Syntax as the last step in the evolution of language

Dieter Wunderlich (Düsseldorf, Berlin) Cambridge, March, 7, 2006

In this talk I identify Universal grammar (UG) with the language acquisition device (LAD) that enables infants to learn any human language from a given linguistic input. More precisely, LAD is regarded as the information to the brain how it has to process chunks of memorized linguistic input in order to find proper grammatical generalizations.

Following Briscoe (2003) and others, I take the position that the LAD did not emerge in a single (and extremely unlikely) evolutionary step, but rather evolved incrementally in a number of independent steps. I am therefore assuming that the several features considered by Hockett (1960, 1966) and others to be characteristic for human language (if contrasted with animal communication) have different origins.

Concerning the evolution of the human genotype, the FOXP2 mutation, proposed by Lai at al. (2001, *Nature*) and studied in more detail by Enard et al. (2002a,b, *Science* and *Nature*), seems to be the most recent change affecting human language, dated at about 160,000 years ago (but not more than 200,000 years ago).

What I am going to argue for in this talk is that proper syntax (dealing with dislocations) did not emerge before the well-known neolithic 'revolution' at the end of the glacial period, that is, 10 or 12,000 years ago. If that is true syntax should be regarded as a cultural rather than a biological trait; it is not likely to be determined by the genotype because selection pressure is required to maintain a biological trait. Without such selection pressure for a period of more than 100.000 years, one would expect a trait to be whittled away by genetic drift. However, with such selection pressure, a newly emerged trait will continue to adapt, and will have been further refined by genetic assimilation (Briscoe 2003: 303). Therefore, one could at most accept the idea that syntax is a product of further genetic assimilation.

It is generally acknowledged that one can distinguish four major phases in the evolution of man.

(i) Phase (i) extends from the time when the predecessors of men and chimpanzees separated, and subsequently various hominine species such as australopithecus evolved, until the appearance of homo habilis and homo erectus (7 to 1.8 mill. years ago)

(ii) Phase (ii) covers the time from the rise of homo erectus, who first left Africa and colonized large parts of Europe and Asia, until the appearance of homo sapiens in East Africa (1.8 to 0.2 mill. years, i.e., more than 100,000 generations, ago)

(iii) Phase (iii) covers the time from the rise of homo sapiens, who colonized the Old World, and also Australia, New Guinea, and the Americas, until the invention of agriculture in several parts of the Old and New World (200,000 to 10,000 years, i.e. more than 8,000 generations, ago).

(iv) Phase (iv) covers the modern historical times, beginning not earlier than 10 to 12,000 years ago (about 600 generations).

Assuming a fanlike evolution one expects that certain members of a previous phase will survive in the following one: correspondingly, traces of **paranthropus** have been found until 1.1 mill. years ago, and traces of homo erectus (**neanderthaler**) until 27,000 years ago. Similarly, traces of features characteristic of phase (iii) can be found until today, namely, in small and isolated linguistic communities of hunter-gatherers.

Let me briefly consider a few prerequisites established in phase (i) and then turn to the two more interesting phases (ii) to (iv).

Characteristic for phase (i) is the evolution of upright moving, which freed the hands from being occupied by locomotion, and thus enabled the early hominines to begin with and improve manufacturing. We can also imagine that the neuronal mirror system for grasping, already known for monkeys, was gradually extended: the mirror neurons belong to the motoric field of the brain, they get activated if an individual sees another one grasping for food (Rizzolatti et al. 1995). The mirror system hypothesis (Rizzolatti & Arbib 1998) can best explain why and how ⇒1 *intentionality* and ⇒2 *parity*, two of the most fundamental traits of human language, have evolved. Intentionality means that the utterer intends communication to have a particular effect on the recipient, and parity means that speaker and hearer roles are interchangeable: what counts for the speaker must count for the listener.

Phase (ii) concerns the early man. About homo ergaster (or erectus) we know that he managed to maintain fire (1.5 mill. years ago), and nearly at the same time improved manufacturing: the earliest hand axes are 1.4 mill. years old. Both activities require a certain amount of intentional planning ⇒3a *beyond the here-and-now*, so that one has at least to concede that homo erectus possessed the capability of ⇒3b *complex propositional thinking* (in the sense that a proposition was composed into a predicate and one or more referential anchors, and that second-order predicates were possible as well).

If it is true that hand axes served to be thrown, this new achievement in turn profited from an increasing size of the brain (Calvin 1990). Both ⇒4 *fast processing* and ⇒5 *mapping from hierarchical structure to temporal ordering*, two other fundamental features of human language, can be attributed to progresses in the timing of actions necessary for producing and using hand axes, that is, to sensomotoric skills that could later have been adapted for language.

Furthermore, the advanced sensomotoric control of manual and facial expression, supported by further development of the neuronal mirror system, could have enabled the emergence of **protosign,** a first gestural language (Arbib 2005), possibly only shortly after homo habilis or homo erectus appeared. Such a scenario motivates why all the features independently developed for manual actions (such as intentionality, parity, fast processing, and mapping from hierarchical structuring to temporal ordering) had been transferred to language.

In addition, the need of preparing mirror neuron assemblies in the brain could explain **the child's instinct of imitation**, which clearly distinguishes man from chimpanzees and becomes the motor of language learning. Moreover, **language learning becomes the motor of further language evolution**. It is reasonable to assume that ⇒6 *cultural evolution*, enabled through iterated learning by members of subsequent generations on the basis of slightly modified input, already started in the time of homo erectus.

Finally, a beginning with gestural language makes it plausible that iconic encodings (possible with gestures but not as easily with sounds) could be transformed stepwise to more abstract ⇒7 *symbols*. Signers are likely to have combined individual signs as much as they learned to combine hand movements in other actions; here, the iconic interpretation of a temporal ordering lies at hand. This suggests that some kind of ⇒8 *compositionality* (the productive combination of signs) could have already played a role in protosign. Corballis (2003) adds further arguments for the gestural origin of language. In any case, the development of a more differentiated communication system can motivate the enormous cultural achievements of homo erectus, especially of neanderthalers.

Phase (iii) concerns the modern man (homo sapiens).
In a further step, the control of the vocal apparatus (including lips, tongue, velum and larynx) got improved, so that ⇒9 the *vocal-auditory modality* could take priority over the gestural-visual one. **Protospeech** could gradually free the hands from being necessarily involved in communication, which was an obvious advantage compared to a purely gestural system, and might have happened just at the appearance of homo sapiens 170,000 years ago. The FOXP2 mutation, reconstructed for about this time by genetic methods, could have brought important progresses in the vocal articulation.

As Studdert-Kennedy (2005) argues, and Oudeyer (2005) has shown through simulation, both ⇒10 *discreteness* of articulatory features, as well as ⇒11 the *duality of patterning* (minimal units do not bear meaning), emerge as an automatic self-organizing consequence of random interactions among speakers-hearers. All more complex combinations then inherit discreteness from the minimal units.

In these combinations, some sort of **basic asymmetry** is at work: one element functions as the head, defining the behaviour within a greater complex, whereas all others are non-heads.

- A vowel is the head of a syllable, and a stressed syllable is the head of a prosodic word.
- Similarly, complex predicates such as compounds and adjunction structures have one element as the head.
- The lexical inventory is partitioned into two complementary categorial types, verbs and nouns, with the verb as the head of a clause.
- Furthermore, the arguments of a transitive verb are strictly ordered, with the lowest argument functioning as the 'goal' of predication (and thus being nearer to the verb).
- Finally, the element in focus can be considered the head of a piece of discourse.

I think that these prerequisites suffice to describe what is innate for the emergence of grammar in a modern sense.

According to Chomsky (2005), Universal Grammar or what is strongly built into the LAD is reduced to MERGE, which I take here as **internal merge**: argument requirements of the combined items are either saturated or inherited to the result, and the information of modifiers is checked for whether it is compatible with what they modify. The function of internal merge is thus similar to operations of Categorial Grammar.

We have good reasons to assume that **linguistic diversity** started just in the process of organizing articulatory features, and based on that, organizing the vocabulary as well as idiomatic phrases, probably long before small groups of homo sapiens migrated to the Near East, to Europe and Asia, and from there to various places of the New World (60 to 30.000 years ago). Of course, groups that have separated undergo separate changes, but random fluctuations in the very beginning are more likely to have produced the amount of phonological variation inherent to human languages.

As Carstairs-McCarthy (2005) argues convincingly, ⇒12 **early morphology** could have started with a reinterpretation of allomorphic alternations produced by rapid speech. Here, again, a high amount of diversity could have evolved very early. Until today, phonomorphology is perhaps the domain with the highest cross-linguistic diversity.

What about syntactic diversity?

The amount of syntactic diversity is often underestimated by syntacticians who claim that particular syntactic universals are at work (which often are only generalizations cconcerning some striking linguistic families). Some of the universals of the eighties were so specific, and at the same time complex, that it was unreasonable to assume them to be innate. However, since the beginning of the Minimalist Program (Chomsky 1995), universal principles have been reduced, and nowadays, some of these principles have been shown to be correlated with or grammaticalized from processing principles (Fanselow, Kliegl & Schlesewsky 1999, Hawkins 2004), which characterize how the brain works if confronted with linguistic input. Moreover, detailed typological studies revealed that many alleged universal notions or principles are in fact not characteristic for all human languages and thus are not universals.

The notion of *grammatical subject*, for instance, fails in the inverse type languages of the Algonquian family, and so does the notion of *grammatical subject-object asymmetry*. These languages also make the notion of *abstract case* doubtful because none of the arguments of a transitive verb belongs morphosyntactically nearer to the verb than the other, even if one can rightly state that these arguments are ordered semantically (and thus can use the notions of logical subject and object). As Bailin & Grafstein 1991, and Dahlstrom 1991:99 have shown, the Algonquian languages also violate the *binding principle* which requires that an antecedent must either c-command or linearly precede an anaphor in order to bind it.

The sentences (1a) and (1b) only differ in the voice morpheme directly attached to the verb stem; the direct morpheme /aa/ encodes that the more salient argument (a proximate person) is the higher one (the logical subject), while the inverse morpheme /igo/ encodes that it is the lower one (the logical object). The sentences (2a) and (2b) only differ in that 'John' belongs to the matrix or the dependent clause. All these sentences are grammatical according to the co-indexation principle (3), which requires that proximate 'Mary' is identical with the proximate possessor of 'sister' in (1), and that proximate 'John' is identical with the proximate person encoded in both verbs of (2), regardless of where 'John' is located in the sentence (Wunderlich 2005). This co-indexation principle is language-specific insofar as obviation (or 4th person) is a category not known in languages outside the Americas.

(1) Subject-object symmetry in Ojibwa

a. o-miseez-an o-gii-wiidookaw-**aa**-wan Mary.
3-sister-OBV 3-PAST-help-**DIR**-OBV M.
'Mary$_i$ helped her$_i$ sister.'

b. o-miseez-an o-gii-wiidookaw-**ig**-wan Mary.
3-sister-OBV 3-PAST-help-**INV**-OBV M.
'Her$_i$ sister helped Mary$_i$.'

(2) Co-indexation between dependent and matrix clause in Ojibwa

a. John o-gikeendaan aakozi-d .
John 3-know [sick-3]
'John$_i$ knows he$_i$ is sick.'

b. o-gikeendaan aakozi-d John.
3-know [sick-3 John]
'He$_i$ knows John$_i$ is sick.'

(3) Co-indexation principle: Only elements of the same obviation status, that is, either proximate or obviative elements, can be co-indexed.

Observations regarding morphosyntactic diversity make it **doubtful whether morphology and syntax emerged at the same time.**

As is well-known, morphology and syntax can in principle do the same job, so that one of them seems superfluous. Indeed some languages nearly lack morphology except perhaps compounding (isolating languages such as Vietnamese), while others nearly lack syntax except juxtaposition of elements (polysynthetic languages such as Yimas of New Guinea, Nivkh of Siberia, and Greenlandic). These two types of languages, isolating ones and polysynthetic ones, are nearly incommensurable. No one can characterize the sort of language from which both could have developed.

Creole languages, created under the influence of poor input from a pidgin, are nearly isolating, a fact that prompted Bickerton (1981, and later) to assume that they show most clearly the influence of UG. Similarly, Klein & Perdue (1997) claim that UG is involved in the Basic Variety created by foreign workers in Europe, which has a poor syntax and no morphology. Bickerton and Klein & Perdue each believe that linguistic compositionality started with simple syntax.

Polysynthesis on the other hand is centered around the concept of head-marking, which means that arguments of the verb are encoded on the verb, and those of the noun are encoded on the noun, whereas the relationship between noun and verb is only indirect, unless the noun is incorporated into the verb. In addition, polysynthetic languages display bound morphemes with adverbial or attributive functions and often also serialized verbs, to various degrees. Mattissen (2004) distinguishes two types of internal organization: the verb form can offer a template, that is a fixed number of slots for different elements which are fixed in their position and their order relative to each other, or it can offer a frame of a few fixed grammatical positions, whereas all adverbial elements are ordered according to the intended meaning and their respective scope. Sometimes, polysynthetic forms are found which are likely to be fused from two or more independent chains, which indicates that polysynthesis itself is a late product of repeated grammaticalizations. In any case, it seems that only languages with head-marking are susceptible to such kind of fusion.

In general, head-marking languages have rich morphology but quite simple syntax. Since affixes on the verb represent the arguments, an inflected verb already represents a full clause. Independent nouns or NPs only serve for more explicit referential specification, and have the syntactic status of a free adjunct.

A **comparison between morphology and syntax** reveals that morphology is less flexible than syntax because it lacks any indication of dislocation, and therefore can be regarded as poorer than syntax.

- A morphological complex is less flexible than a syntactic combination. It is characterized by fixed positions (except some forms of polysynthesis), and no dislocation of elements, no agreement between elements, and no assigment of focus or topic takes place.
- A morphological complex is affected by more phonological rules, and thus susceptible to more irregularities, than a syntactic combination.
- A memorized morphological complex is more rapidly processed than a syntactic combination.
- Morphology is more difficult to get acquired by adult learners than syntax.

These observations make it highly improbable that syntax preceded morphology. In the contrary, if morphology tends to be more irregular and more faster processed, one rather expects morphology to be prior to syntax.

I believe that morphology in form of head-marking morphology is a trait of phase (iii), which survived in the phase (iv), whereas syntax (in the sense that it involves dislocation) is not necessarily a feature of phase (iii) but belongs to phase (iv).

Phase (iv) concerns the size of linguistic communities, which is correlated with economical and societal factors.

For thousands of generations, linguistic communities were quite small and isolated groups of hunter-gatherers; with a size between 150 and 1000 individuals, sligthly increasing towards the end of the ice age. More people couldn't find their living in an area of several hundreds square miles, unless the circumstances were extremely favourable. Seasonal trading between such groups probably existed but did non give the opportunity of much contact. Since it is still unclear what sort of events caused the emergence of art and the astonishing improvement of tools and pottery beginning 35,000 years ago (was it a breakthrough because of accumulated cultural abilities or because of certain cognitive or linguistic enhancements?), we can only speculate about the consequences for social networks in these groups.

It is certain, however, that at the end of the ice age 12,000 years ago the living conditions highly improved, the size of communities increased, the gatherers settled, and finally agriculture was invented at various places around the world, which in turn caused a rapid increase of the population and forced new organizational forms, among them the invention of script.

In order to describe the recent distribution of languages (before the 16th century AD, when modern colonization started), Nichols (1992) distinguished between **spread zones** (where languages or language families rapidly spread, serving as lingua franca, and consequent languages succeeded, and in which little genetic and low structural diversity is found) and **residual zones** (often at the periphery of spread zones, with high genetic and high structural diversity, and no lingua franca besides local bilingualism). She found high correlations between head-marking and residual zones, and also between head-marking (and other morphological features) and the New World and the Pacific, whereas the presence of prepositional phrases correlated with the Old World area.

In an ongoing study, Dahl (2006) prefers a distinction on the basis of economy, which, however, leads to similar results. He distinguishes between the **farmer zone** ("comprising languages traditionally spoken in areas with fully established agriculture") and the **hunter zone** ("comprising languages traditionally spoken in areas not fully affected by the Neolithic transition"), and regards New Guinea as the special case of a gardener zone, which is somewhat in between. Dahl points out that languages of the hunter zone show more "free" word order and less VO order, and more morphological complexities than those of the farmer zone, and that they do not include isolating languages.

Dahl also observed that the language density (the number of languages per mill. sq. km) is nearly the same for all macro-regions of the world (except New Guinea), namely between 22 and 70, whereas the speaker density (speakers per sq. km) is much higher in the Old World (namely between 150 and 22 in Europe, Asia, and Africa) than in the New World (namely 1) and New Guinea (9). A density of 1 speaker/sq.km means that a group of 1,000 people occupies a region of 32 kms at each side, so that external contacts must be rare.

(4) Language and speaker density (Dahl 2006)

Macro-area	languages in area	million speakers	speakers/ language	million sq.kms	languages/ mill. sq.km	speakers/ sq.km
Europe	240	1500	6,25 mill.	10	24	151
Asia	2000	3500	1,75 mill.	45	44	77.4
Africa	2100	675	0,32 mill.	30	70	22.5
New Guinea	1200	7	5,800	0.75	1,600	9.3
Oceania	260	1	3,800	-		
North America	600	20	33,000	24	25	0.8
South America	400	20	20,000	18	22	1.1
Australia	230	0.05	220	7.5	30	0.005

These observations amount to the conclusion that languages with few speakers (i.e. "small languages") are likely to be more conservative than those with many speakers (i.e. "large languages"), and they are more likely to be characterized as languages with rich morphology and poorly-developed syntax.

This conclusion is supported by Trudgill (2004), who, in the context of a phonological typology (which does not concern us here), points out the following:

> "Small, isolated, low-contact communities with tight social network structures (i) will have large amounts of shared information in common and will therefore able to tolerate lower degrees of linguistic redundancy of certain types [...], (ii) are more likely to be able [...] to ensure the transmission of linguistic complexity from one generation to another. Such communities are thus likely to be more linguistically conservative, i.e., to show a slower rate of linguistic change, and more likely to demonstrate complexities and irregularities. [...]"
>
> „Communities involved in large amounts of language contact, to the extent that this is contact between adolescents and adults who are beyond the critical threshold for language acquisition, are likely to demonstrate linguistic pidginisation, including simplification, as a result of imperfect language learning." (Trudgill 2004: 306)

Trudgill further argues that irregular and non-transparent forms cause particular problems of memory load for adult learners. Their mode of imperfect learning leads to regularisation of irregularities, to an increase in transparency, and to an increase in analytic over synthetic structures.

For the present purpose it is essential to keep in mind that speakers of a small community have large amounts of shared information, including memorized linguistic forms, which can rapidly be processed in repeated as well as ritual encounters.

This situation is changed if the community is growing, partitioned into various specialized or areally separated groups, where less information is shared, the social networks become more pervious, and the probability of external contacts increases. In sum, linguistic communication becomes increasingly more varied.

More variation of interaction settings forces the speech act participants

- to use more specifications by independent NPs
- to be more explicit regarding topic and focus
- to use more transparent combinations rather than memorized forms
- to use forms that are less prone to irregularities

so that the input for the respective next learner generation gets modified.

Moreover, a spreading population experiences more external language contacts. Adults who live in the occupied areas, as well as immigrants who try to get integrated, use the dominating language as a lingua franca, and thereby produce simplified and at the same time more transparent varieties, which accelerates the process of language change.

Under the given circumstances, competition between independent demands forces the emergence of positional variants (i.e. dislocation). For instance, the requirement of realizing grammatical functions positionally (subject precedes object) and the requirement of realizing discourse functions positionally (topic precedes focus) can conflict with each other, and therefore various orderings such as SVO, $O_{top}SV$, and $O_{top}VS_{foc}$ can emerge.

Something of this might have happened to the previous languages with rich morphology. My hypothesis, then, is:

> Syntax (in the sense that it enables flexible ordering by dislocation of elements, and that it displays particular positions for topic and focus, and eventually dependent marking such as morphological case) is a product of cultural evolution (that is, of iterated learning under the influence of cultural factors). **Syntax emerges in a linguistic community with high variation of interaction settings**, which is more likely to take place in languages of the farmer zone than in those of the hunter zone.

Of course, not all linguistic communities were involved in the agricultural expansion, or in the rapid change towards more syntactic patterning, and the economic and the linguistic factors not always coincided. Indeed many small languages with rich morphology remained, so that the linguistic diversity found today partly originates from more recent change, and partly preserves elder stages. These different origins explain why such incommensurable language types such as the isolating and the polysynthetic ones exist side by side. The present coexistence of dislocating syntax and head-marking morphology surely opens the window to different time depths.

The question arises: **Do we have to assume specific syntactic universals in order to explain the emergence of dislocating syntax**?

Hurford (2000) and Kirby (2002) made simulations with iterated learning models, which show that a stable compositional (recursive) syntax can arise within thousands of generations given completely unstructured strings of symbols at the beginning, a learning algorithm that can induce heuristically-driven grammars, and the ability of agents to associate strings with complex meanings. These simulations did not make any distinction between morphology and syntax. If speakers already used head-marking regularly, a syntax with the dislocation property, or even an isolating language, certainly could emerge from that state within fewer generations, given certain preconditions that make the starting state unstable (for instance, imperfect learning). However, I do not know of any simulation that aimed at transforming a given linguistic type into another.

A condition of these simulations was that speakers can assign complex meanings, which is realistic insofar as one assumes that already early homo was likely to entertain complex thoughts. If the notion of a mental attitude with a propositional object (such as 'believe') is available, recursion is available, too. Corresponding mental attitude verbs must have been present at the time 35,000 years ago when art appeared.

Specific syntactic universals dealing with dislocation are not necessary. Constraints dealing with dislocation can be adapted from the geometric system serving for an optimal perception of motion (figure-ground, locality, transformations, traces). These constraints can have competing demands; it is therefore their respective ranking that regulates how the actual balance between maximal expressivity (explicitness, distinctivenes, transparency) and minimal expense is taken.

I think that syntax emerged by some reranking of constraints, for instance, that a specified NP became better than a pronominal affix, and that the realization of topic and focus became high-ranked. This reranking was forced by external factors. The invention of dislocation was an advantage because more forms could be taken into consideration; it thus expanded the grammatical space. In the end, new constructions took over the task of elder ones. In other words, syntax forces less-flexible and redundant sorts of morphology to disappear.

References

Arbib, Michael. 2005. The mirror system hypothesis: How did protolanguage evolve? In Tallerman, 21-47.

Bailin, Alan & Ann Grafstein. 1991. The assignment of thematic roles in Ojibwa. *Linguistics* 29, 397-422.

Bickerton, Derek. 1981. *Roots of language*. Ann Arbor, Mich.: Karoma.

Briscoe, Ted. 2003. Grammatical assimilation. In Christensen & Kirby, 295-316.

Calvin, William H. 1991. *The ascent of mind. Ice age climates and the evolution of intelligence*. New York: Bantam Books.

Carstairs-McCarthy, Andrew. 2005. The evolutionary origin of morphology. In Tallerman, 166-184.

Chomsky, Noam. 1995. *The minimalist program*. MIT Press.

Chomsky, Noam. 2005. On phases. Ms.

Christensen, Morton H. & Simon Kirby (eds.) 2003. *Language evolution*. Oxford UP.

Corballis, Michael C. 2003. From hand to mouth: The gestural origins of language. In Christensen & Kirby, 201-218.

Dahl, Östen. 2006. In search of typological diversity. Symposium *Current topics in typology*, FU Berlin, 14. Jan. 2006.

Dahlstrom, Amy. 1991. *Plains Cree Morphosyntax*. New York: Garland.

Enard, Wolfgang et al. 2002a. Intra- and interspecific variation in primate gene expression patterns. *Science* 296: 340-343.

Enard, Wolfgang et al. 2002b. Molecular evolution of FOXP2, a gene involved in speech and language. *Nature* 418: 869-872.

Hockett, Charles. 1960. The origin of speech. *Scientific American* 203: 88-96.

Hockett, Charles. 1966. The problem of universals in language. In Greenberg (ed.) *Universals of language*, 1-29. MIT Press.

Hurford, James R. 2000. The emergence of syntax. In C. Knight, M. Studdert-Kennedy, and J.R. Hurford (eds.) *The evolutionary emergence of language: Social function and the origins of linguistic form*, 219-230. Cambridge UP

Kirby, Simon. 2002. Learning, bottlenecks, and the evolution of recursive syntax. In E. Briscoe (ed.) *Linguistic evolution through language acquisition: Formal and computational models*, 173-204. Cambridge UP.

Klein, Wolfgang & Clive Perdue. 1997. The Basic Variety, or: Couldn't language be much simpler? *Second Language Research* 13: 301-347.

Lai, Cecilia S. et al. 2001. A forkhead-domain gene is mutated in a severe speech and language disorder. *Nature* 413: 519-523.

Mattissen, Johanna. 2004. A structural typology of polysynthesis. *Word* 55: 189–216.

Nichols, Johanna. 1992. *Linguistic diversity in space and time*. Chicago UP.

Oudeyer, Pierre-Yves. 2005. From holistic to discrete speech sounds: the blind snowflake-maker hypothesis. In Tallerman, 68-99.

Rizzolatti, Giacomo, Luciani Fadiga, Vittorio Gallese, & Leonardo Fogassi. 1996. Premotor cortex and the recognition of motor actions. *Cognitive Brain Research* 3: 131-141.

Rizzolatti, Giacomo & Michael A. Arbib. 1998. Language within our grasp. *Trends in Neuroscience* 21: 188-194.

Studdert-Kennedy, Michael. 2005. How did language go discrete? In Tallerman, 48-67.

Tallerman, Maggie (ed.) 2005. *Language origins. Perspectives on evolution*. Oxford UP.

Trudgill, Peter. 2004. Linguistic and social typology. *Linguistic Typology* 8: 305-320.

Wunderlich, Dieter. 2004. Why assume UG? *Studies in Language* 28: 615-641.

Wunderlich, Dieter. 2005. The challenge by inverse morphology. *Lingue e Linguaggio* 4: 195-214.