The evolution of syntax: what do we know?

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Linguistisches Kolloquium 2019/20, Department of English and Linguistics, Johannes Gutenberg-Universität Mainz, 18/11/2019

The evolution of syntax: what do we know? ➡ NOTHING

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PROLOGUE: do we know anything about language evolution?

„For centuries, people have speculated over the origins of human language. […] The irony is that the quest is a fruitless one. Each generation asks the same questions, and reaches the same impasse – the absence of any evidence relating to the matter, given the vast, distant time-scale involved. We have no direct knowledge of the origins and early development of language, nor is it easy to imagine how such knowledge might ever be obtained. We can only speculate, arrive at our own conclusions, and remain dissatisfied. Indeed, so dissatisfied was one group of 19th-century scholars that they took drastic action: in 1866, the Linguistic Society of Paris published an edict banning discussion of the topic at their meetings. But the theorizing continues, and these days there is a resurgence of interest, as new archaeological finds and modern techniques of analysis provide fresh hints of what may once have been." (Crystal 1998)

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Embodied syntax	• Transitivity • Word order

Human evolution

- „It would appear that the modern-human-origins debate is not for the faint of heart." (Lindly & Clark 1990: 251)
- Human evolution is a highly controversial topic both within and outside of the scientific realm.
  - Creationism
  - General public etc.

Source: ScienceAlert

Language evolution and archaeology (1)

- Language evolution is necessarily an interdisciplinary topic.
- Linguistic studies and discussion are few and far between.
- Much of the work so far has been done by palaeoanthropologists and archaeologists. Their hypotheses remain, however, mostly speculative.
- E.g. the putative perforated *Nassarius kraussianus* shell beads from South Africa (Henshillwood et al. 2004; d'Errico et al. 2005)

Language evolution and archaeology (2)

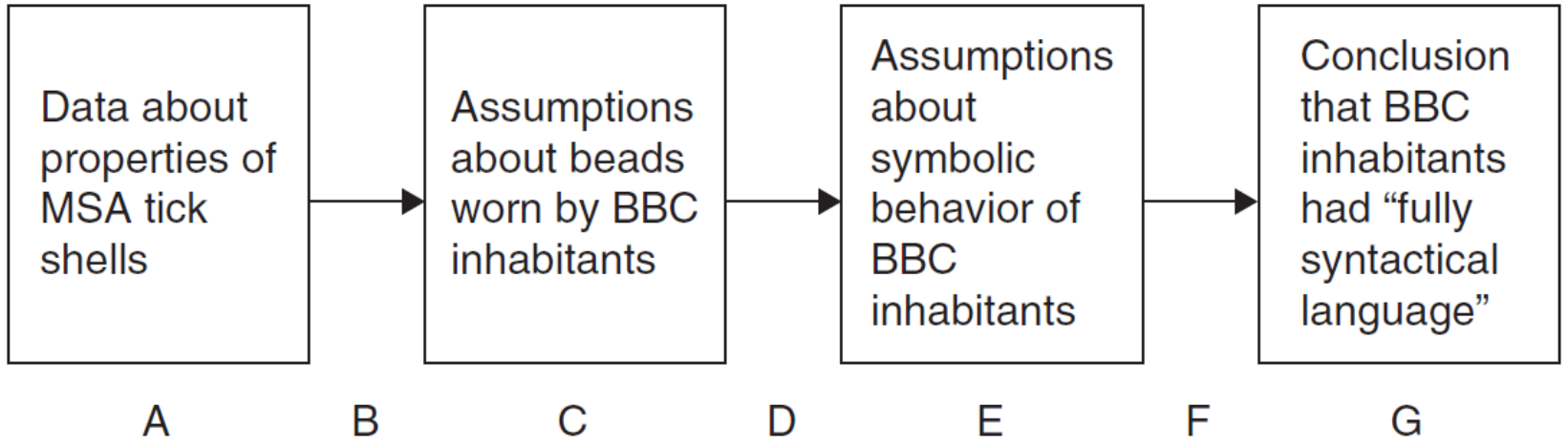


FIG. 5.2 Structure of the compound inference about the language used by the inhabitants of Blombos Cave ("Blombos Cave" is abbreviated in boxes C, E, and G as "BBC").

Source: Botha (2009: 95)

Language evolution and archaeology (3)

- „What if all eighty remaining speakers of Banawá died out suddenly and their bones were discovered only 100,000 years hence? [W]ould 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 recrod indicates that ancient human populations lacked these essential cognitive attributes." (Everett 2016: 8–9)

Language evolution and genetics

- Axiomatically, language evolution began via mutations: „First, there is mutation. […] Without mutation, there could be no evolution" (McMahon & McMahon 2013: 8).
- Genetics of language remains largely understudied.
- Some topics in the genetics of language (evolution) include: forkhead box protein P2 (FOXP2), Williams syndrome, specific language impairment, ProtocadherinX/Y etc.
- „[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)

Chomsky's „genetic model"

- Noam Chomsky has become famous for proposing a „mutation-based" account of language evolution. However, his hypotheses are, in short, 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)

Negation of genetics in language evolution

- Some linguists are reluctant to include genetics into language evolution models, e.g. Everett (2016: 70–71):
  - „[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." (p. 70–71)

Language evolution and (cumulative) culture

- Today many stress the role of (cumulative) culture in language evolution, but some also appear to misunderstand it.
  - „Language gradually emerged from a culture, formed by people who communicated one another via human brains. *Language is the handmaiden of culture*." (Everett 2016: xvii)
- The term *culture* is in need of a more precise definition.
  - „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." (Whiten et al. 1999: 682)

Language evolution as gene-culture co-evolution

- Language evolution is a case of gene-culture co-evolution, as in the case of the appearance of milk consumption.

Source: Curry (2013)

Exaptation in evolutionary biology

- **Exaptation** = the process of the emergence of structures and/or functions from pre-existing structures and/or functions (Gould & Vrba 1982)

Anatomy	Behavior
Bird feathers	Mouth licking in wolves and domestic dogs
Heat regulation, display, flight	Begging for food, signal for submissiveness

Source: manfredrichter (Pixabay)

Source: ElfinFox (Pixabay)

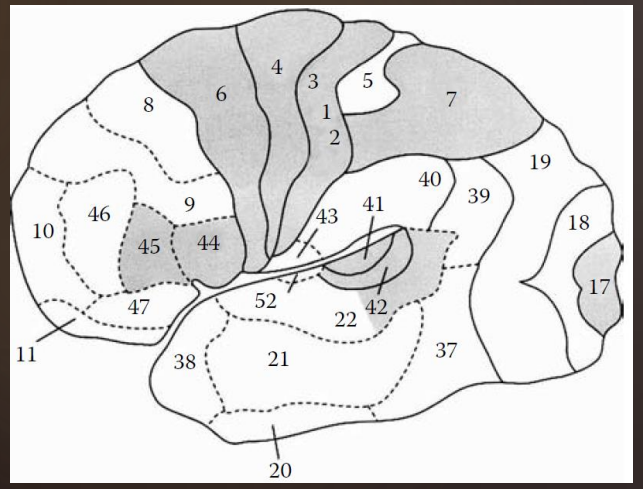
Exaptation in human evolution

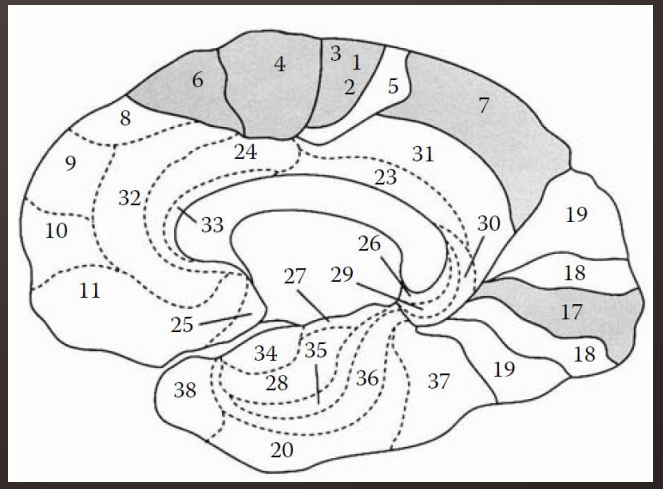
- Exaptationist evolution vs. modular evolution

- Exaptation has played a crucial role in the evolution of parts of the human muscular system.
  - „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)

Domain-general systems, and speech (1)

- In the context of speech and language evolution we are talking about the exaptation from pre-existing brain structures and functions.
- Motor brain areas are involved in speech production via activation of motor plans and muscle articulators, as well as movement coordination.





Lateral and midsagittal views of crucial speech cortical areas (including reading)
Source: Mildner (2015: 36)

Domain-general systems, and speech (2)

- Motor areas are also probably involved in speech perception (e.g. the motor theory of speech perception).

- Bishop (2001) reports correlations and considerable genetic overlap between developmental dyspraxia and specific language impairment, mostly in speech production quality.

Domain-general systems, and language (1)

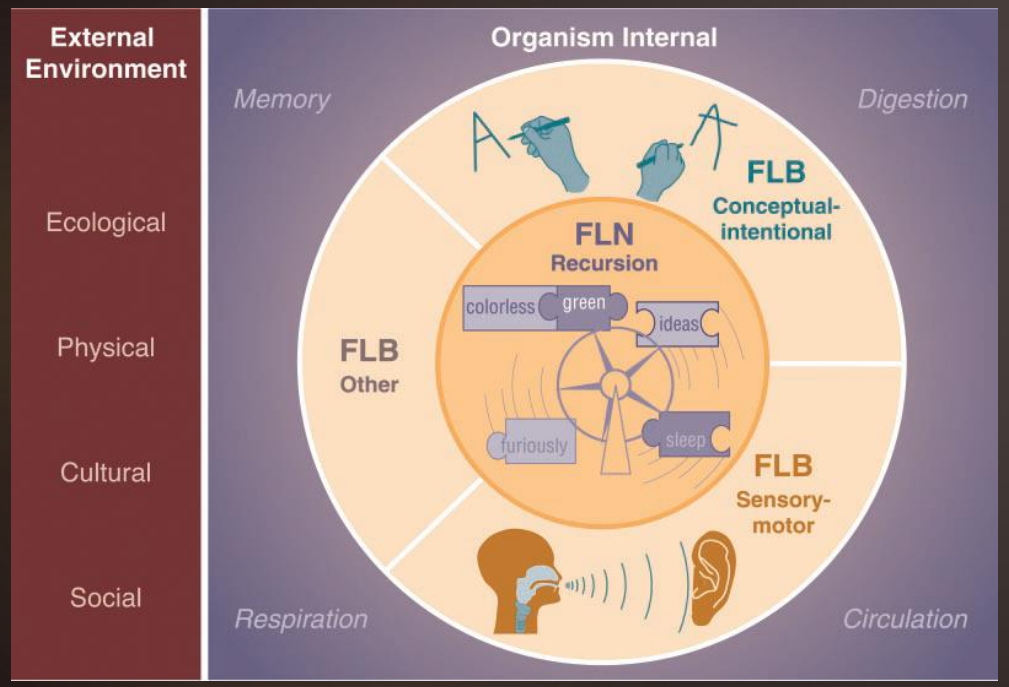
- Concerning language evolution, most likely candidates for exaptation are:
  - 1. sensorimotor processing (including visuospatial processing)
  - 2. declarative and procedural memory
  - 3. executive functioning and general working memory

Domain-general systems, and language (2)

- De Beni et al. (2005): role of verbal and visuospatial working memory in language reception
  - Listening of „spatial" and „non-spatial" texts with concurrent cognitive tasks
- Van Beilen et al. (2004): correlations between semantic fluency and executive functioning
- Hamrick et al. (2018): role of procedural memory in grammar acquisition and advanced grammar learning
  - „The findings yielded large effect sizes and held consistently across languages, language families, linguistic structures, and tasks" (Hamrick et al. 2018: 1487)

Hauser et al. (2002) and the faculty of language (1)

- Hauser, Chomsky & Fitch (2002): faculty of language in the broad sense (FLB) vs. faculty of language in the narrow sense (FLN)



- Their assumptions are axiomatic.
- Their assumptions are introspective.
- Recursion is never defined (!).
- It is not clear why „recursion" should be considered as the „only uniquely human component of the faculty of language".

Source: Hauser et al. (2002)

Hauser et al. (2002) and the faculty of language (2)

- „[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)

- „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 2012: 390)

Embodiment doesn't necessarily imply exaptation

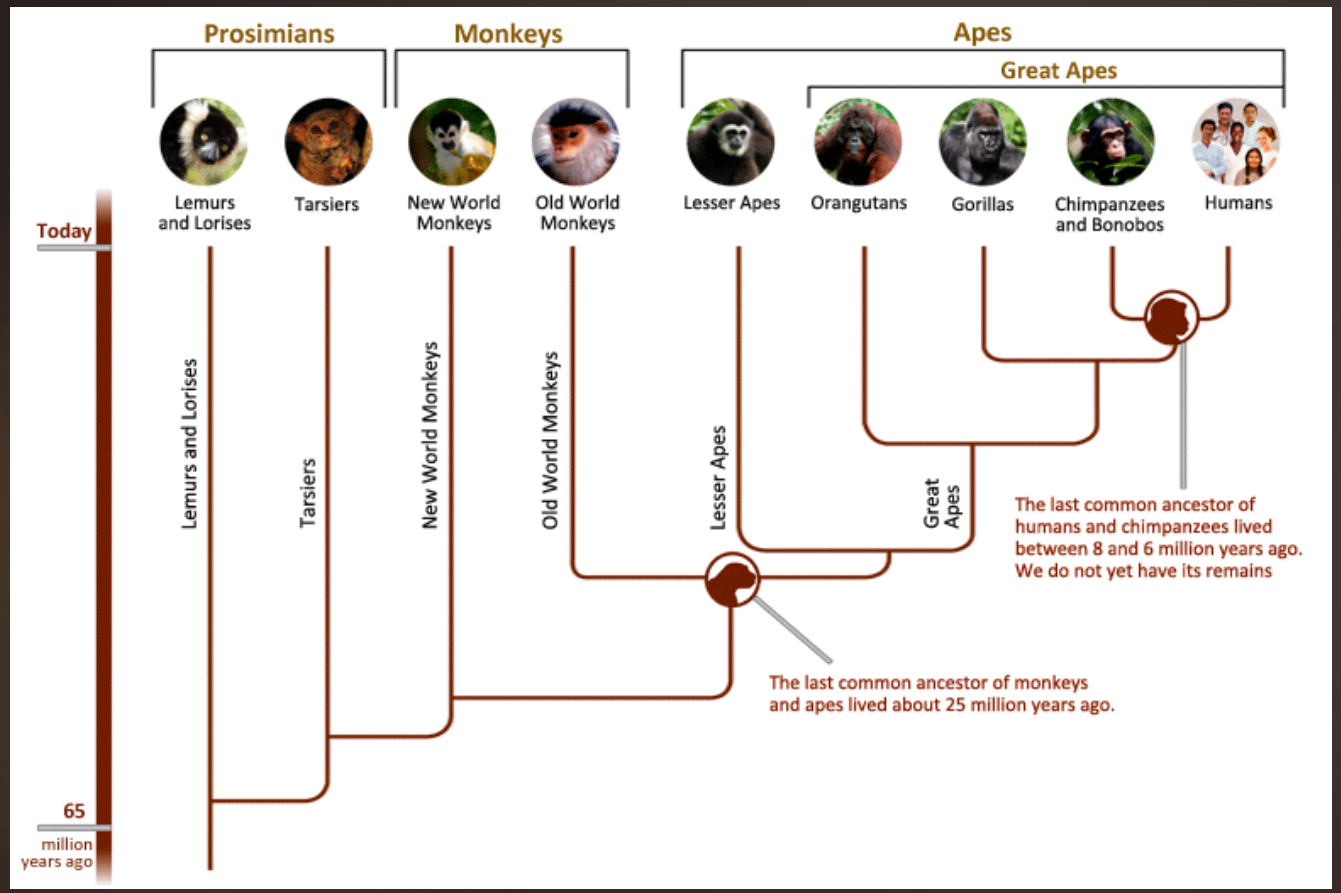
- Synchronic embodiment can suggest phylogenetic exaptation (Occam's razor).

- The alternative, modular, hypothesis is problematic:
  - It would imply that there were two phases of language evolution (language emergence and language embodiment).
  - It would imply that there was a significant brain reorganization in the wake of various genetic mutations.
  - It doesn't explain why some linguistic phenomena are more embodied than others.
  - It is unclear how a modular language system would have functioned.

Cartesian philosophy, discontinuity and the „modern" humanities

„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. 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." (Hurford 2007: 9)

Humans are primates (1)



Source: Smithsonian Institution

Humans are primates (2)

> 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. (Heesen et al. 2019: 1)

Bickerton's „paradox of continuity" (1)

- „[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, 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." (Bickerton 1990: 75)

- LANGUAGE IS UNIQUE.

Bickerton's „paradox of continuity" (2)

Problems with Bickerton's paradox of continuity	Absence of evidence about the existence of a particular phenomenon in a sample doesn't imply nonexistence of the phenomenon in the sample, let alone nature (!).
	Some aspects of animal communication systems can be characterized as „productive".
	It is not clear why should qualitative/quantitative differences between language and animal communication systems be taken as arguments for discontinuity.

Ideas of discontinuity in linguistics (1)

- It would appear that the argumentation of discontinuity in linguistics is following:
- Language is phylogenetically independent on animal communication systems because language is „unique", and language is „unique" because it appears sure to the naked linguist's eye that language has certain features which are lacking in animal communication systems.

- It is not clear how such argumentation is theoretically or empirically valid from the viewpoint of the present models of evolutionary biology.

Ideas of discontinuity in linguistics (2)

> [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.**" (Darwin 2013: 29–30)

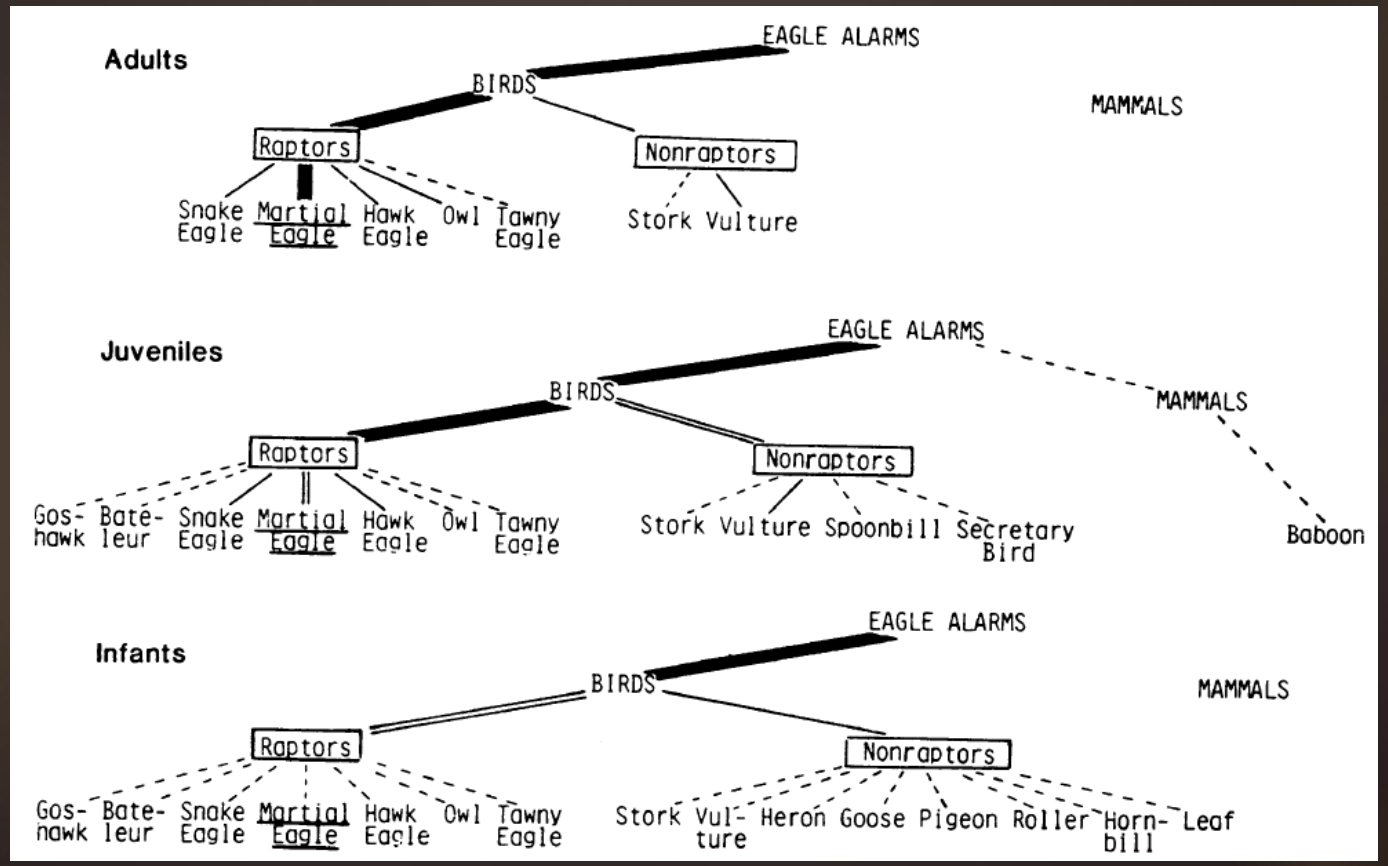
(„Lexical") Semantics in vervet communication (1)

- Struhsaker (1967) and Seyfarth et al. (1980): semantic communication in vervets (*Chlorocebus pygerythrus*)
- Alarm calls for five predators: leopard (*Panthera pardus*), martial eagle (*Polemaetus bellicosus*), African rock python (*Python sebae*), babbons (*Papio*) and unfamiliar humans
- Vervet alarm calls are semantic (denotative) and symbolic (in Saussurean sense)

Source: Amandad (Pixabay)

(„Lexical") Semantics in vervet communication (2)

- Vervet alarm calls appear to be at least partially learned (vs. innate).



Source: Seyfarth et al. (1980: 802)

(„Lexical") Semantics in animal communication (3)

- There are other similar examples in other animals, and not only mammals:
- „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)

Syntax in „natural" animal communication (1)

„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)

Syntax in „natural" animal communication (2)

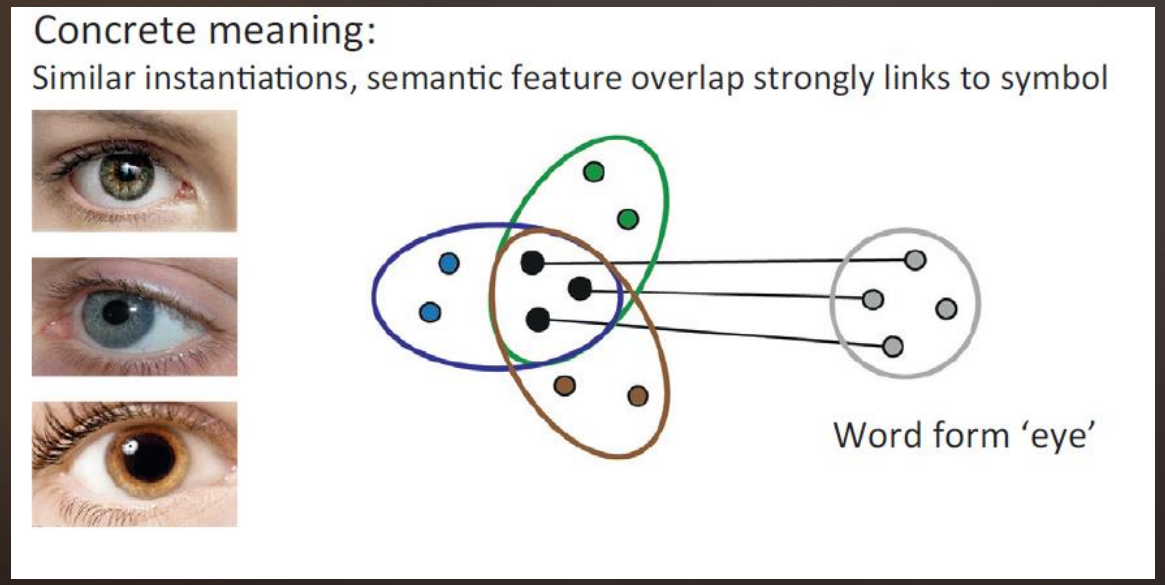
- Suzuki et al. (2016) claim to have found semantic syntax in the Japanese tits (*Parus minor*)

ABC	• scan for danger
D	• approach the caller
ABC-D	• scan and approach
D-ABC	• mostly no change in behavior

Source: Santa3 (Pixabay)

Concept modality vs. amodality

- Semantic version of the embodiment vs. modularity dichotomy
- „[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." (Haimovici 2018: 10)



Source: Pulvermüller (2013: 465)

Animacy and biological motion (1)

- Animacy is a semantic as well as a morphosyntactic category.
  - E.g. in „Serbo-Croatian": *Vidim miš-Ø.* vs. *Vidim miš-a.* 'I see a mouse' (Barić et al. 2005: 104)

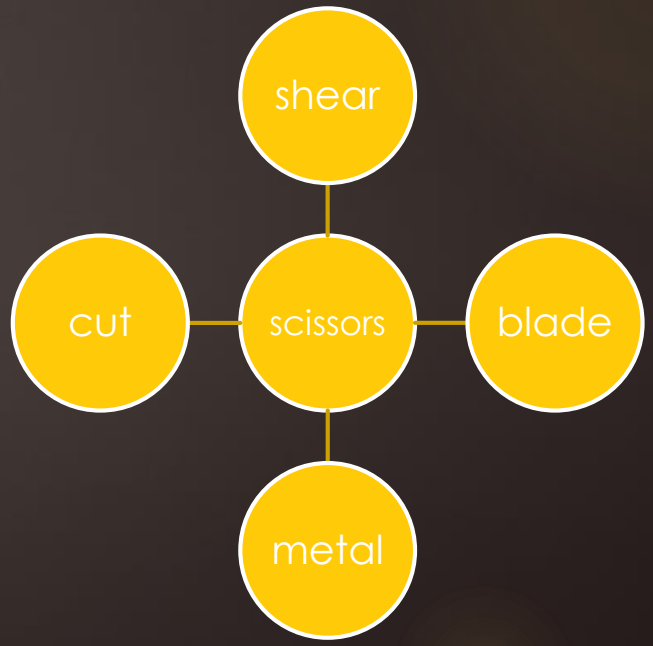
- Animacy is cognitively related to the detection of biological motion:
  - 'Biological motion' is a label attached to a kind of motion typical of an animal; it is distinct from trees waving in the wind, rocks tumbling down a cliff, waves in the sea, or eddies in a stream. Recognizing biological motion 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)
- Animacy can be understood as potential biological motion (Hurford 2007: 43).

Animacy and biological motion (2)

- Detection of biological motion appears to be innate in humans as well as other animals:
  - „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)
  - „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." (Hurford 2007: 42)

Lexical animacy

- In linguistics, meaning of animate words is believed to be founded on sensory features as opposed to functional features which characterize the meaning of inanimate words (e.g. Caramazza & Shelton 1998).



The animacy effect

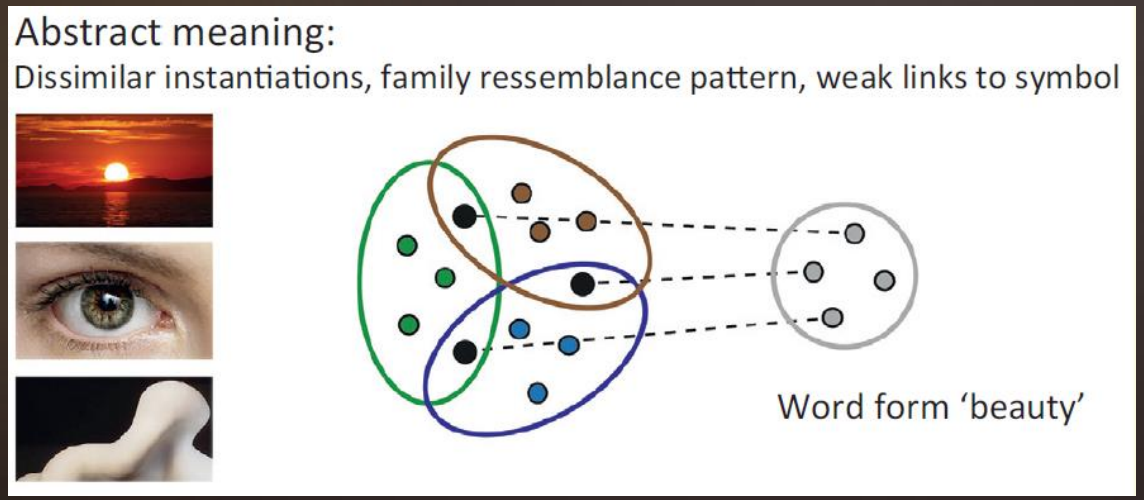
- Animacy is a prominent cognitive category that affects processing in other cognitive domains, e.g. the so called animacy effect on memory tasks.
- Animate words and visual depictions of animate concepts are better remembered relative to inanimate words and concepts (Bonin et al. 2014; Nairne et al. 2013).
- The animacy effect is also found in metamemory (Li et al. 2016).

Lexical concreteness/abstractness

- Concreteness and abstractness are not categorical, but gradual measures (Peti-Stantić et al. 2018).
- Concrete words are recognized faster and are remembered better compared to abstract words (Kroll & Merves 1986; Marschark & Paivio 1977; James 1975).
- Cognitive linguistics: abstract semantics arises from concrete semantics via mechanisms of metaphor and image schemas (e.g. Lakoff 1987; Taylor 2003).

Lexical concreteness/abstractness: neuroscience (1)

- Neuroscience of language is currently in development: „[I]t remains a […] challenge to integrate neuroscience with the social sciences" (Stout & Hecht 2015).
- Concrete words are processed bilaterally with a „modest leftward asymmetry", while abstract words appear to be left-lateralized (Binder et al. 2005; Mildner 2015: 199).



Source: Pulvermüller (2013: 465)

Lexical concreteness/abstractness: neuroscience (2)

- Abstract words are also relatively embodied, namely in motor and emotional brain regions.
- Moseley et al. (2012): fMRI, passive listening of emotional (e.g. *dread*, *spite*), face (e.g. *gnaw*, *chew*) and hand verbs (e.g. *peel*, *grasp*)
  - Emotional verbs correlated with activation in the limbic and primary motor cortices (incl. 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." (p. 1634)

Lexical concreteness/abstractness: neuroscience (3)

- Dreyer & Pulvermüller (2018): fMRI, passive reading of „mental" words such as *thought*, *logic* etc. compared to action words
  - They found activation in the face area of the primary motor cortex associated with processing of „mental" words.
  - „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." (p. 52)

Action semantics: neuroscience (1)

- Neurophysiological studies show somatotopic activation of words related to face/mouth, hand/arm and foot actions.
- Hauk et al. (2004): fMRI, passive reading of face (e.g. *lick*), hand (e.g. *pick*) and foot action verbs (e.g. *kick*)
  - „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" (p. 301)

Action semantics: neuroscience (2)

- Studies investigating the ACE effect (action-sentence compatibility effect) support the notion of the embodiment of action semantics.
- Mollo et al. (2016): EEG and MEG, motoric priming during lexical and semantic decision with hand and foot action verbs (SOA: 500 ms)
  - Congruency effects were found in motor areas, but also the superior temporal cortex.
  - The connection between motor and language functions is also found in areas traditionally associated with language or semantic functions.

Action semantics: neuroscience (3)

- Studies using transcranial magnetic stimulation also support the embodiment theory of action semantics.
- Pulvermüller et al. (2005): TMS of „left" motor areas during lexical decision with hand and foot action verbs
  - „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." (p. 793)

- Evidence of embodiment is also found in psychosemantics, e.g. the BOI measure (body–object interaction), but also measures of graspability, ease of gesticulation and the number of possible actions (Heard et al. 2018; Siakaluk et al. 2008a,b).

Neural correlates of linguistic syntax

- As semantic processing, syntactic processing is also associated with distributed neural activation in the frontotemporoparietal areas.
  - 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 […]. 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 […]. The involvement of the motor system in sentence processing is not only due to phonological and articulatory mapping […] because it also provides a grounding node for certain kinds of conceptual-semantic information. (Ghio & Tettamanti 2016: 647)

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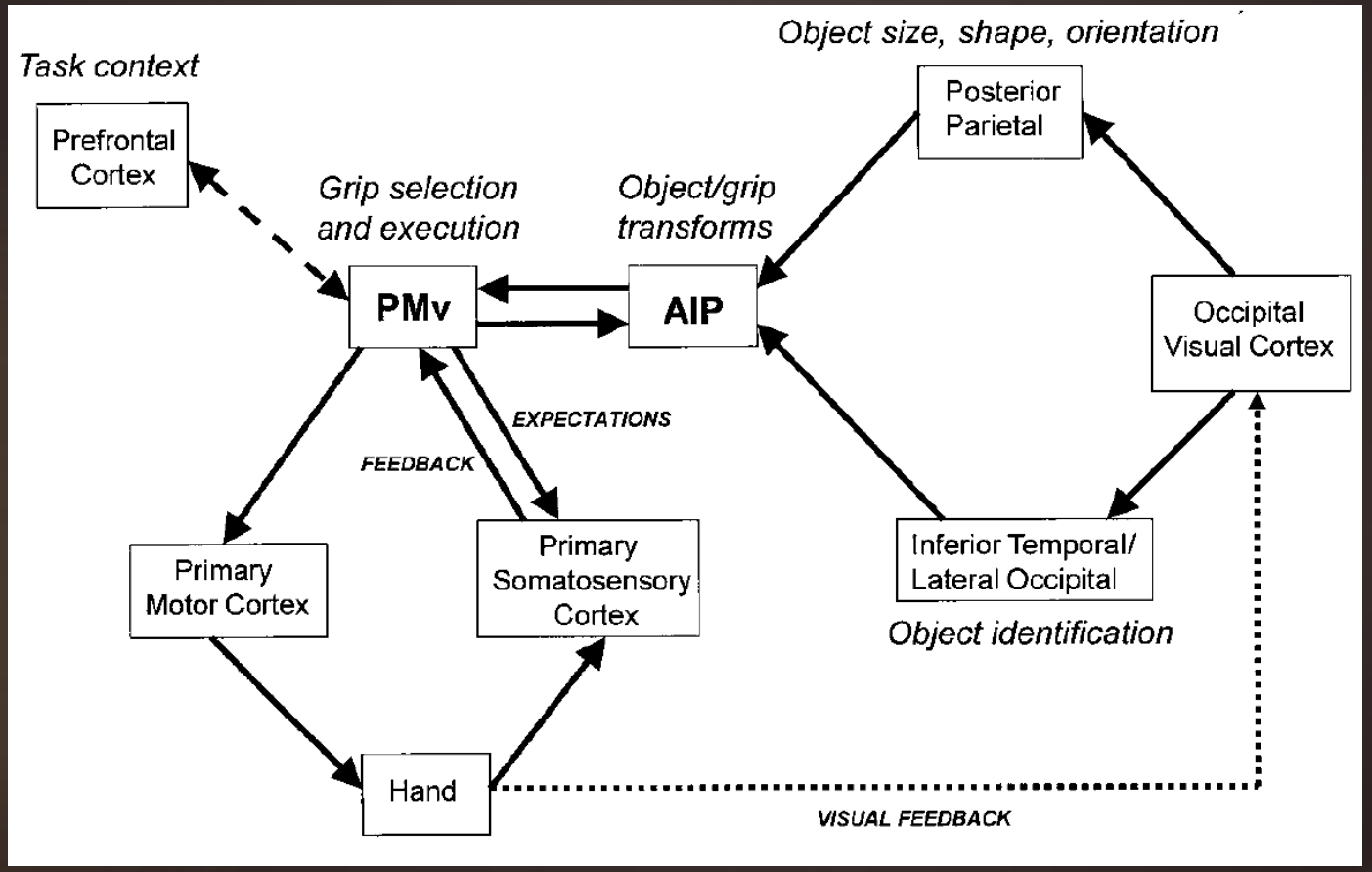
Action production (and understanding)



Source: Stout (2010: 165)

Transitivity in theoretical linguistics (1)

- Semantic vs. syntactic transitivity
- Semantic transitivity is not a categorical, but a gradual phenomenon
  - Prototypical semantic transitivity: a volitional agent acts on a patient by changing his state or position (thus, the typical agent is human)
  - „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." (Creissels 2016: 18)
  - The typical patient is inanimate?

Transitivity in theoretical linguistics (2)

- Core transitive verbs: verbs which code prototypical semantic events (basic transitive coding)
  - Compare: *He broke the window.* vs. *I feel love.* vs. *She is crossing the street./She was sleeping all night.*
- Core transitive verbs are considered to be a linguistic universal and to show „a high degree of formal homogeneity".
  - „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." (Creissels 2016: 19–20)

Transitivity in theoretical linguistics (3)

- Wright (2001, 2002) differentiates between externally and internally caused change of state verbs (e.g. *break* vs. *bloom*).
- Internally caused change of state verbs relative to externally caused change of state verbs
  - are significantly less coded in transitive frames,
  - they include significantly more often natural forces as agents,
  - and that they are rated as significantly less acceptable in transitive frames.

Neuroscience of syntactic transitivity (1)

- The methodology in these studies is a horror-story.
- Tettamanti et al. (2005): fMRI, passive listening of sentences with face, foot and hand-related actions („abstract" sentences as controls)
  - „Sentences were created by matching a transitive verb in the first-person singular to a syntactically and semantically congruent object complement. Each verb was paired with different objects each time. Subjects heard a total of 40 sentences per experimental condition (mouth, hand, leg), plus 120 baseline (abstract) sentences."
  - Ghio & Tettamanti (2016: 649) claim that „sentence of the subject–verb–object type" were used.
  - Kemmerer (2012: 58), however, writes: „[P]articipants listened passively to four types of Italian sentences that were syntactically equivalent but described different kinds of situations: leg/foot actions (e.g., Calcio il pallone ''I kick the ball''); arm/hand actions (e.g., Afferro il coltello ''I grasp a knife''); mouth actions (e.g., Mordo la mela ''I bite an apple''); and psychological states (e.g., Apprezzo la sincerita ''I appreciate sincerity'')."

Neuroscience of syntactic transitivity (2)

- Tettamanti et al. (2005): Methodology remains shrouded in mystery, but it appears they compared transitive constructions which were semantically transitive in the experimental set and intransitive in the control set.
  - Compared to the control set, experimental sentences evoked greater activation in the frontotemporoparietal network incl. the pars opercularis (BA 44), premotoric cortex, inferior parietal lobule, intraparietal sulcus and pMTG.
  - „These data provide the first direct evidence that listening to sentences that describe actions engages the visuomotor circuits which subserve action execution and observation." (action semantics)
  - Syntactic transitivity doesn't have a unified neural correlate.
  - Is the embodiment effect due to the entire transitive scenario or due to the meaning of particular components (e.g. verbs)?

Neuroscience of syntactic transitivity (3)

- Desai et al. (2010): fMRI, active listening of hand and arm-related action sentences compared to „abstract" sentences (e.g. *They consider the risk.*).
  - Experimental sentences produced greater activation in parts of the parietal and temporal cortices.
  - Previous question remain unanswered.
- Similar studies with similar results and similarly enigmatic interpretations concerning the embodiment of semantic and syntactic transitivity include Van Dam & Desai (2016), Aziz-Zadeh et al. (2006), Scorolli et al. (2012), Progovac et al. (2018).

Neuroscience of syntactic transitivity (4)

- Ferretti et al. (2001): transitive verbs prime typical agents (*arresting–cop*), patients (*arresting–criminal*) and instruments (*stirred–spoon*), but not locations (*swam–ocean*)
  - A short SOA (250 ms) was used, indicating an automatic neural connection.
  - Results suggest that we can really talk about the embodiment of semantic transitivity in previous studies as it would be difficult to separate the effects of verb meaning, and agents and patients (and instruments).
- Glenberg & Kaschak (2002): ACE, hand actions and transfer sentences differing in the direction of action/transfer
  - Imperative sentences, sentences denoting transfer of concrete objects, sentences denoting „transfer of abstract entitites"
  - ACE was found for all sentence types!

Basic word order

- Basic word order is a controversial linguistic construct (Newmeyer 2003):
  - There are no clear criteria for determining basic word order across languages.
  - Some languages appear to have no basic word order.
  - The universalist approach to the subject and object components is potentiall problematic from a cross-linguistic perspective.
  - The relative frequency of the sentence type used for establishing the basic word order is „extremely low".
- Nevertheless, Newmeyer (2003) concludes that the basic word order approach is okay.

Basic word order from a cross-linguistic perspective

RED RIJEČI	UDIO
SOV	41,03 %
SVO	35,44 %
nema	13,73 %
VSO	6,90 %
VOS	1,82 %
OVS	0,80 %
OSV	0,29 %

- SOV and SVO are also the dominant word orders in sign languages (Napoli & Sutton-Spence 2014).

According to: Dryer (2011)

Dominance of SOV and SVO 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: 52)

Agent/subject saliency (1)

- Two principles appear to affect the word order proportions: subject saliency, and verb–object juxtapositioning
- According to Kemmerer (2012), subject saliency reflects how the brain understands core transitive events in which the agent is the head of a causal chain affecting the patient
- Agent saliency is evidenced in empirical studies (Cohn & Paczynski 2013; Cohn et al. 2017):
  - information about the agent compared to the patient facilitates prediction of action in the future
  - agents are longer viewed in visual depictions than patients
  - visual depictions primed by agents are processed faster compared to depictions primed by patients

Agent/subject saliency (2)

- Nominative-accusative languages are cross-linguistically more frequent compared to ergative-absolutive languages (Bickel et al. 2015; Nichols 1993)
- Bornkessel et al. (2004): ERP, reception of dependent object clauses in which the syntactic and semantic roles are ambiguous until the end of the sentence
  - *… dass Betram Surferinnen gratuliert hat.* vs. *… dass Betram Surferinnen gratuliert haben.*
  - A combination of a biphasic negativity after 400 ms and late positivity in the latter sentence type
  - Results suggest that the first argument is automatically processed as an agent until further analysis shows otherwise
  - Similar results by Bickel et al. (2015) who investigated Hindi.

Agent/subject saliency and Broca's area (1)

- Kemmerer (2012) speculates that the two dominant word orders reflect the ways in which Broca's area processes actions in general.
- Broca's area is a very controversial topic and it appears that today nobody really knows precisely what Broca's area is, nor where it is.
  - Nevertheless, theorizing and research continue (as they should).
- Broca's area is highly multifunctional: motor skills in tool use (Hopkins et al. 2017), production of nonverbal motor behaviors (Hupfeld et al. 2017), nonverbal action understanding (Fazio et al. 2009), imitation (Kühn et al. 2013), music (Elmer et al. 2018), visuospatial perception (Bahlmann et al.), speech, language, etc.
  - „These findings have prompted a search for a common functional denominator, and some of the major candidates currently being debated are cognitive control, sequence processing, and hierarchical processing." (Kemmerer 2012: 55)

Agent/subject saliency and Broca's area (2)

- In short, SOV and SVO would reflect the temporal structure of the causal action chain which is coded in Broca's area, and which is enabled through a phylogenetically older system of sequential and hierarchical organization of bodily movements and actions.
- Kemmerer (2012: 62) admits his theory 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."

Conclusions (1)

- While I have given no direct evidence for exaptation in language evolution, relative synchronic embodiment of particular linguistic functions suggests that exaptation is a more plausible evolutionary scenario than modularity.
- Animal studies suggest that at least some animals have symbolic communication (in the Saussurean sense). Furthermore, at least some animals display syntactic capacities within their communication systems. These results stand opposed to the discontinuity theories of language evolution.
- There is strong evidence for the embodiment of particular lexical-semantic phenomena. This includes concrete and action words, as well as abstract words. Bilaterality of the processing of concrete meanings suggests that functional laterelization was not a prerequisite for concrete words. Many studies reported somatotopic association between action verbs and brain activation.

Conclusions (2)

- Animacy appears to rely on robust mechanisms of biological motion detection suggesting that it might have been an early semantic phenomenon. Furthermore, the typical agents are animate or specifically human. The typical patient appears to be inanimate.
- Transitivity studies also show connections to the visuomotor/sensorimotor brain system involved in action production and understanding. Processing of prototypical semantic transitivity appears to be highly embodied. Thus, transitive events might have been one of the first experiences to have been linguistically lexicalized. Syntactic transitivity could also be relatively embodied, however, further studies are needed. It appears that syntactic transitivity phylogenetically arose from semantic transitivity.

Conclusions (3)

- The principle of agent/subject saliency could suggest that rudimentary syntactic components might have been an early phenomenon in language evolution, i.e. if agents were lexicalized, they were probably linearly placed first. This is supported by the cross-linguistic dominance of SOV and SVO word orders, the neurocognitive saliency of agents, the prevalence of Nom.-Acc. relative to Erg.-Abs. languages and neurophysiological studies showing that the first argument is automatically analysed as the agent. Kemmerer (2012) suggested this reflects how Broca's area, or parts of the visuomotor system, process prototypical transitive events in which the starting focus is on the agent.

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