

Introduction

1. Merge
 - (a) A lexical item (LI) is a syntactic object (SO)
 - (b) *Merge*: an operation that takes n SOs already formed, and constructs from them a new SO. (with n usually taken to be 2) [based on Chomsky 2005:6]
2. Claims of this paper:
 - (a) Structure Building (SB) is specific to humans but not to (narrow) syntax or even language (hence not part of the narrow faculty of language (FLN))- contra [HCF 2002])
 - (b) SB does NOT by itself alone combine two syntactic objects into a new syntactic object
 - (c) SB accounts for unbounded recursion but unbounded recursion is not its only or most important diagnostics, and recursion arises just as a side effect
 - (d) A major use of SB is alleviating the limitations of short term memory in production/analysis by providing a systematic procedure for organizing the input sequence into chunks in the sense of [Miller 1956:11]. Hence, alleviated short term memory effects are also a diagnostics for structure building (and a more important one).
3. FLN is not just recursion and interfaces, but is a richly structured system ('the grammatical component') with many properties that are highly specific to human language:
 - (a) grammatical category: N, V, A, P, D, C, T, Coord, Num, ...
 - (b) other grammatical features: *person, number, gender/class, case, tense, aspect, mood, force, voice, pronominals v. bound anaphors, ...*
 - (c) and their possible values: *1,2,3; singular, dual, plural etc; masc, fem, neuter, class1,.. classN; nominative, accusative, genitive, dative, ...; etc etc*
 - (d) syntactic selection features: [=N =P], [=N =N] ([Chomsky 1965] here in [Stabler 2011] style)
 - (e) modification features: [=A] (e.g. *very* can only modify phrases of category A)
 - (f) a set ('lexicon') of grammatical items defined in terms of these features
 - i. closed class items (of grammatical category D, C, T, Coord, ...)
 - ii. open class items (of grammatical category N, V, A, ...)
 - (g) grammatical relations: *subject, object, indirect object, predicate, head, complement, ...*
 - (h) syntactic selection and modification principles
 - (i) agreement and government/case assignment operations
 - (j) non-recursive combinatorial operations
4. For an account of how (3) can be accounted for from an evolutionary point of view, see [Odijk 2011]

Part A: specific to humans but not to syntax or even language

5. Chomsky acknowledges or even suggests himself that *Merge* is used outside of narrow syntax and even outside of the language faculty:

Generally [Chomsky 2010a:53], [Chomsky 2010a:53]

Natural numbers [Chomsky 2004] [Chomsky 2005:6]; see also [Chomsky 2010a:53])

Vision [Jackendoff & Pinker 2005: 217-218]; [Chomsky 2010a:53]

Music [Fitch 2010:121]; [Katz & Pesetsky 2011]; [Chomsky 2011: 22'53"-23':26"]
(perhaps)

Morphology / Lexicon [Chomsky2010a:53]

Planning [Chomsky2010a:53]

6. but he always considers these as ‘derivative of’ / ‘parasitic on’ / ‘an offshoot of’ the language faculty (‘There is no other possible explanation’ [Chomsky 2011: 22'53"-23':26"])

7. Other domains Chomsky does not mention

Discourse [Levinson & Evans 2010] and references there; [Koschmann 2010] and see below

Artificial languages Logic, Mathematics, Programming languages, Number notation systems¹

Thinking / C-I Component

- (a) Complex concepts constructed by using SB
- i. *uncle*: $\exists_z \text{MALE}(x) \ \& \ \text{SIBLING}(x,z) \ \& \ \text{PARENT}(z,y)$
 - ii. *kill* : $\text{CAUSE}(x, \text{BECOME}(\text{NOT}(\text{ALIVE}(y))))$
 - iii. natural numbers
- (b) in production one sometimes has to ‘search for’ words (suggesting that a complex C-I representation is already there
- (c) in production one wants to express some complex though C, one constructs a syntactic structure S to express this, piggy-backing on this a C-I structure C' for the syntactic structure is constructed. One can make errors in expressing the complex thought (i.e. $C' \neq C$), and one can be aware of this and correct oneself: this implies that C must exist, that C' must exist and C' and C can be compared to one another.

¹We mean here the unconscious capacity of humans to produce and analyze an indefinite number of expressions from such artificial languages. Our scientific understanding of the concept of ‘recursion’ is irrelevant here.

- (d) the ‘searching for words’ is part of core syntax, not just of the syntax/S-M interface, cf. failed retrieval of an idiomatic expression (*‘hij heeft de klok horen luiden maar weet niet waar de klepel hangt’*): only partially retrieved: some but not all lexical items and part of the syntactic structure of an idiomatic expression: *‘Dat toont aan dat hij eh eh, nou ja je weet wel van de klok en de klepel’*

Morphology Compounding, derivation. But perhaps this is syntax

Phonology Phonotactic rules. See below

Phonology Metrical structure (though perhaps metrical structure piggy-backs on syntax)

Orthography Graphotactic rules. See below

8. If recursion outside of language is ‘parasitic on language’ (using *Merge*) then why don’t we have
 - (a) Case assignment to musical notes ‘parasitic on language’?
 - (b) Agreement in person and number between digits in an integer ‘parasitic on language’?
 - (c) Etc.
9. I conclude: *Merge* must be an independent component interacting with other components, among them the grammatical component.
10. Chomsky: arithmetics, music must all be offshoots of language otherwise ‘There is no other possible explanation for its existence’, ‘otherwise, again, it would be very hard to explain’.
11. I agree that they must be due to the *same* mechanism (which is the case if (9) is assumed), but not that this mechanism is part of FLN (which is not the case if (9) is assumed).

Part B

12. Merge does NOT by itself combine two syntactic objects into a new syntactic object: a combinatorial principle/rule is required as well, cf.
 - (a) *This annoys me very
 - (b) *The the the
 - (c) *John John John
 - (d) *Annoy annoy annoy
13. [Chomsky 2005:6] does mention that
 - (a) ‘for an LI to enter into a computation,[...], it must have some property permitting this operation’.

- (b) ‘an LI has a feature that permits it to be merged’ (the ‘edge feature’ (EF))
 - (c) ‘The fact that *Merge* iterates without limit is a property at least of LIs - and optimally, only of LIs, as I will assume. EF articulates the fact that *Merge* is unbounded, that language is a recursive infinite system of a particular kind.’
14. What is implicit here is that *Merge* requires a combinatorial principle (say, the ‘Edge Feature Principle’), and this combinatorial principle requires an LI to have an edge feature for *Merge* to be applicable)
15. Interaction of combinatorial operations and Structure Building (SB):
- (a) O_C is an object of component C
 - (b) $[X]$ is a sequence of objects of type X
 - (c) OP_C is a combinatorial operation for objects of component C
 - (d) $OP_C: [O_C] \rightarrow \{O_C\}$ where $\{X\}$ is a sequence, a set, or a multiset of objects of type X depending on your favorite theory or on component C
 - (e) a sequence or set of objects of type O_C is itself not an object of type O_C
 - (f) To turn such set/sequence into an object of type O_C , additional structure is needed, e.g. a *node* = (Label, $\{O_C\}$) (=SB)
 - (g) simplest interaction: an OP_C applies to a $[O_C]$, yielding a $\{O_C\}$, and SB applies to this to create an object of type O_C
16. From Phrase Structure (PS) Rules to Bare Syntax. Problems with PS Rules:
- (a) Headedness not expressed: solved by X'-Theory and in Bare Syntax by Label=label of one of the daughters
 - (b) Non-heads: fully superfluous because of lexical strict subcategorization/modification properties, but Chomsky has never made this explicit (in contrast to e.g. HPSG's SUBCAT feature and its SUBCAT principle ([Pollard&Sag 1994:34], and Stabler (e.g. [Stabler 2011]) – both inspired by the categorial grammar approach
 - (c) It is most natural to use syntactic selection and modification principles as combinatorial operations that must have applied before SB is applicable.
 - (d) Checking such combinatorial conditions/operations later complicates things in particular if there is no such combinatorial principle (e.g. in the case of digits and syllables, see below).
17. Examples of combinatorial operations for syntax
- (a) Universal principles such as
 - i. ‘Edge Feature Principle’,
 - ii. syntactic selection principles (strict subcategorization), e.g. [Stabler 2011] $word1::=X Y word2::X \rightarrow word1::Y word2::X$
 - iii. modification principles, e.g.
 - A. $[X1_{MOD=[Y]}, X2_{CAT=Y}] \rightarrow \{X1_{MOD=[]} X2\}$

- B. *very* with property MOD=[A] can modify a syntactic object of syntactic category A but not of syntactic category V
- (b) language-specific or even construction-specific combinatorial rules
 - (c) or whatever your favorite combinatorial principles/rules are
18. Since SB is not an operation of syntax, it can't do anything specific to syntax to determine the properties of the newly created SO. Hence the properties of the newly created object must be derived from the input element properties (= Inclusiveness)
19. For the same reason, the relevant operation to determine the properties of the newly created SO must be a very general one (e.g copying, unification, re-entrancy (token-identity)). Only one element must be selected as input since combining the properties of two or more elements will (almost) always lead to incompatibility or be undefined (we almost derive Headedness).

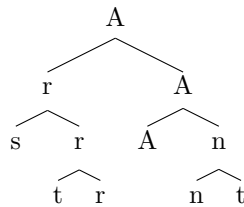
Part C

20. Unbounded recursion in natural language is real and must be accounted for. *Merge* can indeed account for unbounded recursion, but unbounded recursion is just a side effect that can occur if the combinatorial principle/rule happens to allow this.
21. What Chomsky says about this is not incorrect but there is overemphasis on recursion:
- (a) All approaches agree that a core property of FLN is **recursion**, attributed to the narrow syntax in the conception just outlined. [...] "This capacity of FLN yields discrete infinity" [HCF 2002: 1570-1571]
 - (b) "we suggest that FLN- the computational mechanism of **recursion** -is recently evolved and unique to our species", [HCF 2002: 1573].
 - (c) "in fact, we propose in this hypothesis that FLN comprises **only** the core computational mechanisms of **recursion** as they appear in narrow syntax" (emphasis mine) [HCF 2002: 1573]
 - (d) "at a minimum, then, FLN includes the capacity of **Recursion**" [FHC 2005:183]
22. But recursion is severely limited in many cases. Two examples from syntax:
- (a) Complementation
 - i. $V \rightarrow V \text{ XP}$ (if V syntactically selects for XP)
 - ii. Each lexical item allows only a finite (in fact very small (max 3 perhaps 4 including subjects)) number of complements (\rightarrow recursion limited)
 - iii. Which (by the way) follows from the theory proposed here in which the grammatical component has no recursive mechanisms (\rightarrow finite) + short term memory size (\rightarrow small)
 - iv. There is no logical necessity for this:

- A. in all programming languages procedures/functions can take an indefinite number of arguments
- B. a specific predicate taking an indefinite number of arguments is also conceivable
- v. but it does not occur in natural language
- (b) number expressions
 - i. numbers are the prime example of values without an upper bound
 - ii. is claimed by Chomsky to originate from recursion in language
 - iii. But: every natural language has number expressions for only a **finite** set of numbers
 - iv. Follows from a semantic condition on rules for number expressions (which itself may follow from the Packing Strategy, [Hurford 2007], though I have my doubts)
 - A. nine hundred ninety nine thousand / *(a) thousand thousand
 - B. one thousand nine hundred ninety nine / * (a) thousand (a) thousand
 - v. #Number expressions is always finite, even though it can be extended indefinitely (but always finite) by inventing a new 'word'

Rule	Semantics LHS	Condition
Number \rightarrow Digit	= [[Digit]]	True
Number \rightarrow Phrase (Number)	= [[Phrase]] + [[Number]]	[[Number]] < [[Phrase]]
Phrase \rightarrow (Number) M	= [[Number]] * [[M]]	[[Number]] < [[M]]

23. It is therefore not unreasonable to assume SB also operates in domains even if they are finite in nature, e.g. in phonotactics:
- (a) Sonority Sequencing Principle restricts recursion
 - (b) Combine a phoneme P1 with phoneme P2 provided that P2 is less sonorant than P1 (P1 will be the head)
 - (c) If you start out with a syllabic phoneme this will result in a syllable:
 - (d)



- (e) where A=[...+syll...]
- (f) Exceptions are possible but always listed as exceptions (cf. Dutch *psycholoog*, *wesþ*), and causing pronunciation problems

Part D

24. Compare the contrast between(24a) and (24b):
- Get by of tired the sitting beginning was very on sister bank her Alice to
 - Alice was beginning to get very tired of sitting by her sister on the bank
25. A major use of SB in production/analysis is alleviating the limitations of short term memory in production/analysis by providing a systematic procedure for organizing the input sequence into chunks in the sense of [Miller 1956:11]: ‘grouping input events and apply a name to the group, and then remember the new name rather than the original input events’ .
26. Working Memory (WM), which includes Short Term Memory(STM)
27. STM can contain only a small number of items (7+/- 2 [Miller 1956])
28. Elements in WM can only be accessed via a slot in STM
29. if a combinatorial rule is not applicable, it leads to overflow of STM for long sequences:

STM	m	n	g	l	s	a	a	o	i
WM									

30. combinatorial rules applicable:

STM	[+syll]	[+syll]	[+syll]	[+syll]					
WM	$\widehat{\text{man}}$	$\widehat{\text{ga}}$	$\widehat{\text{li}}$	$\widehat{\text{so}}$					

31. If, for an object sequence, a combinatorial rule exists and is applicable, SB can be applied. A combinatorial rule can be
- automatic : unconscious, fast, no external memory needed, few errors
 - not-automatic: conscious, slow, requires additional memory (pen and paper; keyboard and screen), and error-prone.
32. Examples
- Phonology (automatic): Cf. /mnglsaaoi/ v. /mangaliso/ 9 phonemes v. 4 syllables
 - Orthography (automatic): Cf. mnglsaaoi v. mangaliso
 - Syllable sequences: no combinatorial rule. SB cannot apply
 - Long sequence of syllables processed with difficulty or not at all and only if you learn them by heart
 - Llanfairpwllgwyngyllgogerychwyrndrobwyll-llantysiliogogoch
 - A sequence of syllables can however be replaced by a single occurrence of a grammatical item (‘morpheme’) that it is related to (arbitrarily)-if you know the language

- iv. → each morpheme consists only of a small number of syllables
 - (d) Decimal number notation: (not automatic): 3458472748903
 - i. the rule is known and simple: take what you have so far (initially 0), multiply by 10 and add the value of the next digit, etc until all digits of the sequence have been consumed
 - ii. but humans cannot do this automatically
 - (e) Roman number notation (not automatic): MCMLXXXIII
 - (f) Programming languages (not automatic)
 - (g) Morphology (automatic) – compounding, derivation, agglutination
 - (h) Syntax (automatic), cf. (32(h)i) v. (32(h)ii):
 - i. Get by of tired the sitting beginning was very on sister bank her Alice to
 - ii. Alice was beginning to get very tired of sitting by her sister on the bank
 - (i) C-I component (automatic)
 - (j) Discourse (automatic): discourse coherence rules
 - (k) Music (automatic)
33. From an evolutionary perspective, with SB not only syntax as we know it now became possible, but also complex thoughts, sequences of phonemes (phonology), sequences of morphemes (morphology), sequences of sentences (discourse), sequences of tones (music), etc. etc.
34. It alleviates STM limitations only to a very small degree. Center-embedding very quickly causes short term memory problems again, causing lesser or no acceptability (cf. [Yngve 1960] e.g. (p. 461) ??This is the malt that the rat that the cat that the dog worried killed ate

Conclusions

35. I submit that the claims of (2) have been convincingly demonstrated

References

- Chomsky 2004** Chomsky, N. (2004), 'Biolinguistics and Human Capacity', lecture delivered at MTA, Budapest, May 17, 2004 <http://www.chomsky.info/talks/20040517.htm>. Also appeared as Chapter 7 of Noam Chomsky, *Language and Mind*, Third Edition, Cambridge University Press pp 173-185.
- Chomsky 2005** Chomsky, Noam (2005), 'On Phases', unpublished manuscript, MIT.
- Chomsky 2010a** Chomsky, N. (2010), 'Some simple evo devo theses: how true might they be for language?', in [Larson et al. 2010], pp. 45-62. also available at <http://www.people.fas.harvard.edu/~fs39x/readings/chomsky-evodevo.pdf>
- Chomsky 2010b** Chomsky, Noam (2010), 'The Mysteries of Nature: How Deeply Hidden', in J. Bricmont & J. Franck (eds.) *Chomsky Notebook*, pp. 3-33. New York: Columbia University Press.
- Chomsky 2011** Chomsky, N. (2011), Lecture on Linguistics, Leiden, the Netherlands, March 14, 2011. accessible via URL <http://media.fsw.leidenuniv.nl/getmedia.php?id=5119>
- HCF 2002** Hauser, M.D., N. Chomsky & W.T. Fitch (2002), 'The Faculty of Language: what is it, who has it, and how did it evolve', *Science* 298, 1569-1579.

- Jackendoff & Pinker 2005** Ray Jackendoff & S. Pinker (2005), 'The nature of the language faculty and its implications for evolution of language (Reply to Fitch, Hauser, and Chomsky)', *Cognition* 97, pp 211-225.
- Hurford 2007** Hurford, James R. (2007), "A performed practice explains a linguistic universal: Counting gives the Packing Strategy", *Lingua* 117(5) 2007. pp. 773-783.
- Katz & Pesetsky 2011** Katz, Jonah & David Pesetsky (2011), 'The Identity Thesis for Language and Music', unpublished paper, Version 2.1, revised January 2011.
- http://ling.auf.net/lingbuzz?_s=wduLK0tTeLoKRvHS&_k=Rfc_6Rz7P-wf56s9&3
- Koschmann 2010** T. Koschmann (2010), 'On the universality of recursion', *Lingua* 120, pp. 2691-2694. [Larson et al 2010] Larson, R.K., V. Dprez, and H. Yamakido (2010), *The Evolution of Human Language - Biolinguistic Perspectives*, Cambridge: Cambridge University Press.
- Larson et al 2010** Larson, R.K., V. Dprez, & H. Yamakido (2010), *The Evolution of Human Language - Biolinguistic Perspectives*, Cambridge: Cambridge University Press.
- Levinson & Evans 2010** Stephen C. Levinson & N. Evans (2010), 'Time for a sea-change in linguistics: Response to comments on 'The Myth of Language Universals'', *Lingua* 120, pp. 2733-2758.
- Miller 1956** Miller, G. A. (1956). "The magical number seven, plus or minus two: Some limits on our capacity for processing information". *Psychological Review* 63 (2): 81-97. doi:10.1037/h0043158. PMID 13310704. (pdf)
- Odijk 1993** Odijk, J. (1993), 'Natural Language, Communication, and Man-Machine Interfaces, unpublished paper, IPO, Eindhoven.
- Odijk 2011** Odijk, J. 2011, 'The CC-Theory of the Origin of Language', downloadable from <http://ling.auf.net/lingbuzz/001337>
- Pollard & Sag 1994** *Head-Driven Phrase Structure Grammar*. Stanford: CSLI & Chicago: Chicago Press
- Stabler 2011** Stabler, E. P., 2011. Computational perspectives on minimalism. In C. Boeckx (Ed.), *Oxford handbook of linguistic minimalism* (p. 617-641). Oxford: Oxford University Press.
- Yngve 1960** Yngve, Victor H. 1960a. 'A model and an hypothesis for language structure'. *Proceedings of the American Philosophical Society*, 104(5):444-466

Appendix A: Quotes

Domain	Source	Quote	BUT
Generally	[Chomsky 2010a:53]	"one may raise the factual question of whether the basic properties of language, notably recursive generation, are unique to the language faculty or are found elsewhere. [...] We know that it is not"	
Generally	[Chomsky 2010a:53]	"Nonetheless, it is interesting to ask whether this operation is language-specific. We know that it is not."	Chomsky considers all as derivative of / parasitic on language
Natural Numbers	[Chomsky 2004**; see also: [Chomsky 2005:6] and [Chomsky 2010a:53]]; and [Chomsky 2011: 22'53"-23':26"] below]	"the most restrictive case of Merge applies to a single object, forming a singleton set. Restriction to this case yields the successor function, from which the rest of the theory of natural numbers can be developed in familiar ways."	'one possibility is [that] the natural numbers result from a simple constraint on the language faculty, which would make recursion in arithmetic "parasitic on the language faculty".'
Vision	[Chomsky 2010a:53] (implicitly replying to [Jackendoff & Pinker 2005 217-218]?)	"Suppose the single item in the lexicon is a complex object, say some visual array. Then Merge will yield a discrete infinity of visual patterns"	"this is simply a special case of arithmetic" and "tells us nothing new about recursion beyond language"
Music	[Fitch 2010:121]	music 'has a form of syntax (a set of rules for combining these [notes, JO] into larger hierarchical structures of essentially unbounded complexity'	
Music	[Chomsky 2011: 22'53"-23':26"]	"A language is plainly a computational system, and as far as is known, unique in nature in this respect. It is hard to find another system of digital infinity that has computational properties. In fact, there may not be any, but this is one. Actually, arithmetic is another, but it almost certainly is an offshoot of language. There is no other possible explanation for its existence. And people talk about music but in so far as it is true for music"	"it probably is also an offshoot of language, otherwise, again, it would be very hard to explain."
Morphology / Lexicon	[Chomsky2010a:53]	"if we add a recursive operation[...] to form an infinite lexicon, on the model of some actual (if rather trivial) lexical rules of natural language"	then "this is" also "simply a special case of arithmetic"
Planning	[Chomsky2010a:53]	"Similar questions might be asked about the planning systems investigated by George Miller and associates 45 years ago If these and other cases fall under the same general rubric,"	" then unbounded Merge is not only a genetically determined property of language, but also unique to it."