), face actions (e.g., *gnaw*, *chew*), and hand actions (e.g., *peel*, *grasp*). Processing of emotional words was associated with activity in the limbic and primary motor cortices, including the face and hand areas: “We conclude that, similar to their role in action word processing, activation of frontocentral motor systems in the dorsal stream reflects the semantic binding of sign and meaning of abstract words denoting emotions and possibly other body internal states.” (Moseley et al. 2012: 1634). Other studies have also found that some types of abstract words are embodied in emotion processes (Citron & Goldberg 2014; Kousta et al. 2011).

Dreyer & Pulvermüller (2018) applied fMRI while subjects were passively reading abstract “mental” words like *thought* and *logic* and action words. The authors reported that the motor face area was associated with mental word processing: “We conclude that a role of motor systems in semantic processing is not restricted to concrete words but extends to at least some abstract mental symbols previously thought to be entirely ‘disembodied’ and divorced from semantically related sensorimotor processing.” (Dreyer & Pulvermüller 2018: 52). The association between mental words and motor areas potentially suggests that the concepts of these words at least partly emerged from concrete concepts associated with face actions.

3.1.2. Lexical action semantics

If concrete semantics is associated with sensory brain areas containing semantic features of concrete concepts in the form of sensory information, a plausible assumption would be that action semantics will be correlated with activity in motor areas, i.e., that the retrieval of action words and concepts will demand retrieval of specific motor information. Hauk et al. (2004) conducted an fMRI study in which subjects passively read three groups of action verbs: face action verbs (e.g., *lick*), hand action verbs (e.g., *pick*), and foot action verbs (e.g., *kick*). The three verb groups were associated with differential somatotopic activation in the motor and premotor cortices, i.e., in the face, hand, and foot areas: “This rules out a unified “meaning center” in the human brain and supports a dynamic view according to which words are processed by distributed neuronal assemblies with cortical topographies that reflect word semantics” (Hauk et al. 2004: 301). These results have been replicated by a number of studies⁴⁰.

⁴⁰ “With respect to the embodiment of action-word semantics, Pulvermüller, Härle, and Hummel (2001) and Hauk and Pulvermüller (2004) reported differences between action-word types in the ERP at approximately 200 ms that were consistent with somatotopy.” (Hauk 2016: 782)

A large number of studies aimed at investigating the congruity effects between semantic features of the stimuli (i.e., words) and performance on an action task given typically before or during the semantic task. If there is congruity, this is called the action-sentence compatibility effect (ACE). Hauk (2016: 780) comments on these studies:

However, they are not direct evidence for the neuronal overlap of the representations and processes for action concepts and movements. Such interference could still occur at a higher level, where information from these two systems converges, or it could be caused by spreading activation (i.e., a passive “leakage” of activation from one brain system to another) without a functional contribution.

Mollo et al. (2016) used a combination of EEG and MEG in a study of motor priming of hand and foot action words. Subjects were engaged in lexical and semantic decision tasks, while the priming consisted of initiating the task by pressing a key with either the hand or foot. ACE was observed in motor areas, but also the superior temporal cortex. Results suggest that previous activation of motor areas facilitates the activation of corresponding semantic areas and that some classical language areas are associated with this phenomenon.

Pulvermüller et al. (2005) applied transcranial magnetic stimulation on motor areas of the linguistically dominant (left) hemisphere during lexical decision with hand and foot words: “Arm area TMS led to faster arm than leg word responses and the reverse effect, faster lexical decisions on leg than arm words, was present when TMS was applied to leg areas.” (Pulvermüller et al. 2005: 793). There were no significant differences between the two semantic categories in the effect of TMS of the right hemisphere. The authors concluded:

The picture of cortical function arising from these data is that of the cortex as a storehouse of words and their meanings bound together by distributed neuronal systems with specific topographies. These neuronal ensembles, which may have formed during ontogenesis as a consequence of genetic factors and experience, would be spread out over classic core language areas, where all word-related assemblies have some of their neurons, and specific semantically related neurons in supplementary language areas, e.g. in sensorimotor cortex. This view opens an avenue for reconciling classic modular language models with distributed models and can account for both challenges of the cognitive neuroscience of language, the predominance of aphasia after left perisylvian lesions and the widespread activation in a range of language tasks revealed by neuroimaging (Pulvermüller 2003). (Pulvermüller et al. 2005: 797)

Willems et al. (2019) investigated using fMRI the differences between right-handers and left-handers in correlations between the lateralized activation of the premotor cortex and hand action verbs in a lexical decision task:

Right-handers preferentially activated the left premotor cortex during lexical decisions on manual-action verbs (compared with nonmanual-action verbs), whereas left-handers preferentially activated right premotor areas. This finding helps refine theories of embodied semantics, suggesting that implicit mental simulation during language processing is body specific: Right- and lefthanders, who perform actions differently, use correspondingly different areas of the brain for representing action verb meanings. (Willems et al. 2010: 67)

The results of this study suggest that hand action verb processing is (“left”) lateralized which is notable because highly concrete and imageable words are typically processed bilaterally. Because abstract noun processing is typically left lateralized, it is possible that abstract word meanings are phylogenetically more associated with action verb meanings (or specifically hand action verb meanings) than with concrete noun meanings. It is thus also interesting that Dreyer & Pulvermüller (2018) established a relationship between mental words and the motor face area.

The role of perceptuo-motor functions in action processing is investigated within psychosemantics as well. One topic of interest has been the lexical parameter of body-object interaction (BOI). BOI relates to the easiness with which the human body can manipulate an object (Heard et al. 2019; Siakaluk et al. 2008a). For example, the word *pencil* might be rated higher on BOI compared to *volcano*. Words rated higher on BOI are processed faster compared to words rated lower on BOI (Siakaluk et al. 2008b). Heard et al. (2019) collected ratings for seven semantic dimension for 621 words: graspability, ease of pantomime, number of actions, animacy, size, danger, and usefulness. Graspability, ease of pantomime, and number of actions were positively correlated with BOI. Furthermore, “these dimensions together explained more variance [in lexical and semantic decision tasks] than did BOI ratings alone” (Heard et al. 2019: 1).

3.2. Exaptation of linguistic syntax

As was the case with lexical-semantic processing, syntactic processing is also associated with the activity in various brain areas, including perceptuo-motor areas:

Current neuroscientific models of sentence processing recognize the coordinate labor between perisylvian language areas in the frontal and temporo-parietal cortices and supportive brain networks supplying short-term memory and other executive functions. Together, they subserve the reversible mapping of phonological lexical forms onto semantic and syntactic information in language comprehension and production, respectively (Friederici 2012; Kemmerer 2015). The involvement of left-hemispheric middle and superior temporal, inferior-posterior parietal, as well as inferior frontal brain regions in various sentence comprehension tasks has been revealed by a host of neuropsychological and neuroimaging studies (Dronkers [et al.] 2004; Pallier [et al.] 2011; Vigneau et al. 2006). Part of this supportive brain network is also the left-hemispheric lateral premotor cortex, sometimes extending more posteriorly into the primary motor area and more anteriorly into the middle frontal gyrus (Kemmerer 2015; Vigneau et al. 2006). The involvement of the motor system in sentence processing is not only due to phonological and articulatory mapping (Pulvermüller & Fadiga 2010) [...] because it also provides a grounding node for certain kinds of conceptual-semantic information. (Ghio & Tettamanti 2016: 647)

Ghio & Tettamanti (2016) emphasize in the context of syntactic processing (1) the role of classical language areas, but also areas involved in working memory and executive functioning which enable the simultaneous processing of phonological, semantic, and syntactic information in both reception and production, as well as (2) the role of frontotemporoparietal areas and specifically the role of the left lateral premotor cortex and surrounding areas in the processing of syntactical semantics. In psycholinguistics and neurolinguistics, most studies have been done in the domain of lexical semantics: “[M]uch less attention has been given to multi-word utterances such as phrases or sentences. In this respect, it has been observed that the meaning of a word presented in isolation is often underspecified and is, in many cases, prone to different interpretations.” (Ghio & Tettamanti 2016: 647). Nevertheless, the “syntax” studies deal mostly with action semantics. I shall focus on the implications of these studies for our understanding of transitivity and word order from the perspective of syntactic semantics. Problematically, in the psychosyntactic and neurosyntactic literature, there appears to be a degree of misunderstanding of what is semantics and what is syntax. The experimental designs of these studies and the putative hypotheses the studies are testing are not seldomly linguistically incompatible (e.g.,

testing hypotheses on syntactic transitivity using, exclusively, language materials from face and extremity action semantics).

3.2.1. Transitivity

Linguistic literature differentiates between semantic and syntactic transitivity, whereby syntactic transitivity conceptually originates from semantic transitivity: “There is a relationship between semantic and syntactic transitivity, since logically, syntactic transitivity can only be defined with reference to semantic transitivity.” (Creissels 2016: 18). Both semantically transitive and intransitive events and states⁴¹ can be syntactically coded transitively, while semantically transitive events do not have to be coded transitively. Semantic transitivity refers to events where two objects interact with each other. Semantic transitivity is not a categorical but a gradual semantic phenomenon, i.e., some events may be more transitive than others. Prototypical semantic transitivity involves events in which one participant (agent) changes the state or position of another participant (patient) through action (Creissels 2016: 18). Also, prototypical transitivity implies that the agent is consciously or volitionally acting to change the state of the patient or control his position. Conscious, i.e., volitional action implies the prototypical agent is animate or specifically human. Creissels notes that the meaning of the English word *break* is compatible with the highest possible level of semantic transitivity, which is not the case with the words *hit* and *eat*:

Hitting events are not prototypically transitive events, because the affected (or non-agentive) participant in a hitting event does not undergo a change of state or position, and consequently is not a typical patient. As regards eating events, the point is that the primary motivation of the action performed by the active participant in an eating event is not to change the state of the other participant or control its position, but rather to satisfy a physiological need, and consequently, the active participant in an eating event is not a typical agent.⁴²

⁴¹ “Transitive clauses can express a tremendous range of situation types, including many that have nothing to do with agentive behavior, as in *This line parallels that line* (for additional examples see Jackendoff 2002: 135–136).” (Kemmerer 2012: 53).

⁴² Creissels (2016: 19) adds: “[H]it is not a core transitive verb (and in many languages, hittees are coded differently from typical patients), and eat is not a core transitive verb either (which explains why many languages have two totally different translational equivalents of English eat, one of them transitive and the other intransitive, a situation that seems to never occur with core transitive verbs).”

The difference in the degree of semantic transitivity between the English verbs *break* and *hit* would be a potential yet weak argument that the prototypical patient is inanimate. Transitive verbs coding prototypical transitive events are called core transitive verbs. These are bivalent verbs which code these events in terms of subject and direct object and have the capacity to be the head of a clause. Terminologically, these verbs display basic transitive coding (Creissels 2016: 21). Barić et al. (432–435) differentiate between three semantic macrotypes of transitive verbs in Standard Croatian: (1) verbs whose actions move or change the object, (2) verbs whose actions establish a relationship towards an object, and (3) verbs denoting spatial and temporal relations. Creissels (2016: 19) defines core transitive verbs as a universal syntactic phenomenon, while the “delimitation of [...] [differently syntactically] transitive verbs [...] [is] language-specific and relies on formal criteria⁴³.” Creissels (2016: 19–20) adds:

By contrast, cross-linguistically, as discussed among others by Tsunoda (1985) and Lazard (1994) and confirmed by Hartmann et al. (2014), no other class of verbs defined in terms of semantic role assignment shows a comparable propensity to group together into the same valency class. This suggests a cognitive prominence of this semantic class of verbs, and justifies giving it a central status in a typology of argument coding and in a typology of the interface between argument structure and morphosyntax.

Wright (2001, 2002) differentiates between verbs of externally caused state change (e.g., *break*) and verbs of internally caused state change (e.g., *bloom*). Although both types of verbs appear in syntactically transitive coding frames, Wright (2001) showed that verbs of internally caused change appear significantly less in transitive constructions compared to verbs of externally caused change, that they typically include natural forces as agents, and that their use in transitive constructions is rated significantly less acceptable compared to verbs of externally caused change. Additionally, syntactically transitive verbs can also be coded intransitively, e.g., *Steven is eating in the kitchen*. (cf. Helbig & Buscha 2001: 48).

Neuroscientific studies potentially show that processing of transitive constructions is at least partly embodied in the perceptuo-motor system, at least in the case of semantically transitive verbs. Tettamanti et al. (2005) compared in their fMRI study passive listening of core transitive

⁴³ Cf. “For example, English *see* is not a core transitive verb, but the coding it assigns to its arguments identifies it as transitive, since verbs such as *break* or *fix* assign the same coding to their arguments. Basque *ikusi* ‘see’ is also a transitive verb, since its coding frame <ERG, Ø> is the same as that of *puskatu* ‘break’ [...]. By contrast, Akhvakh *harigurua* ‘see’ is not transitive, since its coding frame <DAT, Ø> is different from the coding frame <ERG, Ø> selected in Akhvakh *biq’orua* ‘break’ [...].” (Creissels 2016: 20).

sentences (face, foot, and hand actions) and semantically intransitive transitive sentences. Compared to semantically intransitive sentences, the semantically transitive sentences evoked higher activation in the left frontotemporoparietal network, including pars opercularis (BA 44, part of Broca's area), premotor cortex, inferior parietal lobule, intraparietal sulcus, and the posterior part of the middle temporal gyrus. The combination of activity in the motor and parietal areas, including BA 44, suggests the role of visuospatial mechanisms in the reception of transitive constructions which are also semantically transitive. The authors concluded: "These data provide the first direct evidence that listening to sentences that describe actions engages the visuomotor circuits which subserve action execution and observation." (Tettamanti et al. 2005: 273). The results of this study suggest that syntactic transitivity does not have a unified neural correlate and that brain activation during processing of syntactically transitive sentences depends on the degree of the coded semantic transitivity. It is interesting that the semantically transitive sentences elicited higher activation in the prefrontal areas, including BA 44 (traditionally believed to be part of Broca's area). Also, the results of this study suggest that processing of semantically transitive verbs in transitive coding frames is embodied in the perceptuo-motor system. However, it remains unclear whether the effect of embodiment is the result of action verb processing (as suggested by lexical action semantics studies) or is the effect of embodiment the result of the processing of the entire transitive proposition.

Glenberg & Kaschak (2002) investigated the effect of the given hand action on active listening of three types of sentences which approximately expressed a transfer of an object. Both hand actions and sentences differed in the direction of this transfer, toward the body or away from the body. They reported the ACE effect for all three sentence types: (1) imperative sentences (no examples given), (2) transfer of concrete objects (*He opened/closed the drawer.*), and (3) "abstract object transfer" (*Liz told you the story./I told Liz the story.*). The results suggest that the processing of syntactically transitive, but semantically intransitive constructions is embodied in the motor system as well.

Ferretti et al. (2001) reported from their animacy and lexical decision tasks that transitive verbs prime typical agents (e.g., *arresting-cop*), patients (e.g., *arresting-criminal*), and instruments (e.g., *stirred-spoon*) but not locations (e.g., *swam-ocean*). In the first two conditions, gerunds were used, while in the other two conditions, preterites were used: "The past-tense form was

used as opposed to the ing form used in Experiments 1 and 2 because an ing ending often resulted in an adjective-like pairing with the noun target” (Ferretti et al. 2001: 525). Because the study employed a short stimulus-onset asynchrony (250 ms), the results suggest an automatized functional connectivity between action verb meanings and specific concepts which can appear in various semantic relations with the verb in semantically compositional constructions. This implies that with the activation of these verbs, other concepts which typically build argument structures with the verb are also activated through spreading semantic activation. This further indicates that it would be potentially difficult to differentiate between the effect of action and the effect of either agent, patient, or instrument and that during the activation of these verbs, entire semantically transitive scenarios typical for this verb are also activated. Finally, this indicates that the embodiment effect observed in previously described studies is indeed associated with the entire transitive scenario and not only with the action verb or other coded components.

Adani et al. (2017) investigated the acquisition of transitive relative clauses (e.g., *Welche Farbe hat der Mann, den der Junge kratzt?* ‘Of which color is the man who is being scratched by the boy?’). The authors concluded based on their results that animacy and grammatical number modulate the acquisition of these constructions in three-year-old children. In four-year-old children (and more markedly in five-year-old children), the processing of these constructions appears faster and more efficient when the two noun phrases differ in grammatical number. Other studies have found that morphology can modulate the inclusion of perceptuo-motor areas in the processing of sentences of the type subject–verb–object. Sentences expressing actions which did not happen despite the potential agent’s volition (e.g., *He wanted to close the door.*) did not elicit the ACE effect, contrary to past tense (e.g., *He opened the bottle.*) and pluperfect sentences (e.g., *He had opened the bottle.*) (Zwaan et al. 2010; see also Bergen & Wheeler 2010; Taylor & Zwaan 2008). Using fMRI, Progovac et al. (2018) compared reading of Serbian sentences with verbs coded in transitive and mediopassive frames (e.g., *Mama, ovaj pas se ujeda!* ‘literally: Mom, this dog is biting himself!’, i.e., ‘Mom, this dog is biting (me)!’ and *Ne guraj se!* ‘Don’t push (yourself)!’). They recorded significantly higher activation during reading of transitive sentences bilaterally in basal ganglia and BA 6. However, there are several potential issues in the study. Firstly, Progovac et al. (2018) analyze the mediopassive constructions as “more rudimentary” compared to transitive constructions because they are missing the “transitive layer” according to the minimalist model. Drawing their arguments from the minimalist model, the

authors also describe the mediopassive constructions as “minimal syntactic structures”. This seems problematic because the mediopassive verbs from the examples are all derived variants of transitive verbs. Furthermore, the glosses in the paper suggest that the mediopassive constructions could be interpreted as both semantically transitive and semantically intransitive. Secondly, in most places in the text the authors write that the experimental language was Serbian, yet in the description of the subjects it is noted that the subjects were speakers of Serbo-Croatian⁴⁴ (testing was conducted with the diaspora in the US). Thirdly, as the authors also confess, all subjects were “fluent” in English. Independently of these issues, this study investigated a language with the richest morphology thus far.

3.2.2. Word order and Broca’s area functions

Basic transitive constructions are often used to define a language’s basic word order which typically refers to the order of the constituents verb (predicate), subject, and object. However, the notion of basic word order has been criticized in the linguistic literature, largely because there are no clear criteria for determining basic word order in a given language and because of the potentially problematic universalist view on syntactic constituents of subject and object which, it appears, does not reflect linguistic typological reality:

It is standard practice in typological studies to classify languages in terms of the basic order of the positioning of their subject, the verb and the object. For a wide variety of reasons, a wide variety of scholars have deemed such a classification problematic: the various criteria that have been appealed to in order to motivate one or another basic order often lead to contradictory results, some languages seem to manifest no basic order by any reasonable criteria, and the ‘subject’ and ‘object’ relations themselves are problematic, both in that no consistent criteria exist to identify them cross-linguistically and in that some languages might lack such relations altogether. (Newmeyer 2003: 69)

The notion of basic word order is associated with the broader notion of canonical word order which is typically observed in „main clause declaratives when the subjects and objects are encoded by fully referential lexical noun phrases (as opposed to pronominal or clitic elements).”

⁴⁴ Although it would be very problematic to compare “Croatian” and “Serbian” on a cognitive level from a number of aspects, I will just say that my “Croatian” mental lexicon (or its conscious part) can interpret the debatable isolated laboratory construction *Mama, ovaj pas se ujeda!* either as a reflexive (i.e., that the dog is biting itself) or as a type of subjective modality (i.e., that the dog can and/or should be bitten by an onlooker). Both interpretations refer to semantically abnormal events and these meanings were not intended by the authors. In fact, this sentence appears ungrammatical to me.

(Newmeyer 2003: 69). However, the relative frequency of canonical sentences in language corpora is “extremely low”. Because of this, Newmeyer (2003: 70) writes of the canonical word order paradox – „the fact that canonical sentences, though minoritarian in actual discourse, have typological importance”. Newmeyer (2003: 84–85) concludes in the end, however, that the identification of the canonical or basic word order using canonical sentences is justified:

Now, of course, such sentences are not frequently uttered – efficient discourse packaging keeps them from being used very often. But the processing-based links that form the basis for typological generalizations seem to pay attention to most frequently used canonical ordering, rather than the most frequently used utterance type in general. The speaker of French, as Lambrecht points out, utters sentences like *Elle l'aime* more frequently than those like *Marie aime Jean*. But he or she certainly utters sentences of the latter form more frequently than sentences like *Marie Jean aime*. And because of that, French behaves typologically like an SVO language, not like an SOV language.

Of the six possible basic word order combinations, the dominant word orders across the world's languages are subject–object–verb (SOV) and subject–verb–object (SVO). The first to have shown this using typological analysis was Greenberg (1963) (cf. Gell-Mann & Ruhlen 2011). The most comprehensive study thus far has been conducted by Dryer (2011) on a sample of 1377 languages. 86 % of the languages in the sample have a basic word order. All six possible basic word orders are evidenced in the sample. SOV and SVO are dominant. SOV and SVO are dominant basic word orders in sign languages as well (Napoli & Sutton-Spence 2014).

Kemmerer (2012: 52) summarizes other studies also suggesting that SOV and SVO are the dominant word orders:

Additional evidence that SOV and SVO word orders are overwhelmingly preferred comes from several other sources. First, Kimmelman [2012] found that in a sample of 24 sign languages, 21 (88%) have SOV and/or SVO as the dominant sequencing pattern(s). Second, within the last 70 years, Al-Sayyid Bedouin Sign Language (ABSL) has gradually arisen in an isolated community with a high incidence of genetically based prelingual deafness, and in the space of a single generation, it assumed a grammatical structure characterized by SOV order (Sandler et al. 2005). Given that none of the neighboring spoken or signed languages are SOV, this property of ABSL presumably developed spontaneously. Third, Goldin-Meadow et al. (2008) asked speakers of three SVO languages (English, Spanish, and Mandarin) and one SOV language (Turkish) to perform two non-verbal tasks: first, describe events using manual gestures without speech; and second, reconstruct events illustrated in pictures. The investigators found

that in both tasks all of the participants were strongly inclined to use the same sequencing strategy – specifically, agent-patient- action, which is analogous to the SOV pattern in spoken languages. Taken together, these three sets of results support the view that SOV and SVO word orders – perhaps especially the former – reflect the most cognitively natural ways of linearizing the fundamental elements in a transitive clause.

Kemmerer (2012) emphasizes two basic principles which likely largely explain the dominance of the SOV and SVO word orders: (1) subject saliency according to which the subject precedes the object, and (2) verb and object juxtapositioning. Subject saliency may have a stronger effect on word order since “the third most common ordering pattern, VSO, preserves the former principle at the cost of violating the latter (Song 1991)” (Kemmerer 2012: 53). Kemmerer assumes that subject saliency is largely based on the understanding of core transitive events in which the agent is the head of a causative chain affecting the patient. Similarly, Kemmerer further believes that verb and object juxtapositioning might reflect the fact that in core transitive events the patient’s change is not directly associated with the agent but with the action: “[I]t is the agent’s action, rather than the agent per se, that changes the state of the patient.” (Kemmerer 2012: 54).

Cohn & Paczynski (2013) conducted a study in which subjects viewed visual depictions of events. The authors reported that subjects who had prior information about the agent better predicted the possible actions compared to subjects who had prior information about the patient, that agents are viewed significantly longer compared to patients independently of order of presentation, and that visual depictions of events are processed faster after agent presentation compared to patient presentation: “We suggest that Agent First orders facilitate the interpretation of events as they unfold and that the saliency of Agents within visual representations of events is driven by anticipation of upcoming events.” (Cohn & Paczynski 2013: 73). Cohn et al. (2017) reported further results suggesting that humans predict the course of a transitive event using information about the preparatory body postures in agents (e.g., waving the arm backwards to throw or hit). In their ERP-study “[p]reparatory agents evoked a greater frontal positivity (600–900 ms) relative to non-preparatory agents and patients, while subsequent completed actions panels following non-preparatory agents elicited a smaller frontal positivity (600–900 ms). These results suggest that preparatory (vs. non-) postures may differentially impact the processing of agents and subsequent actions in real time.” (Cohn et al. 2017: 1). Furthermore, it has been suggested that the world’s languages prefer accusative-nominative structures compared

to ergative-absolutive⁴⁵ (Nichols 1993). Ergativity understands the marking of the subject (i.e., agent) if the verb is transitive. If the agent is the cognitively most salient component of a transitive event, the assumption in morphosyntax would be that the agent should be typically coded via some neutral form.

There are indications from experimental studies that the first noun phrase in a sentence is automatically processed as a subject and/or as referring to an agent, independently of the language's word order or the word order in a given experimental sentence. Bornkessel et al. (2004) conducted an ERP-study in which they investigated the reception of dependent object clauses in which the syntactical roles of subject and dative object, i.e., the semantic roles of agent and patient, were ambiguous until the last word in the sentence whose place was taken by a finite form of the auxiliary verb for building the perfect tense, e.g. ... *dass Betram Surferinnen gratuliert hat*. '... that Betram congratulated the [female] surfers' and ... *dass Betram Surferinnen gratuliert haben*. '... that the [female] surfers congratulated Betram'. In the second type of clauses, the authors observed in the evoked brain potentials a combination of biphasic negativity after 400 ms and late positivity. No significant amplitudes were observed in the first type of clauses. Results suggest that the first noun phrase (when in neutral form) is automatically analyzed as an agent by the semantic system and as a subject by the syntactic system until there is a "rule break" and the sequence is re-analyzed. Notably, all sentences combined proper nouns and human-denoting feminine nouns, so these results might be due to an interaction between the effect of the first position in the sentence (noun phrase in a neutral form) and humanness effect. Comparable results were reported by Bickel et al. (2015) who investigated this using ERP in speakers of Hindi, a language displaying ergativity in some contexts "where initial base-form noun phrases most commonly denote patients because many agents receive a special case marker ("ergative") and are often left out in discourse".

Barðdal et al. (2014) discussed the so-called alternating predicates in Icelandic and German. Alternating predicates include predicates in dative-nominative constructions which exhibit two

⁴⁵ Cf. Bickel et al. (2015: 2) who analyzed a sample of 617 languages: "[S]ubstantial proportions of ergatives cluster only in what we call here the Pacific region (New Guinea, Australia, Oceania) and, to a lesser extent, in South America. Even in these regions, ergatives are often confined to subsystems of grammar, e.g. they occur only with third person pronouns, but not others, or only in certain tenses or aspects. In fact, the use of the Hindi ergative is also limited to sentences that contain what is called 'perfective aspect' verb forms. This skewed distribution raises the possibility that a species-wide principle acts against the development or maintenance of ergatives over time."

linear argument structures: Dat-Nom and Nom-Dat⁴⁶. Barðdal et al. showed in a thorough linguistic analysis that both dative and nominative arguments in alternating predicates can be syntactically analyzed as subjects, depending on whether they have taken the first position in the Dat-Nom construction or not: “When the word order is Dat- Nom, the dative takes on the behavioral properties of subjects, whereas with the Nom-Dat word order, the nominative shows exactly the same behavioral subject properties (Barðdal et al. 2014: 95). In German Dat-Nom constructions (e.g., *Mir gefällt das Lied*. ‘literally Me likes the song.’, i.e., ‘I like the song.’), whose predicates are exclusively alternating, the first argument acts syntactically as a subject, independently of the case of the noun phrase. In Icelandic both non-alternating (e.g., *líka*) and alternating predicates (e.g., *falla*) can enter Dat-Nom constructions. Although Barðdal et al. do not address the cognitive aspects of Dat-Nom constructions, their linguistic analysis indirectly supports the assumptions on the association between the first argument in a sentence and the semantic role of agent. If we assume that the subject argument evolutionarily arose from the semantic role of agent, the observed argument rule in the Dat-Nom constructions with alternating predicates in Icelandic and German potentially reflects a conservative syntactic-semantic phenomenon according to which the first argument in a sentence is principally reserved for the semantic role of agent or a role which is semantically closest to the agent (in this case, the experiencer).

Relative language universals can be a reflection of cultural-historical processes, but they could also be a manifestation of some robust cognitive mechanisms. Dunn et al. (2011) believe that word order and the putative structural generalisations inferred from it are best explained by cultural-historical processes⁴⁷:

First, contrary to the generative account of parameter setting, we show that the evolution of only a few word-order features of languages are strongly correlated. Second, contrary to the Greenbergian generalizations, we show that most observed functional dependencies between traits are lineage-specific

⁴⁶ “[A] detailed comparison between the two word orders shows that one is not a topicalization of the other, but that these are in fact two distinct, but related argument structure constructions.” (Barðdal et al. 2014: 95).

⁴⁷ See Croft et al. (2011) for one of the many commentaries and criticisms of the paper by Dunn et al. (2011): “We argue in this commentary that certain assumptions made by Dunn and colleagues in the application of the model pose serious issues in accepting the conclusions, notably the absence of any Type II error analysis to assess the rate of false negatives, the absence of contact effects, and the nature of the phylogenies used. Although our examination of Dunn et al.’s analysis is critical, we nevertheless believe that typologists should welcome the model and encourage the development of a revised model with more linguistically plausible assumptions.” (Croft et al. 2011: 433–434; see also Croft 2016).

rather than universal tendencies. These findings support the view that—at least with respect to word order— cultural evolution is the primary factor that determines linguistic structure, with the current state of a linguistic system shaping and constraining future states. (Dunn et al. 2011: 79)

If we assume that there is a cognitive factor affecting the typological variation in word order in the manner that SOV and SVO word orders are the dominant ones, then the mere existence of other word orders implies that this cognitive factor is not the only factor modulating typological variation in word order. Nevertheless, neuroscientific studies suggest that there is a strong cognitive preference for SOV and SVO word orders. Kemmerer (2012) proposes that the two most frequent word orders in world's languages reflect the natural ways in which Broca's area conceptually processes actions. Anatomically, Broca's area relates to Brodmann's areas 44 (pars opercularis) and 45 (pars triangularis) within the left inferior frontal gyrus. However, due to functional connections between BAs 44 and 45, and some other areas, some experts have proposed the notion of Broca's complex which would additionally encompass BA 47 (pars orbitalis) (Hagoort 2005), while some have proposed the inclusion of BA 46 and parts of BA 6 as well (Ardilla et al. 2016). In any case, there are great anatomical variations in Broca's area, including location, in the human population:

Considerable individual anatomical and morphological variations between the inferior frontal gyrus and related sulcal structures were detected. ... The inferior frontal sulcus was identified as a single segment in 54 % of the right and two separate segments in 52 % of the left hemispheres, which was the most common pattern. The diagonal sulcus was present in 48 % of the right and 54 % of the left hemispheres. It was most frequently connected to the ascending ramus on both sides. A 'V' shape was observed in 42.5 % of the right hemispheres and a 'Y' shape in 38.3 % of the left hemispheres, which was the most common shape of the pars triangularis. ... Knowledge of the anatomical variations in this region is indispensable for understanding the functional structure and performing safe surgery. However, most previously published studies have aimed to determine the anatomical asymmetry of the motor speech area without illuminating the topographical anatomy encountered during surgery. (Eser Ocak & Kocaeli 2017: 357)

Broca's area is traditionally associated with speech production (Mildner 2015: 76–78). However, studies have shown that Broca's area is also associated with specific linguistic processes (Grodzinsky & Amunts 2006; Grodzinsky 2000). Tyler et al. (2011) demonstrated that BA 45, BA 47, and the posterior middle temporal gyrus are involved in syntactic processing in healthy subjects who were compared to patients with left hemisphere damage. During passive listening

of sentences brain activation was in significant correlation with white matter integrity of BA 45 and posterior middle temporal gyrus: “On this view, the left inferior frontal gyrus may not itself be specialized for syntactic processing, but plays an essential role in the neural network that carries out syntactic computations.” (Tyler et al. 2011: 415). If we are to judge from the one given example, sentence stimuli were dependent object sentences with a short head clause containing a verb phrase (subject and verb, e.g. *The newspaper reported...*) and a dependent clause which contained a predicate noun whose subject was a combination of a gerund and genitive noun (e.g., ... *that bullying teenagers is bad for their self-esteem.*). It is interesting that the authors observed here the role of BA 45 using more complex syntactic structures compared to studies of semantic transitivity which reported association with BA 44 (e.g., Tettamanti et al. 2005). Given that the two Brodmann areas are leaned on each other and that it is believed they form a functional unit, it would be tempting to suggest that eventual mechanisms of schematization of the existing conceptual action knowledge evolutionarily enabled in BA 45 the integration of functions with BA 44 which are clearly, among others, associated with action semantics and semantic transitivity processing:

[T]he posterior part of Broca’s area – i.e., BA44 – is essential for (1) representing actions during both execution and observation, (2) representing actions at a conceptual level that is body-part-independent, (3) representing specifically the sequential and hierarchical organization of action concepts, and (4) representing the canonical linearization of action concepts in transitive clauses. (Kemmerer 2012: 56)

Several scholars have suggested that, from an evolutionary perspective, once BA44 became adept at extracting the skeletal structure of goal-directed actions, it could then apply that ability to other cognitive domains (e.g., Fiebach and Schubotz 2006; van Schie et al. 2006; Tettamanti and Weniger 2006; Fadiga et al. 2009; Pulvermüller and Fadiga 2010). And in fact there is growing evidence that BA44 does play a pivotal role in identifying the hierarchical patterns that are latent in many different kinds of sequential events, including music (e.g., Maess et al. 2001), visuospatial stimuli (e.g., Bahlmann et al. 2009), artificial grammars (e.g., Friederici et al. 2006), and, as described in the immediately preceding section (i.e., Section 3.5), natural grammars. (Kemmerer 2012: 61)

However, Broca’s area is only one of the brain areas involved in linguistic syntactic processing. Thus, independently of the validity of these claims, other anatomical and functional units should be included into theorizing and speculation as well (cf. Tate et al. 2014).

Broca's area is highly multifunctional. Its role has been observed in motor skills for tool use (Hopkins et al. 2017) and the production of nonverbal motor behaviors in general (Hupfeld et al. 2017), nonverbal action understanding (Fazio et al. 2009), imitation (Kühn et al. 2013), music (Elmer et al. 2018; Fedorenko et al. 2009; Kunert et al. 2015; Fadiga et al. 2009), visuo-spatial perception (Bahlmann et al. 2009), etc. Kemmerer (2012: 55) adds: "These findings have prompted a search for a common functional denominator, and some of the major candidates currently being debated are cognitive control (e.g., Novick et al. 2010), sequence processing (e.g., Gelfand & Bookheimer 2003), and hierarchical processing (e.g., Koechlin & Jubault 2006)." Based on a detailed review of the literature Kemmerer concludes that the typologically dominant word orders SOV and SVO reflect the temporal structure of the causal action chain coded in Broca's area, which has evolutionarily exapted from an older system of sequential and hierarchical processing of bodily movements and actions. Stil, Kemmerer (2012: 62) admits this is speculative:

Although this proposal is grounded in a wealth of empirical studies, it is admittedly a bold and speculative attempt to bridge the gap between linguistic typology and cognitive neuroscience. Whether it is on the right track remains to be seen, but hopefully it will stimulate further research on the interaction between the cross-linguistic representation of action and the functional architecture of Broca's area.

4. PROTOLANGUAGE MODEL OF LANGUAGE EVOLUTION

4.1. One words, two words...

Jackendoff & Wittenberg (2014) propose a hierarchical model of syntax evolution which takes into account the number of words which can be combined for the purposes of an utterance and the possibilities of grouping words of one utterance into phrases. The authors employed the method of introspection: “[W]e are adopting the unfamiliar and sometimes painful methodology of assuming as little syntactic structure as possible.” (Jackendoff & Wittenberg 2014: 67). The authors hope their model will provide a high-quality theoretical frame for research of interlanguage differences in syntactic complexity and for the description of “certain subsystems of fully complex languages, stages of language acquisition, aspects of language processing, and, crucially, the interplay of language with other cognitive systems.” Jackendoff & Wittenberg (2014) suggest that the earliest stages of syntax evolution demanded more efforts in pragmatic and contextual processing. More complex grammars express thoughts more explicitly and thus presumably lower the cognitive demands of language reception.

The earliest grammar of which Jackendoff & Wittenberg could think is the one-word grammar. In one-word grammar there can be only one-word utterances. The authors relate the one-word grammar to vocalizations of non-human primates, early phases of language acquisition, and some modern-language lexical structures which do not appear to exhibit neither lexical-semantic or syntactic properties, e.g., *hello*, *ouch*, *upsey-daisy*, *abracadabra*, etc. With the lack of morphosyntax, pragmatic enrichment is crucial for understanding utterances of one-word-grammar languages. The next putative phase in syntax evolution was the two-word grammar in which one or two lexical units can constitute an utterance. In a two-word grammar the semantic relationship between two words in a two-word utterance is not explicitly expressed. It can thus be assumed that pragmatic processing is crucial in two-word grammars as well, but perhaps to a lesser degree compared to one-word grammars. Jackendoff & Wittenberg (2014) note the functional-argument, modification, a co-argument shemas as three ways of semantically combining words in an utterance. The authors associate two-word grammars with pivot schemas in child language where a specific number of words is more or less systematically combined with a large number of other words. After the two-word grammar, the concatenative grammar

emerged (according to the model) which enabled combining an infinite number of words in a single utterance, but these words could not have formed phrases. Although the authors believe that the order of thematic roles (or word order) and information structure (thema/remata) were likely relevant factors in concatenative grammar, it is unclear whether these phenomena appeared in the two-word or concatenative grammar stage of language evolution. In the next stage of syntax evolution, the grammar of simple phrases, words can be combined into phrases but phrases cannot contain other phrases. The authors mention both prosody and syntactic constituents as mechanisms of combining words into phrases. The last phase of syntax evolution would, according to the authors, be the grammar of recursive phrases.

It is difficult to comment on this model of language evolution because it is largely based on introspection, yet it is possible to integrate the findings described previously in this paper into parts of Jackendoff's and Wittenberg's (2014) model. Vervets' alarm calls would correspond to a one-word grammar. If humans also began with a one-word grammar, the present data suggest that it is more likely that the first words were concrete and/or highly imageable rather than abstract. It is also possible that the first words denoted animate entities and/or actions. Presumably, in two-word grammars words emerge which have meanings more typical for modern-like nouns and verbs. Because studies suggest that semantic transitivity is more embodied in the perceptuo-motor system compared to semantic intransitivity and that basic transitive coding is a linguistic universal, the first two-word combinations could have referred to transitive events. One word might have had a verb-like character and denoted an action, while the other word could have denoted an agent or a patient. It is difficult to say whether agents and patients can be evolutionarily differentiated. Because studies have demonstrated the saliency of animacy and agentivity as semantic categories, and the saliency of the subject as a syntactic category, it appears plausible that in two-word utterances composed of words referring to an agent and their action the agent took the first position in the utterance, i.e., the position before the action-referring word. This would suggest that there was inevitably a specific linear rule applied in coding agents and their action, indicating that the formation of a verb phrase was inevitable and that the first phrases might have been present already in two-word grammars.

4.2. Language fossils and protolanguage as language evolution models

Bickerton (1990) proposes that syntax evolution happened in two steps. The first step was the emergence of protolanguage and the second step was the emergence of modern-like language. Bickerton assumes that protolanguage existed due to the putative presence of “language fossils” in modern languages:

It should be apparent that no event happens in the world without leaving traces of itself, subtle and indirect though these may be. Often the only possible evidence for a past event appears in the ripples spreading out from it that can still be discerned in the contemporary world. The origins of the universe, for instance, cannot be observed directly, but can be deduced from currently observable phenomena such as background radiation and the red shift of receding galaxies. It therefore seems only reasonable to suppose that there may exist contemporary phenomena—that would give us some insight into the processes through which language emerged. (Bickerton 1990: 106)

Language fossils are synchronic linguistic systems which, in general words, differ from most synchronic linguistic systems (or stable modern languages) in morphosyntactical complexity. Thus, the protolanguage and language fossil theorizing is mostly limited to morphosyntax. In the meantime, the term *language fossil* has extended its meaning to also include modern languages in stable linguistic communities such as Riau Indonesian, Pirahã, and some newly emerged sign languages (Sandler et al. 2005). Some have also proposed that there are fossil constructions within (“normal”) modern languages. For example, Progovac (2016) proposes that Serbian verb-noun compounds (e.g., *cepidlaka*, *jebivetar*) can from a minimalist perspective be considered language fossils: “In syntax one can define living fossils as constructions which exhibit rudimentary syntax/semantics, not accounted for by the principles of modern(morpho)syntax, but which nonetheless show some continuity with it.” (Progovac 2016: 3). It would thus appear that there exist neither a clear definition of language fossils, nor objective criteria for identifying them.

Bickerton (1990: 105ff.), who was the first to introduce the notion of language fossil into linguistics, lists four putative groups of language fossils: human languages as learned by captive apes (Bickerton 1990: 106–110; Wallman 1992), language of children under two years of age (Bavin 2009; Cattell 2007; Clark 2009), language of feral children, as well as pidgins (Botha 2006; Roberge 2008). Putative key differences between protolanguage from language fossils and modern language include non-existence of basic word order in protolanguage, verbs have only

adjuncts (i.e., arguments are never obligatory), phrases are short and simple, and there is a lack of grammatical words and morphemes.

4.2.1. Pirahã as a language without embedding

Pirahã is a language spoken in Amazonia by a group of approximately 500 speakers. The key linguist in the research of Pirahã is Daniel L. Everett who has spent a great deal of his life with the Pirahã speakers. Hurford (2012: 389) notes that the most comprehensive investigations of Pirahã can be found in Everett (1986, 1987). However, Everett (2005) is a much more well-known publication on Pirahã and also a highly controversial one. Everett (2005) lists several Pirahã features which he believes are considerably simpler compared to what can be found in other languages of the world. Among others, Everett (2005: 628) claims that Pirahã does not exhibit embedding: “One more unusual feature of Pirahã, perhaps the strangest of all, is the absence of clear evidence for embedding. Indeed, the evidence suggests that Pirahã lacks embedding altogether.” It is very difficult to interpret Everett’s (2005) assumptions (not *evidence*) about embedding in Pirahã: “[A]n outsider to this debate not very familiar with Pirahã cannot hope to arbitrate in such cases.” (Hurford 2012: 393). Furthermore, Everett’s (2005) papers has been harshly criticized and attacked⁴⁸ by a number of linguist and non-linguist experts, and it cannot be denied that the methods in Everett (2005) are disappointingly and alarmingly intransparent, bringing Everett’s interpretations into question (at best). Everett (2005: 629), among others, claims that the verb *gái* ‘say’ does not embed a dependent object clause like in some other languages but that the verb is “nominalized” by adding the suffix *-sai*:

The verb “to say” (*gái*) in Pirahã is always nominalized. It takes no inflection at all. The simplest translation of it is as a possessive noun phrase “my saying,” with the following clause interpreted as a type of comment. The “complement clause” is thus a juxtaposed clause interpreted as the content of what was said but not obviously involving embedding.

Everett mentions a few other examples of the putative verb nominalization before a juxtapositioned “clause” which is putatively semantically but not syntactically related to the previous “clause”. Everett glosses the putative suffix *-sai* with the meaning *nominative*, but the

⁴⁸ E.g., “Everett has missed an opportunity here to follow up on interest generated by Gordon’s (2004) persuasive analysis of the Pirahã absence of numeracy: only with a sober catalogue of carefully documented features would we be in a position to ask whether they formed a larger pattern and what the origins of that pattern might be.” (comment by Stephena Levinsona, Everett 2005: 638).

putative suffix *-áa'ái*, putatively used for nominalizing the verb *ob* 'see', with the meaning *attractive*⁴⁹. Hurford (2012: 393) notes: "Many languages, including Hungarian, Turkish, Shona, and Japanese, use a verbal affix to express a causative meaning that in English would be expressed by an embedded clause." Hurford includes here the language Inuktitut as well, citing Kalmár (1985: 159):

The normal equivalent of a complement [embedded] clause in Inuktitut can be expressed as a morpheme within the boundaries of the verb: There are the suffixes *-guuq* (it is said that, he/she/they say that), *-tuqaq* (it seems that), *palatsi* (it sounds like), and perhaps some others. In such cases the resulting word is like a complex sentence with a complement clause [in other languages].

Futrell et al. (2016) conducted a corpus study of embedding of Pirahã and concluded: "We do not find unambiguous evidence for recursive embedding of sentences or noun phrases in the corpus." Nevins et al. (2009) discuss that *sai* is actually a subordinate conjunction. Hurford (2012: 394ff.) reviews literature on other languages for at least some authors believe do not exhibit embedding but drew no firm conclusions.

4.2.2. Riau Indonesia as an isolating-monocategorial-association language

Riau Indonesian is spoken by approximately five million speakers. "Riau Indonesian' is a label conveniently given to a group of closely related Malay-derived dialects spoken in the province." (Hurford 2012: 401). Riau Indonesian is the mother tongue of the majority of children growing up in the Riau province. The following information was extracted from Gil (2009). In line with the protolanguage model, Gil (2009) assumes that language was syntactically considerably simpler during the early phases of language evolution compared to modern languages, as well as that there are modern languages of very low syntactic complexity, comparable of the early syntactical stages of language evolution. Gil (2009) proposes a model for such languages, calling them isolating-monocategorial-associational (or IMA) languages. The term implies that that IMA languages do not exhibit morphology, syntactical categories, or semantic compositionality. Instead of rules of semantic compositionality, compositional meanings are understood via an "associational operator" which creates a semantic relationship between the words. Taking the model of Jackendoff & Wittenberg (2014) into account, Gil's (2009) model would correspond to

⁴⁹ A non-linguist reader of this text should not be confused by the incidental *-ive* in both *nominative* and *attractive*, as the latter does not represent a grammatical case.

two-word-grammar phase (or concatenative-grammar phase), but the status of phrases and recursion in Gil's model remains unclear. In any case, Gil (2009) notes that a natural IMA language has thus far not been discovered, which is why he differentiates between pure and relative IMA languages. As an example of a relative IMA language, Gil (2009: 23) proposes Riau Indonesian. Gil (2009: 23) states that the "basic sentence structure" in Riau Indonesian can be characterized as a pure IMA segment. He exemplifies this with the sentence *Ayam makan*, in which *ayam* denotes a chicken and *makan* denotes an eating action. According to Gil (2009), it is unclear whether in such a sentence *ayam* should be interpreted as the agent or the patient⁵⁰. Gil further writes that such sentences are "typical" of Riau Indonesian and that they are not "telegraphic" or otherwise stylistically marked in any way." According to Gil (2009), Riau Indonesian cannot be viewed as a pure IMA language because it exhibits affixation, compounding, reduplication, truncation, and other morphological phenomena for which Gil (2009) states are not obligatory. Furthermore, both open and closed morphosyntactic categories are present in Riau Indonesian, as well as "additional rules of compositional semantics that make reference to specific lexical items or to particular syntactic configurations, for example, word order." Gil's (2009) model is in line with some of the propositions from Jackendoff & Wittenberg (2014) as it suggests that syntactic categories are not needed to understand utterances from two-word and concatenative grammars. However, the question of word order remains somewhat unanswered in Gil's paper. Many are sceptical of Gil's model and accounts of Riau Indonesian:

Gil writes: "So far, I have found no evidence for syntactic categories other than the open category S and the closed category S/S, and no evidence for syntactic structures other than those that can be built up recursively from subtrees such as those in (9)." That is good as far as it goes, but one can legitimately wonder how hard he has looked. Has he looked hard enough to discover a difference like Agent Raising, if something comparable were to exist in RI? [...] I do not want to convey disrespect for Gil [...].

Gil's methodology, similar to Everett's (2005) is highly intransparent, making his interpretations and assumptions inevitably questionable and controversial. Furthermore, I agree with Baker (2005) that it would be interesting to explore the positions in which subjects, i.e., agents appear in the sentence, given the assumption of subject and agent saliency.

4.2.3. Modern-language structures as language fossils

⁵⁰ A year ago in an Indonesian restaurant in Cologne, Germany, I asked the waiter, an Indonesian and native speaker of "Indonesian", what does *Ayam makan* mean. He replied *Chicken eats*.

While Gil (2009) proposes that there are entire modern languages which correspond to early syntax evolution stages with their low syntactical complexity, Progovac (2016) proposes that there are syntactic structures in all modern languages which are a reflection of some earlier phases of syntax evolution, equating them with language fossils. Progovac (2016: 2) bases her assumptions on the minimalist model of syntax in which sentences and phrases are analyzed as hierarchical structures which can be divided into several layers. The part of the hierarchy Progovac uses comprises three layers: basic verb phrase, transitive verb phrase, and tense phrase. For example, in the English sentence *Deer will eat fish.*, *eat fish* is a basic verb phrase. In basic verb phrases subjects and objects are not differentiated. By introducing the subject, an explicit transitive layer is created: *deer eat fish*. The tense layer is hierarchically the highest because both basic verb and transitive verb phrase layers are needed for the tense layer. Progovac (2016) assumes that one of the earliest phases of syntax evolution was the phase of basic verb phrases, basing her assumptions on an explorative review verb-noun compounds in English and Serbian. (e.g., *killjoy*, *jebivetar*). Such a phase of basic verb phrases would correspond to a two-word grammar in whose utterances one word would be more similar to verbs, while the other to nouns. Furthermore, “noun” is not marked with respect to thematic or syntactic roles.

In any case, I believe there is an issue in this model, as well as other models which propose that the first two-word combinations displayed no syntactical behavior. In these models the two words in the utterance denote atomic concepts (compared to propositions). By its definition, a two-word utterance expresses a proposition in which the two concepts denoted by the words have to be in some semantic relationship. If we assume that there are no rules to define which semantic role should be assigned to a particular word in the utterance, this would mean (a) that in cca. 50% of the situations, the speakers would use this or that order for the same combination of words but (b) that the listener would understand the utterances in cca. 100% of the situations. If this is true, then the two words used could only be used with one (“predetermined”) semantic role. In other words, a combination of two words such as *elephant* and *kill*, could only convey either the proposition ELEPHANT KILLS or ELEPHANT (BEING) KILLED, independently of the word order. Otherwise, and in the absence of relevant situational stimuli, the listener could never understand the utterance, despite understanding the individual words.

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