A processing approach to the typology of Noun Phrases

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This paper examines cross-linguistic variation in the syntax and morpho-syntax of Noun Phrases from the perspective of on-line processing demands. It is argued that some new descriptive generalizations can be formulated in this way, of potential relevance for any theory wishing to explain why languages exhibit the variation patterns that they do. Two processing hypotheses are proposed: anything that is an NP must be recognized as such, i.e. every NP must be 'constructable'; and all the items that belong to NP must be 'attachable' to it, and the amount of syntactic, morpho-syntactic or lexical encoding of attachment will be in proportion to complexity and efficiency in processing. Selected predictions following from these hypotheses are defined, tested, and found to be supported, suggesting that processing has played a significant role in shaping grammars in this area.

1. Introduction

There is much cross-linguistic variation in the syntactic and morpho-syntactic devices that define the structure of Noun Phrases (see Rijkhoff 2002, Plank 2003). Some languages have definite or indefinite articles, some have classifiers, some make extensive use of nominalizing particles, case marking is found in some, case copying throughout the noun phrase in a subset of these, other kinds of agreement patterns can be found on certain modifiers, 'linkers' exist in some languages for NP-internal constituents, a 'construct state' attaches NP to a sister category in others, and so on. The positioning of these items within the NP also exhibits variation.

My goal is to examine these patterns from an on-line processing perspective. I will argue that we can understand the variation better if we look at grammars in this way. Predictions can be made for the existence of certain structural devices, and for their presence versus absence, on the basis of general principles that are supported by experimental and corpus findings from language performance. The more general hypothesis that underlies this approach has been formulated in Hawkins (2004):

(1)   *Performance-Grammar Correspondence Hypothesis* (PGCH)
      Grammars have conventionalized syntactic structures in proportion
      to their degree of preference in performance, as evidenced by pat-
      terns of selection in corpora and by ease of processing in psycholin-
      guistic experiments.

The PGCH accounts for many universal and distributional
regularities, it motivates many exceptions to current universals
(Newmeyer 2005, Hawkins 2004), and it makes correct predictions for
many variation patterns across grammars that are not currently pre-
dicted by grammatical considerations alone.

I shall make use of two simple processing ideas in this context
that need to be incorporated in any model of comprehension (e.g.
Fodor *et al.* 1974) or of production (e.g. Levelt 1989). First, every
phrase that is an NP has to be recognized as such in language use,
i.e. it has to be 'constructable' as an NP. Second, all the words and
immediate constituents that belong to a given NP must be correctly
recognized as belonging to it, i.e. they must be 'attachable' to this NP
rather than to some other phrase.

Noun phrases pose two challenges in this respect for a parser.
First, NPs do not always contain nouns (Ns), i.e. the head category that
'projects' to a mother NP, and that makes it recognizable (cf. Jackendoff
1977, Pollard & Sag 1994). An NP must therefore be 'constructable' from
a variety of other terminal categories that are dominated by NP, the pre-
cise nature of which can vary across languages. Second, it must be made
clear in performance which terminal categories are to be 'attached' to a
given NP, as opposed to some other NP or to other phrases.

The paper begins, in section 2, with a listing of some of the major
syntactic and morpho-syntactic devices that are found in NPs across
languages and that are relevant to any discussion of construction and
attachment. These terms are then defined, and illustrative predic-
tions tested, in sections 3 and 4 respectively.

2. NP Construction and Attachment to NP

2.1 Construction

Several categories construct NP:
Nouns (i.e. lexical items specialized for the category N) like *student*
    and *professor* in English

Pronouns (personal, demonstrative, interrogative, etc): *he/she*, *this/that*, *who*, and their counterparts in other languages, cf. Bhat (2004)

Various determiners including the definite article (in theories in which Determiner Phrase and NP are not distinguished, cf. Hawkins 1993, 1994, Payne 1993)[1]

Nominalizing particles like Lahu *ve* (Matisoff 1972), Mandarin *de* (Li & Thompson 1981) and Cantonese *ge* (Matthews & Yip 1994:113) can combine with a non-noun or pronoun to construct a mother NP, as in the examples of (2), cf. C. Lehmann (1984:61-66):

(2) a. np[chu ve]   (Lahu)
         fat NOMINALIZER
     'one that/who is fat'
    b. np[vp[chī hūn] de]   (Mandarin)
            eat meat NOMINALIZER
     'one   who eats meat'
    c. np[vp[heui hōi-wúi] ge]   (Cantonese)
        go   have-meeting NOMINALIZER
     'those who are going to the meeting'

Classifiers in many languages perform syntactic functions that include the construction of NP (Aikhenvald 2003:87-90), resulting in omission of nouns from NP and pronoun-like uses for classifiers, as in the following example from Jacaltec (Craig 1977:149):

(3) xal naj pel   chubil chuluj   naj   hecal
     said CL Peter that   will-come CL/he tomorrow
     'Peter said that he will come tomorrow'

Case particles or suffixes construct a case-labelled mother or grandmother NP respectively, cf. Hawkins (1994:ch.6) for detailed discussion, e.g. in Japanese, German, Russian:

(4) a. npAcc[tegami o]   (Japanese)
           letter ACC
    b. npAcc[den   Tisch](German)
          the-ACC-SG-MASC table
    c. npAcc[lip-u]   (Russian)
          lime tree-ACC-SG-II

2.2 Attachment

Various (morpho-)syntactic devices signal the attachment of sister categories to a given NP:

Adjective agreement is a clear instance, e.g. Latin adjectives agree in case, number and gender features with some NP[N] (see Vincent 1988) permitting separation of   noun phrase constituents as in (5b):

(5) a. np[illarum   bonarum   feminarum]
           that-GEN-PL-FEM   good-GEN-PL-FEM   woman-GEN-PL-FEM
        'of those good women'
     b. pp[np*i*[magno]   cum np*i*   [periculo]]
             great-ABL-SG-NEUT   with   danger-ABL-SG-NEUT
        'with great danger'

Case copying in 'word-marking' Australian languages like Kalkatungu (Blake 1987, Plank [ed.] 1995) also signals attachment (to a similarly case-marked np[N]), permitting separation of NP constituents as in (6b):

(6) a. np*i*[thuku-yu   yaun-tu]   np*j*[yanyi]   itya-mi   (Kalkatungu)
         dog-ERG   big-ERG   white-man   bite-FUT
        'The big dog will bite the white man'
     b. np*i*[thuku-yu]   np*j*[yanyi]   itya-mi   np*i*[yaun-tu]
         dog-ERG   white-man   bite-FUT   big-ERG

These case suffixes also construct a case-marked mother or grandmother NP, as in (4). I.e. case markers can serve both to construct the dominating (case-labeled) NP and to attach the respective daughters with the same case to it.

Mandarin *de* similarly performs both an attachment and a construction function, attaching NP-dominated constituents together and constructing the mother NP, cf. the discussion in C. Lehmann (1984: 63-66) from which the following examples are taken:

(7) a. np[shuìjiòu de rén]   (Mandarin)
         sleep NOMLZ/ATTACH person
        'sleeping person'
     b. np[[bù hǎo] de   lái-wǎng]
         not good NOMLZ/ATTACH   come-go
        'undesirable contact'
     c. np[s[wǒ lái] de   dìfáng]
         I come NOMLZ/ATTACH   place
        'place from which I am coming'

d. np[s[wǒ vp[jiǎn zhǐ]] de   *jiǎndao*]
      I   cut   paper NOMLZ/ATTACH scissors
'scissors with which I cut paper'

Classifiers also attach NP-sisters to the NP that they construct, as in the following examples from Cantonese in which the classifier attaches a possessor to its head noun (8a) and a (preposed) relative clause to its head noun (8b), cf. Matthews & Yip (1994:107-12):

(8)   a. lóuhbáan ga   chē   (Cantonese)
        boss   CL   car
        'the boss's car'
   b. ngóhdeih hái Faatgwok sihk dī   yéh
        we   in France   eat   CL   food
        'the food we ate in France'

The repeated classifier *-ma* in the following example from Tariana functions like agreement in Latin (5) and case copying in Kalkatungu (6) to signal co-constituency between adjective and noun within NP (Aikhenvald 2003: 94-95): *nu-kapi-da-ma hanu-ma* (1SG-hand-CL:ROUND-CL:SIDE big-CL:SIDE), 'the big side of my finger'.

Linkers such as *na* in Tagalog attach *ulól* ('foolish') and *unggó* ('monkey') into a single NP in *ulól na unggó* ('foolish monkey'), cf. Hengeveld *et al.* (2004: 553)

The construct state in Berber signals co-constituency between nouns (/NPS) in the   construct state and a preceding noun (9b), quantity word (9c), preposition (9d), intransitive verb (9e), and transitive verb (9f) (Keenan 1988):

(9)   a. *Free form*:   aryaz 'man' arba 'boy'   tarbatt 'girl'   (Berber)
      Construct form: uryaz   urba   terbatt
   b. np[axam np[uryaz]]
        tent   man-CONSTR
      'tent of the man/the man's tent'
   c. np[yun uryaz]
        one   man-CONSTR
      'one man'
   d. pp[tama (n) np[uryaz]]
        near   man-CONSTR
      'near the man'
   e. s[lla vp[t-alla   np[terbatt]]]
        IMPF   she-cry   girl-CONSTR
      'The girl is crying'

f. s[vp[i-annay np[urba]   np[tarbatt]]]
         he-saw   boy-CONSTR   girl
   'The boy saw the girl'

   The construct state signals attachment of these immediate constituents but does not unambiguously construct any particular mother or grandmother phrase. The mother most immediately dominating np[N] in the construct state can be NP, PP, or VP, etc.
   A possessive (/genitive) -*s* in English (and similar forms in other languages) signals the attachment of PossP to the head N, and also the construction of a grandmother (or mother) NP (NP*i* in (10)):

(10) np*i*[possp[np*j*[the king of England]-s] daughter]

3. The Constructability Hypothesis

   I begin with the following hypothesis:

(11) *The Constructability Hypothesis* (Hawkins 1994: 379)
       For each phrasal node P there will be at least one word of category C dominated by P that can construct P on each occasion of use.

   It appears that there is always some category C that enables the parser to recognize that C is dominated by a phrase of a particular type, NP, PP, or VP, etc, generally as a daughter or as a granddaughter. Building hierarchical phrase structure trees in syntactic representations on the basis of terminal elements is a key part of grammatical processing. If a given P cannot be properly recognized (or 'constructed'), its integration into the syntactic tree, and its semantic interpretation are at risk. More generally, I have argued that (11) motivates a lot of the grammatical properties of heads of phrases, both lexical and functional, and that it provides a processing explanation for this universal and for many related properties that involve head-like projection.[2]

3.1 NP Construction

   The Constructability Hypothesis leads to a prediction for the structure of NPs:

(12) *Prediction 1: NP Construction*

Any phrase that is of type NP must contain either (i) a lexical head N or pronoun (personal or demonstrative, etc) or proper name, or (ii) some other functional category that can construct NP on each occasion of use in the absence of N or Pro or Name.

We expect NPs to contain either some lexical and inherent head category like a noun or pronoun or name, on the basis of which NP can always be recognized; or alternatively we expect to find categories that project uniquely to NP being especially productive, and indeed obligatory, in the absence of nouns, pronouns and names. Examples are given in (13):

(13) a. Lahu, Mandarin and Cantonese nominalizers, as in (2).

b. Jacaltec classifiers, as in (3).

c. Certain non-nominal categories including numerals and adjectives may unambiguously construct NP in certain languages (Dryer 2004).

d. Spanish permits omission of nouns with certain restrictive adjectives plus the definite article as a constructor of NP (*lo difícil* 'the difficult thing') and has also expanded this option to other categories such as infinitival VPs in *el hacer esto fue fácil* (DEF to-do this was easy) 'doing this was easy' (Lyons 1999: 60, Dryer 2004).

e. Malagasy has expanded it to locative adverbs, as in *ny eto* (DEF here), meaning 'the one(s) who is/are here' (Anderson & Keenan 1985: 294).

f. Case-marking on adjectives in e.g. Latin and German permits them to function as referential NPs, Latin *bonī* (good-Nom-Masc-Pl) 'the good ones', German *Gutes* (good-Nom-Neut-Sg) 'good stuff'.

g. In numerous languages the definite article signals a nominalization of some kind, e.g. Lakhota *ktepi kį wąyake* (kill DEF he-saw) 'he saw the killing' (Lyons 1999: 60), or the construction of a subordinate clause in noun phrase position, e.g. as subject or object, in Huixtan Tzotzil and Quileute (Lyons 1999: 60-61).

h. Head-internal relatives are structurally clauses that function as NPs and they are regularly marked as such by definiteness markers and/or case particles and adpositions, as in Diegueno (Gorbet 1976, Basilico 1996).

i. Free relatives can also consist of a clause functioning as an NP that is constructed by a nominalizing particle, e.g. in Cantonese *léih mh ngoi ge* (you not want Nominalizer) 'what you don't want' (Matthews & Yip 1994: 113).

The values of C constructing NP can vary in these np{C, X} structures, as can the values of X. There are language-particular conventions for the precise set of constructing categories (nominalizing particles, classifiers, definite articles, etc) and for the different values of X (adjective, adverb, infinitival VP, S, etc) that can combine with the relevant C to yield a noun phrase. But the very possibility and cross-linguistic productivity of omitting the noun/pronoun/name and of still having the phrase recognized as NP, in so-called 'nominalizations' and in the other structures illustrated here, follows from the Constructability Hypothesis.

A further prediction made by (11) is relevant for those languages whose lexical items are highly ambiguous with respect to syntactic category, even for the major parts of speech like noun and verb. The Polynesian languages are often discussed in this context (see e.g. Broschart 1997, Hengeveld *et al.* 2004). English has a large number of words that are ambiguous between noun and verb and there are many minimal pairs such as *they want to run/they want the run* and *to play is fun/the play is fun*. The article constructs NP and disambiguates between N and V.

Languages without a unique class of nouns do not have lexical categories that can unambiguously construct NP on each occasion of use. If lexical predicates are vague as to syntactic category, then projection to NP is not guaranteed by lexical entries and the Constructability Hypothesis is not satisfied.

(14) *Prediction 2: Lexical Differentiation*
Languages in which nouns are differentiated in the lexicon from other categories (verbs, adjectives or adverbs) can construct NP from nouns alone. Languages without a unique class of nouns in the lexicon will make use of constructing particles in order to construct NP and disambiguate the head noun from other categories; such particles are not required (though they are not ruled out) in languages with lexically differentiated nouns.

Relevant data come from the Polynesian languages, which make extensive and obligatory use of NP-constructing particles such as 'definite' articles, extending their meanings into the arena of indefiniteness, see Lyons (1999: 57-60). Samoan *le*, Maori *te* and Tongan *e* appear to be best analyzed as general NP constructors: they convert vague or ambiguous predicates into nouns within the NP constructed. Other (tense and aspect) particles construct a clause (IP) or VP and convert ambiguous lexical predicates into verbs (Broschart 1997). We have here a plausible motivation for the expanded grammaticaliza-

tion of definite articles and of other particles in these languages (see Hawkins 2004: 82-92).[3]

3.2 VO versus OV Asymmetries

VO languages have predominantly head-initial phrases that permit early construction of these phrases in parsing, by projection from the respective heads (V projects to VP, N to NP, P to PP, etc). OV languages have predominantly head-final phrases that favor late construction. I have argued (Hawkins 1994, 2001, 2004) that consistent head ordering minimizes processing domains for phrase structure recognition by shortening the distances between heads and that this provides an explanation for the productivity of these two major language types, head-initial and head-final.[4] There is, however, an interesting asymmetry between them that can be seen in so-called non-lexical or functional head categories.

Consider first the combination of a verb with a PP sister within VP, i.e. phrases such as vp[*went* pp[*to the movies*]] in English. There are four logical possibilities for the ordering of V, the lexical head of VP, and P, the lexical head of PP:

(15) a. vp[went pp[to the movies]]   b. [[the movies to]pp went]vp
       |---------| |---------|

    c. vp[went [the movies to]pp]   d. [pp[to the movies] went]vp
       |------------------| |------------------|

(15a) is the English order, (15b) is the Japanese order, and these two sequences with adjacent lexical heads (V and P) guarantee the smallest possible strings of words for the recognition of VP and its immediate constituents (see the underlinings). They are also highly preferred by approximately 94% to a combined 6% for the inconsistently ordered heads of (15c) and (d) in the Hawkins (1983, 1994, 2004) and Dryer (1992) samples.

An additional non-lexical category C within NP that can construct NP, in addition to N, can be efficient in VO languages. Either np[N …] or np[C …] orders can construct NP immediately on its left periphery and provide minimal 'phrasal combination domains' and 'lexical domains' linking e.g. V and NP within a VP (see note 4).

(16) vp[V np[N …]
    vp[V np[C … N …]
      |------|

We expect additional constructor categories C to be productive in VO and head-initial languages, therefore, and to be especially favored when N itself is not initial in NP, e.g. in np[C AdjP N]. The determiner position of English exemplifies this, with left-peripheral articles constructing NP in advance of N. Additional constructing categories in OV and head-final languages, on the other hand, do not have comparable benefits. They lengthen phrasal combination domains and other processing domains linking NP to V when NP precedes, whether the additional constructor precedes or follows N:

(17) [[… N … C]np V]vp
      [[… C … N]np V]vp
         |------------|

Additional constructors of NP can be inefficient in OV orders, therefore, and are predicted to be significantly less productive than their head-initial counterparts as a consequence.

(18) *Prediction 3: VO versus OV asymmetries*
      Constructors of NP other than N, Pro and Name, such as articles, are efficient for NP construction in VO languages and should occur frequently; they are not efficient for this purpose in OV languages and should occur less frequently.

We can test this using the World Atlas of Language Structures (Haspelmath et al. 2005, Dryer 2005ab). WALS provides data on languages that have definite articles as a separate category from demonstrative determiners (from which definite articles have generally evolved historically, see Himmelmann 1997, Lyons 1999). If, as argued in Hawkins (2004: 82-93), it is processing efficiency that drives the grammaticalization of definite articles out of demonstratives, then we expect to see a skewing in the distribution of definite articles in favor of head-initial languages. The figures in (19) show that VO languages do indeed have significantly more definite articles than OV languages. We also expect that non-rigid OVX languages should have more definite articles than OV languages with rigid verb-final order, since OVX languages have more head-initial phrases in their grammars, including head-initial NPs (Hawkins 1983), in which early construction of NP can be an advantage. This prediction is also borne out. The figures in parentheses refer to Dryer's "genera".[5]

(19)	*Def word distinct from Dem*	*No definite article*
Rigid OV	19% (6)	81% (26)
VO	58% (62)	42% (44)
Non-rigid OVX	54% (7)	46% (6)

4. The Attachability Hypothesis

Corresponding to the Constructability Hypothesis (11) I propose (20):

(20) *The Attachability Hypothesis*
For each phrasal node P, all daughter categories {A, B, C, …} must be attachable to P. The degree of syntactic, morpho-syntactic or lexical encoding that facilitates attachability will be in proportion to the processing complexity and/or efficiency of making the attachment.

In other words, all daughters must be attachable, and the more difficult the attachment is, the more grammatical or lexical information is required to bring it about. The use of explicit attachment devices under conditions of difficulty, and their possible omission when processing is easy, is efficient: activation of processing resources and greater effort are reserved for conditions under which they are most useful. This is supported by a large range of grammatical and performance data that motivate the principle of Minimize Forms in Hawkins (2004: 38-48): Form minimizations apply in proportion to the ease with which a given property P can be assigned in processing to a given form F. Rohdenburg's (1996, 1999) complexity principle provides further supporting data from English corpora: "In the case of more or less explicit grammatical options, the more explicit one(s) will be preferred in cognitively more complex environments" (Rohdenburg 1999: 101).
For attachments to NP, (20) leads to the hypothesis in (21):

(21) *NP Attachment Hypothesis*
Any daughters {A, B, C, …} of NP must be attachable to it on each occasion of use, through syntactic, morpho-syntactic or lexical encoding on one or more daughters, whose explicitness and differentiation are in proportion to the processing complexity and/or efficiency of making the attachment.

4.1 Separation of NP Sisters

One clear factor that increases the difficulty of attaching constituents together as sisters is separation from one another.

(22) *Prediction 4: Separation of Sisters*
Morpho-syntactic encoding of NP Attachment will be in proportion to the degree of separation between sisters: the more distance, the more encoding.

Consider first some performance data from English involving relative clauses with explicit relativizers (*who*, *whom*, *which*, and *that*) versus zero. The relativizers construct a relative clause. Their presence can also help to attach the relative to the head, especially when there is animacy agreement between relativizer and head noun (*the professor who* …, etc), but also in the absence of such agreement (since relatives are known to attach to head nouns by Phrase Structure rules). Empirically, it turns out that the presence of the relativizer and the avoidance of zero is proportional to the distance between the relative clause and the head noun. The figures in (23) are taken from Quirk's (1957) corpus of spoken British English. They show that the use of explicit relativizers increases significantly, from 60% to 94%, when there is any separation between nominal head and relative.

(23) a. *Restrictive (non-subject) relatives adjacent to the head noun*
explicit relativizer = 60% (327)   zero = 40% (222)
b. *Restrictive (non-subject) relatives separated from the head noun*
explicit relativizer = 94% (58)   zero = 6% (4)

The figures in (24) measure the impact on relativizer retention resulting from larger versus smaller structural separations and are taken from the Brown corpus (cf. Lohse 2000).

(24) a. *Separated relatives in NP-internal position*
which/that = 72% (142)   zero = 28% (54)
b. *Separated relatives in NP-external position (i.e. extraposed)*
which/that = 94% (17)   zero = 6% (1)

Relatives in (24b) have been completely extracted out of NP (in structures corresponding to *buildings will never fall down which we have constructed*). In (24a) they remain NP-internal but still separated (e.g. by an intervening PP, *buildings in New York which we have constructed*). There is a significant increase from 72% to 94% in relativizer retention when the separated relatives are extraposed. These data support prediction 4.

Consider now some data from grammars involving explicit case marking. In languages that employ case copying as an attachment strategy we predict a possible asymmetry whereby explicit case

marking can be retained on separated, but not on adjacent, sisters. Warlpiri exemplifies this (Blake 1987). Contrast the Warlpiri pair (25) with Kalkatungu (6), repeated here:

(25) a. np[tyarntu   wiri-ngki]+tyu   yarlki-rnu   (Warlpiri)
         dog   big-ERG+me   bite-PAST
    b. np*i*[tyarntu-ngku]+tyu   yarlku-rnu np*i*[wiri-ngki]
         dog-ERG+me   bite-PAST   big-ERG
     'The big dog bit me.'

(6) a. np*i*[thuku-yu]   yaun-tu]   np*j*[yanyi]   itya-mi   (Kalkatungu)
        dog-ERG   big-ERG   white-man   bite-FUT
     'The big dog will bite the white man'
    b. np*i*[thuku-yu]   np*j*[yanyi]   itya-mi   np*i*[yaun-tu]
        dog-ERG   white-man   bite-FUT   big-ERG

Case copying in Kalkatungu occurs on every word of the NP, whether adjacent or not. Warlpiri case copying occurs only when NP sisters are separated (25b). When NP constituents are adjacent (25a) the ergative case marking occurs just once in the NP and is not copied. This pair of Australian languages illustrates the asymmetry underlying Moravcsik's (1995:471) agreement universal:

(26) *Moravcsik's Universal*
     If agreement through case copying applies to NP constituents that are adjacent, it applies to those that are non-adjacent.

Agreement can be absent under adjacency at the same time that it occurs in non-adjacent environments. What is ruled out is the opposite asymmetry: agreement when adjacent and not when non-adjacent. Since agreement is a type of attachment marking we see correspondingly that the explicit encoding of attachment in performance and grammars is found under both adjacency ((23a) and (6a)) and non-adjacency ((23b), (25b) and (6b)). Zero coding is preferred when there is adjacency and is increasingly dispreferred when there is not (compare (23a) with (23b) in performance and (25a) with (25b) in grammars). What is not found is the opposite of the English relativizer pattern and of Warlpiri case coding: explicit attachment coding under adjacency and zero coding for separated items.

An example of case copying in a nominative-accusative language comes from Hualaga Quechua (see Plank 1995: 43 and Koptjevskaja-Tamm 2003: 645). When a possessor phrase is separated from its possessed head, as in (27), the accusative case marker *-ta* appropriate for the whole NP is added to genitive case-marked *Hwan-pa*.

(27) *Hipash-nin-ta   kuya-: Hwan-pa-ta*
daughter-3POSS-ACC love-1   Juan-GEN-ACC
'I love Juan's daughter'

4.2 Minimize NP Attachment Encoding

A further prediction that can be made on the basis of the NP Attachment Hypothesis (21) is:

(28) *Prediction 5: Minimize NP Attachment Encoding*
The explicit encoding of attachment to NP will be in inverse proportion to the availability of other (morpho-syntactic, syntactic and semantic-pragmatic) cues to attachment: the more such cues, the less encoding.

In other words, we predict less explicit attachment marking when there are other cues to attachment. Consider in this regard Haspelmath's (1999: 235) universal regarding the omissibility of definite articles in NPs with possessors depending on the type of possession.

(29) *Haspelmath's Universal*
If the definite article occurs with a noun that is inherently related to an accompanying possessor, such as a kinship term, then it occurs with nouns that are not so inherently related.

I suggest that this universal can be seen as a consequence of the attachment function of the definite article, linking a possessor to a head noun. Kinship involves necessary and inalienable relations between referents, which makes explicit signaling of the attachment less necessary with nouns of this subtype. The definite article can attach a possessor to a head noun in Bulgarian, Nkore-Kiga and Italian (30a), but not when the head noun + possessor describes a kinship relation like 'my mother' (30b), cf. Haspelmath (1999:236) and Koptevskaja-Tamm (2003):

(30)   car-DEF my   DEF-book my   DEF my
     house
     a. Bulgarian *kola-ta mi*; Nkore-Kiga *e-kitabo kyangye*; Italian *la mia casa*

     b. Bulgarian *majka(*-ta) mi*; Nkore-Kiga *(*o-)mukuru wangye*; Italian *(*la) mia madre*
          mother(-DEF) my   (DEF-)sister my
        (DEF) my mother

Support for this attachment explanation comes from the fact that other attachment devices (in section 2.2) show a parallel sensitivity to inalienable possession, suggesting that omissibility is not a consequence of the semantics and pragmatics of definiteness as such in combination with inalienable possession. The Cantonese nominalizer/attachment marker <u>ge</u> can be omitted as an explicit signal of attachment for possessor + noun when there is an inalienable bond between them, like kinship, and especially when the possessor is a pronoun. Contrast *ngóh sailóu* (I younger-brother, i.e. 'my younger brother') with *gaausauh ge baahngūngsāt* (professor NOMLZ/ATTACH office, i.e. 'the professor's office'), cf. Matthews & Yip (1994:107).

A particularly subtle test of the basic idea behind prediction 5 (28) has been made on Zoogocho Zapotec data by Sonnenschein (2005: 98-110). There are different formal means for marking possession in this language, by simple adjacency of nouns (31a), by a possessive prefix (31b) and by a postnominal possessor phrase headed by *che* (of) (31c):

(31) a. tao lalo   (Zoogocho Zapotec)
    grandmother Lalo, i.e. 'Lalo's grandmother'
    b. x-kuzh-a'
       POSS-pig-1SG, i.e. 'my pig'
    c. tigr che-be'
       tiger of-3INFORMAL, i.e. 'her tiger'

Sonnenschein tests the idea that there is a continuum from inalienable possession at the one end ('my head', etc) through frequently possessed items (like 'her pig') to not very frequently possessed items (like 'her tiger'). He shows on the basis of a corpus study that the amount of formal marking for possession correlates inversely with the frequency with which the relevant head nouns are in a semantic possession relation. Possession signaled by simple adjacency (31a) is used for head nouns that are always possessed (like kinship terms and body parts). Possession signaled syntactically by a postnominal possessor phrase (31c) is used with head nouns that are generally unpossessed. And NPs that show either morphological *x-* (31b) or syntactic encoding (31c) are more variably possessed. This intermediate group also shows a preference for the morphological variant when the possession is more inherent, and for the syntactic variant when the possession is less inherent, for example when a possessed house is under construction and the owners are not yet living in it.

Sonnenschein's quantification of the degree and frequency of possession correlating inversely with both the presence versus absence of

possession marking and with its amount and complexity supports the role of additional semantic-pragmatic cues in signaling the attachment of possessor to possessed, resulting in form minimization.

I have argued in this paper that cross-linguistic generalizations can be found in Noun phrase syntax and morpho-syntax when viewed from the processing perspective of the PGCH (1). Two hypotheses have been proposed, Constructability (11) and Attachability (21), from which five predictions have been derived in sections 3 and 4 and tested on illustrative and quantified data. Grammars appear to have conventionalized the preferences of performance that are evident in languages with structural choices between e.g. the presence or absence of a relative pronoun, of an article or a classifier. A processing approach can help us clarify why and how grammars make use of the various devices summarized in section 2 and why different languages exhibit the cross-linguistic variation that they do in this area.

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Notes

[1]   For theories in which Determiner Phrase and NP are distinguished the present paper can be viewed as providing a processing perspective on both NP and DP structure. A number of the details will differ from the account proposed here, regarding which of these maximal projections is actually constructed by particular daughters and regarding the attachments to each, but the same processing logic can carry over to structural analyses incorporating DPs.

[2]   There are numerous differences between different formal models of grammar with respect to the precise set of heads they define, and numerous disagreements exist with respect to particular categories, cf. Dryer (1992) and Corbett *et al.*, eds. (1993) for detailed summaries and discussion. Hawkins (1993, 1994) argues that the disputed categories generally have a 'construction' function in parsing (whence the plausability of considering them heads at all), and that it is this that ultimately motivates the whole notion of 'head of phrase' and its correlating properties.

[3]   One way to test the proposed link between NP-constructing particles and lexical differentiation would be to compare languages with and without lexically unique nouns by selecting various subsets of lexical predicates, quantifying num-

bers of category-ambiguous items (i.e. predicates like *run* and *play* in English, as opposed to *student* and *professor*, which are uniquely nouns), numbers of syntactic environments that require the definite article or other NP constructor, and corpus frequencies for these constructors. Hengeveld *et al.* (2004) provide a useful typology for lexical differentiation across languages and a language sample.

4   The basic efficiency principle to which I appeal in this section is Minimize Domains (Hawkins 2004: 31), defined as follows:

(i) *Minimize Domains* (MiD)

The human processor prefers to minimize the connected sequences of linguistic forms and their conventionally associated syntactic and semantic properties in which relations of combination and/or dependency are processed. The degree of this preference is proportional to the number of relations whose domains can be minimized in competing sequences or structures, and to the extent of the minimization difference in each domain.

MiD predicts that 'phrasal combination domains' should be as short as possible, and that the degree of this preference should be proportional to the minimization difference between competing orderings. This principle (a particular instance of Minimize Domains) was called Early Immediate Constituents (EIC) in Hawkins (1994):

(ii) *Phrasal Combination Domain* (PCD) [Hawkins 2004: 107]

The PCD for a mother node M and its I(mmediate) C(onstituent)s consists of the smallest string of terminal elements (plus all M-dominated non-terminals over the terminals) on the basis of which the processor can construct M and its ICs.

(iii)*Early Immediate Constituents* (EIC) [Hawkins 1994: 69-83]

The human processor prefers linear orders that minimize PCDs (by maximizing their IC-to-word ratios), in proportion to the minimization difference between competing orders.

Empirical support for EIC and for MiD is summarized in Hawkins (1994, 2004) using both corpora from numerous language types and psycholinguistic experiments. Additional corpus and experimental results providing broad support for EIC's/MiD's predictions are presented, for English in Wasow (1997, 2002), Stallings (1998), Stallings *et al*. (1998) and Lohse *et al*. (2004), for Japanese in Yamashita (2002) and Yamashita & Chang (2001), for Cantonese in Matthews & Yeung (2001), and for German in Uszkoreit *et al.* (1998). Hawkins' (2004) MiD is a more general version of the EIC principle that applies to all grammatical relations of combination and dependency. Gibson's (1998, 2000) 'locality' is fundamentally similar in spirit to MiD and the considerable experimental support that Gibson offers for it carries over to MiD.

5   A genus for Dryer (1992) is a genetic grouping of languages comparable in time depth to the subfamilies of Indo-European.

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