

A cross-linguistic analysis of noun incorporation in HPSG

Emily Luedke

University of Washington

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Introduction

- ▶ In this talk, I will be presenting a cross-linguistic HPSG analysis of noun incorporation.
- ▶ This work comes out of my master's thesis at the University of Washington.
- ▶ The ultimate goal of my project was to create a noun incorporation library for the Grammar Matrix customization system.

Definitions

- ▶ Noun Incorporation (NI): “the phenomenon in which a nominal that would otherwise bear a grammatical relation to the verb (such as direct object) is expressed not as an independent noun phrase, but rather as a morphological root that is integrated into the inflected verb to form a kind of composite form.” (Baker et al., 2005)
- ▶ IN: an incorporated noun
- ▶ Incorporating verb: a verb + IN construction

Background

- ▶ LinGO Grammar Matrix: open-source starter-kit for building implemented grammars (Bender et al., 2002)
 - ▶ Uses the frameworks of HPSG and MRS (Minimal Recursion Semantics) (Copestake et al., 2005)
 - ▶ Stores *types* that are hypothesized to be useful for any implemented grammar
- ▶ Customization system: web-based questionnaire to enhance coverage of phenomena specific to a user's language (Bender et al., 2010)
 - ▶ Made up of libraries targeting different linguistic phenomena
 - ▶ Library: stored analyses, elicitation questions on the webpage, and backend code to populate a customized grammar
 - ▶ When doing this type of work, I benefit from other libraries (e.g. existing analyses of similar phenomena, functionality, etc.), but I also need to work in the context of existing libraries.

Methodology

I conducted a literature review on NI from various sources:

- ▶ Typological surveys (e.g. Mithun, 1984; Aikhenvald, 2007; Gerdts, 1998)
- ▶ Formal analyses of NI from both lexicalist (e.g. Di Sciullo and Williams, 1987; Rosen, 1989) and syntactic accounts (e.g. Baker, 1988; Baker et al., 2005)
- ▶ Language-specific analyses (e.g. Allen et al., 1984; Ball, 2005)
- ▶ Existing HPSG analyses of NI (Runner and Aranovich, 2003; Malouf, 1999; Ball, 2005) (see also Koenig and Michelson, 2021)

Typology

Based on my review of the literature, I see a three-way division of syntactic types of NI:

- ▶ Reduction NI
 - ▶ Intransitive
 - ▶ Transitive
- ▶ Promotion NI
 - ▶ Possessor Raising
 - ▶ Oblique Argument Promotion
- ▶ Modifier NI
 - ▶ Stranding
 - ▶ Doubling

Reduction NI | Intransitive

- (1) a. *ətləg-e qoraŋə-∅ təm-nen*
father-ERG reindeer-ABS kill-AOR.3SG:3SG
'The father killed the/a reindeer.' [ckt] (Polinsky, 1990
via Gerds, 1998:88)
- b. *ətləg-en qaa-nmə-gʔe*
father-ABS reindeer-kill-AOR.3SG
'The father killed the reindeer.' [ckt] (Polinsky, 1990
via Gerds, 1998:88)

Incorporation triggers intransitive morphosyntactic behavior (absolutive case marking on the subject, one part agreement on the verb).

- (2) a. *yede dirude a-k'ar-hi*
that chicken 2S:A-eat-FUT
'You will eat that chicken.' [tix] (Allen et al., 1984:296)
- b. *yede a-diru-k'ar-hi*
that 2S:A-chicken-eat-FUT
'You will eat that chicken.' [tix] (Allen et al., 1984:296)

The adjectival demonstrative which modifies *dirude* 'chicken' in (2a) appears 'stranded' outside the verb in (2b), modifying the IN *-diru*.

Analysis | Overview

- ▶ My analysis of NI consists of a pair of lexical rules and, in the case of Modifier NI, an additional phrase structure rule.
- ▶ The first lexical rule is shared by all types of NI — it does the orthographic and semantic work of incorporating the noun.
- ▶ The second lexical rule is specific to the type of NI — it handles the valency aspect and any other semantic work necessary.
- ▶ For Modifier NI, the external modifying element goes through a phrase structure rule which primes it to combine with an incorporating verb in the syntax.

Analysis | General Lexical Rule

$$(3) \left[\begin{array}{l} \textit{noun-incorp-lex-rule} \\ \text{SYNSEM ... COMPS} \left\langle \boxed{1} \left[\dots \text{HOOK} \left[\begin{array}{l} \text{INDEX} \boxed{2} \\ \text{LTOP} \boxed{3} \end{array} \right], \boxed{4} \right] \right\rangle \\ \text{DTR} | \text{SYNSEM ... COMPS} \left\langle \boxed{1}, \boxed{4} \right\rangle \\ \text{C-CONT} | \text{RELS} \left\langle \left[\begin{array}{l} \textit{noun-relation} \\ \text{PRED} \text{ “_house_n_rel”} \\ \text{ARG0} \boxed{2} \\ \text{LBL} \boxed{3} \end{array} \right], \left[\begin{array}{l} \textit{quant-relation} \\ \text{PRED} \text{ “exist_q_rel”} \\ \text{ARG0} \boxed{2} \\ \text{RSTR} \boxed{3} \end{array} \right] \right\rangle \end{array} \right]$$

* This rule contains only specifications of a lexical rule unique to NI. There are other identities made which are handled by supertypes already present in the Grammar Matrix and made available with the Morphotactics library (O'Hara, 2008; Goodman, 2013).

Reduction NI | Intransitive

ətləg-en qaa-nmə-gʔe

father-ABS reindeer-kill-3SGS

'The father killed the reindeer.' [ckt] (Polinsky, 1990 via Gerdts, 1998:88)

Reduction NI | Intransitive | MRS

$$\left[\begin{array}{l}
 \text{mrs} \\
 \text{LTOP} \quad \boxed{h1} \ h \\
 \text{INDEX} \quad \boxed{e2} \ e \\
 \\
 \text{RELS} \quad \left\langle \begin{array}{l} \left[\begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h3} \ h \\ \text{ARG0} \quad \boxed{x5} \ x \\ \text{RSTR} \quad \boxed{h6} \ h \\ \text{BODY} \quad \boxed{h4} \ h \end{array} \right], \left[\begin{array}{l} \text{_father_n_rel} \\ \text{LBL} \quad \boxed{h7} \ h \\ \text{ARG0} \quad \boxed{x5} \end{array} \right], \left[\begin{array}{l} \text{_kill_v_rel} \\ \text{LBL} \quad \boxed{h8} \ h \\ \text{ARG0} \quad \boxed{e2} \\ \text{ARG1} \quad \boxed{x5} \\ \text{ARG2} \quad \boxed{x9} \ x \end{array} \right], \\
 \left[\begin{array}{l} \text{_reindeer_n_rel} \\ \text{LBL} \quad \boxed{h10} \ h \\ \text{ARG0} \quad \boxed{x9} \end{array} \right], \left[\begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h11} \ h \\ \text{ARG0} \quad \boxed{x9} \\ \text{RSTR} \quad \boxed{h13} \ h \\ \text{BODY} \quad \boxed{h12} \ h \end{array} \right]
 \end{array} \right\rangle \\
 \\
 \text{HCONS} \quad \left\langle \left[\begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h6} \\ \text{LARG} \quad \boxed{h7} \end{array} \right], \left[\begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h13} \\ \text{LARG} \quad \boxed{h10} \end{array} \right] \right\rangle
 \end{array} \right]$$

Reduction NI | Intransitive | Rule

$$(4) \left[\begin{array}{l} \text{reduce-intrans-lex-rule} \\ \text{SYNSEM ... VAL} \left[\begin{array}{l} \text{SUBJ} \left\langle \left[\text{LOCAL} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{VAL} \quad \boxed{1} \\ \text{HEAD} \quad +np \end{array} \right] \\ \text{CONT} \mid \text{HOOK} \quad \boxed{2} \end{array} \right] \right] \right\rangle \\ \text{COMPS} \quad \boxed{3} \end{array} \right] \\ \text{DTR} \mid \text{SYNSEM ...} \left[\begin{array}{l} \text{SUBJ} \left\langle \left[\text{LOCAL} \left[\begin{array}{l} \text{CAT} \mid \text{VAL} \quad \boxed{1} \\ \text{CONT} \mid \text{HOOK} \quad \boxed{2} \end{array} \right] \right] \right\rangle \\ \text{COMPS} \left\langle \dots, \boxed{3} \right\rangle \end{array} \right] \end{array} \right]$$

Modifier NI | Stranding

yede a-diru-k'ar-hi

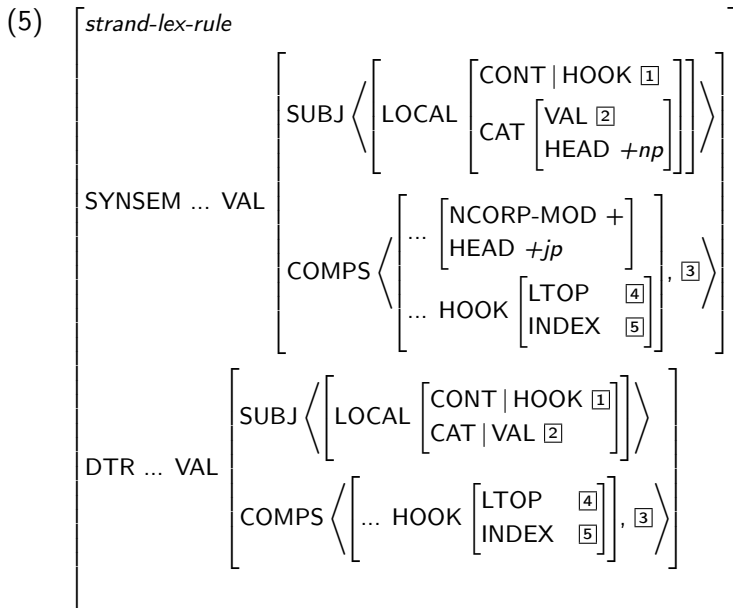
that 2sS/AO-chicken-eat-FUT

'You will eat that chicken.' [tix] (Allen et al., 1984:296 via Baker et al., 2005:150)

Modifier NI | Stranding | MRS

<i>mrs</i>	
LTOP	h1 <i>h</i>
INDEX	e2 <i>e</i>
RELS	$\left\langle \begin{bmatrix} \textit{exist_q_rel} \\ \textit{LBL} \quad \text{h3} \quad \textit{h} \\ \textit{ARG0} \quad \text{x5} \quad \textit{x} \\ \textit{RSTR} \quad \text{h6} \quad \textit{h} \\ \textit{BODY} \quad \text{h4} \quad \textit{h} \end{bmatrix}, \begin{bmatrix} \textit{that_a_rel} \\ \textit{LBL} \quad \text{h7} \quad \textit{h} \\ \textit{ARG0} \quad \text{e8} \quad \textit{e} \\ \textit{ARG1} \quad \text{x5} \end{bmatrix}, \begin{bmatrix} \textit{eat_v_rel} \\ \textit{LBL} \quad \text{h9} \quad \textit{h} \\ \textit{ARG0} \quad \text{e2} \\ \textit{ARG1} \quad \text{x10} \quad \textit{x} \\ \textit{ARG2} \quad \text{x5} \end{bmatrix}, \right.$ $\left. \begin{bmatrix} \textit{chicken_n_rel} \\ \textit{LBL} \quad \text{h7} \\ \textit{ARG0} \quad \text{x5} \end{bmatrix} \right\rangle$
HCONS	$\left\langle \begin{bmatrix} \textit{qeq} \\ \textit{HARG} \quad \text{h6} \\ \textit{LARG} \quad \text{h7} \end{bmatrix} \right\rangle$
ICONS	$\left\langle \begin{bmatrix} \textit{non-focus} \\ \textit{LARG} \quad \text{e2} \\ \textit{RARG} \quad \text{x10} \end{bmatrix} \right\rangle$

Modifier NI | Stranding | Lexical Rule



Modifier NI | Stranding | Phrase Structure Rule

$$(6) \left[\begin{array}{l} \text{adj-ni-mod-phrase} \\ \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{NCORP-MOD} + \\ \text{HEAD-DTR} \dots \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD} \left[\begin{array}{l} +jp \\ \text{MOD} \dots \text{INDEX} \boxed{4} \end{array} \right] \\ \text{NCORP-MOD} - \end{array} \right] \\ \text{CONT} \mid \text{HOOK} \mid \text{LTOP} \boxed{5} \end{array} \right] \\ \text{C-CONT} \left[\begin{array}{l} \text{HOOK} \left[\begin{array}{l} \text{LTOP} \boxed{5} \\ \text{INDEX} \boxed{4} \end{array} \right] \end{array} \right] \end{array} \right]$$

Evaluation | Held-out Languages

Language	Coverage	Overgeneration	Ambiguity
Apurinã	100%	23.1%	2.1
Bribri	100%	7.1%	2.4
Inuktitut	77.8%	33.3%	1.62
Moloko	100%	0%	1.2
Yaqui	100%	12.5%	1

Figure: Held-out language grammar performance

Evaluation | Error Analysis

- ▶ Coverage
 - ▶ Not enough customizability in my library (e.g. ability to allow promoted or doubled arguments to be dropped)
 - ▶ Not enough customizability in other libraries (not playing nicely with the Valence Change library)
- ▶ Overgeneration
 - ▶ Often, contrived grammatical readings of ungrammatical strings
 - ▶ Simple bugs that require minimal grammar engineering
- ▶ Ambiguity
 - ▶ Expected ambiguity between the two types of Promotion NI rules, also between Promotion NI and Doubling rules
 - ▶ NCORP-MOD feature is underconstrained, licenses incorrect structures
 - ▶ Due to other libraries/elements of the customization system (e.g. adverbs not fully implemented, underspecifications on features in the Valence Change library, argument optionality)

Conclusion

- ▶ Successful interactions with other Matrix libraries
 - ▶ For example, interaction of NI and passivization from the Valence Change library (Curtis, 2018).
 - ▶ Incorporation of a demoted subject in Southern Tiwa [tix]:

- (7) a. *khwienide edeureban kanideba*
khwien-ide edeuri-e-ban kan-ide-ba
dog-SG kick-PASS-PAST horse-SG-inst
'The dog was kicked by the horse.' [tix] (Allen et al., 1984:302)
- b. *khwienide kanedeurieban*
khwien-ide kan-edeuri-e-ban
dog-SG horse-kick-PASS-PAST
'The dog was kicked by the horse.' [tix] (Allen et al., 1984:302)

Conclusion

- ▶ I have analyzed multiple types of NI in the framework of HPSG.
- ▶ These analyses are now implemented in the Grammar Matrix.
- ▶ Now, grammarians who want to build an implemented grammar for a language can get a grammar fragment with an analysis of NI customized to the facts of the language.
- ▶ Based on evaluation and error analysis, my NI analysis extends well to unseen data and interacts fairly well with existing libraries.

Thank you!

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<https://doi.org/10.21248/hpsg.2003.20>

Reduction NI | Transitive

- (8) a. *seuan-ide ti-mu-ban*
man-SG 1SGA.3SGO-see-PAST
'I saw the man' [tix] (Allen et al., 1984 via Baker et al., 2005:141)
- b. *ti-seuan-mu-ban*
1SGS/3SGO-man-see-PAST
'I saw the/a man' [tix] (Allen et al., 1984 via Baker et al., 2005:141)

Incorporation does not trigger intransitive morphosyntactic behavior (same agreement marker used whether the noun is incorporated or not).

Promotion NI | Possessor Raising

- (9) *Juan ngilla-waka-fi-y* *Pedro*
Juan buy-cow-3O-IND.3SS Pedro
'Juan bought Pedro's cow.' [arn] (Baker et al., 2005:167)

The verb's direct object is understood to be the possessor of the IN.

Promotion NI | Promoted Oblique Argument

- (10) *tumg-e ekək kaynə-nmə-nen*
friend-ERG son-(ABS) bear-kill-AOR.3SG.3SG
'The friend killed the bear for his son.' [ckt] (Polinsky, 1990
via Gerdts, 1998:91)

An oblique (ex: benefactive argument) is promoted to the direct object position of the verb when the patient argument is incorporated.

Modifier NI

- (11) *sha'teku ni-kuti rabahbót*
eight PART-ZPLS bullhead
wa-hv-[i]tsy-a-hninu-' ki rake-'niha
FACT-MSGS-fish-Ø-buy-PUNC this my-father
'My father (fish-)bought eight bullheads.' [moh] (Baker, 1996:310 via Baker et al., 2005:149)
- (12) *yede a-diru-k'ar-hi*
that 2sS/AO-chicken-eat-FUT
'You will eat that chicken.' [tix] (Allen et al., 1984:296 via Baker et al., 2005:150)

Some external material in the direct object position modifies the IN. This can be a more specific noun (Doubling), or it can be an external modifier like an adjective or demonstrative (Stranding).

Reduction NI | Transitive

ti-seuan-mu-ban

1SGS/3SGO-man-see-PAST

'I saw the/a man' [tix] (Allen et al., 1984 via Baker et al., 2005:141)

Reduction NI | Transitive | MRS

$$\left[\begin{array}{l}
 \text{mrs} \\
 \text{LTOP} \quad \boxed{h1} \ h \\
 \text{INDEX} \quad \boxed{e2} \ e \\
 \\
 \text{RELS} \quad \left\langle \begin{array}{l}
 \begin{array}{l} \text{_see_v_rel} \\ \text{LBL} \quad \boxed{h3} \ h \\ \text{ARG0} \quad \boxed{e2} \\ \text{ARG1} \quad \boxed{x4} \ x \end{array} \\
 \begin{array}{l} \boxed{x5} \ \begin{bmatrix} x \\ \text{SPECI} \quad \text{bool} \\ \text{COG-ST} \quad \text{cog-st} \\ \text{PNG.PER} \quad 3\text{rd} \\ \text{PNG.NUM} \quad \text{sing} \end{bmatrix} \end{array} \end{array} \right\rangle, \begin{array}{l}
 \begin{array}{l} \text{_man_n_rel} \\ \text{LBL} \quad \boxed{h6} \ h \\ \text{ARG0} \quad \boxed{x5} \end{array} \end{array}, \begin{array}{l}
 \begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h7} \ h \\ \text{ARG0} \quad \boxed{x5} \\ \text{RSTR} \quad \boxed{h9} \ h \\ \text{BODY} \quad \boxed{h8} \ h \end{array} \end{array} \right\rangle \\
 \\
 \text{HCONS} \quad \left\langle \begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h9} \\ \text{LARG} \quad \boxed{h6} \end{array} \right\rangle \oplus \text{null} \\
 \\
 \text{ICONS} \quad \left\langle \begin{array}{l} \text{non-focus} \\ \text{LARG} \quad \boxed{e2} \\ \text{RARG} \quad \boxed{x5} \end{array}, \begin{array}{l} \text{non-focus} \\ \text{LARG} \quad \boxed{e2} \\ \text{RARG} \quad \boxed{x4} \end{array} \right\rangle \oplus \text{null}
 \end{array} \right]$$

Reduction NI | Transitive | Rule

(13)
$$\left[\begin{array}{l} \textit{reduce-trans-lex-rule} \\ \text{SYNSEM.LOCAL.CAT.VAL} \\ \text{DTR.SYNSEM.LOCAT.CAT.VAL} \end{array} \left[\begin{array}{l} \text{SUBJ} \quad \boxed{1} \\ \text{COMPS} \quad \boxed{2} \langle \text{OPT } +, \dots \rangle \\ \text{SUBJ} \quad \boxed{1} \\ \text{COMPS} \quad \boxed{2} \end{array} \right] \right]$$

Promotion NI | Possessor Raising

Juan ngilla-waka-fi-y *Pedro*

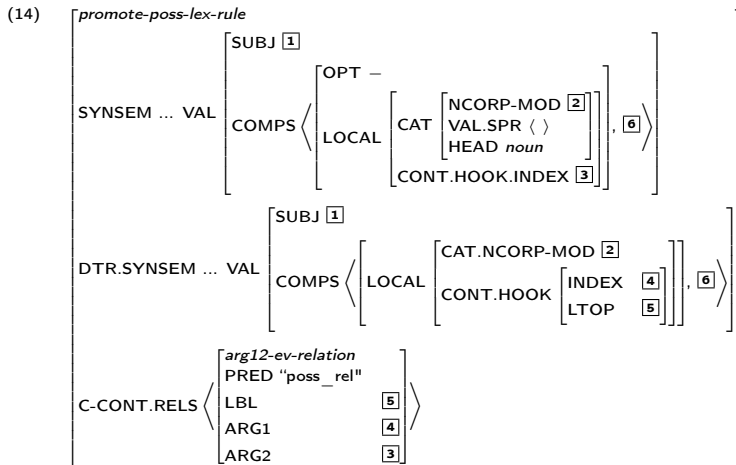
Juan buy-cow-3O-IND.3SS Pedro

'Juan bought Pedro's cow.' [arn] (Baker et al., 2005:167)

Promotion NI | Possessor Raising | MRS

<i>mrs</i>	
LTOP	h1 <i>h</i>
INDEX	e2 <i>e</i>
RELS	$\left[\begin{array}{l} \textit{exist_q_rel} \\ \textit{LBL} \quad \text{h3} \quad h \\ \textit{ARG0} \quad \text{x5} \quad x \\ \textit{RSTR} \quad \text{h6} \quad h \\ \textit{BODY} \quad \text{h4} \quad h \end{array} \right], \left[\begin{array}{l} \textit{_juan_n_rel} \\ \textit{LBL} \quad \text{h7} \quad h \\ \textit{ARG0} \quad \text{x5} \end{array} \right], \left[\begin{array}{l} \textit{_buy_v_rel} \\ \textit{LBL} \quad \text{h8} \quad h \\ \textit{ARG0} \quad \text{e2} \\ \textit{ARG1} \quad \text{x5} \\ \textit{ARG2} \quad \text{x9} \quad x \end{array} \right],$
	$\left\langle \left[\begin{array}{l} \textit{exist_q_rel} \\ \textit{LBL} \quad \text{h10} \quad h \\ \textit{ARG0} \quad \text{x9} \\ \textit{RSTR} \quad \text{h12} \quad h \\ \textit{BODY} \quad \text{h11} \quad h \end{array} \right], \left[\begin{array}{l} \textit{poss_rel} \\ \textit{LBL} \quad \text{h13} \quad h \\ \textit{ARG0} \quad \text{e14} \quad e \\ \textit{ARG1} \quad \text{x9} \\ \textit{ARG2} \quad \text{x15} \quad x \end{array} \right], \left[\begin{array}{l} \textit{exist_q_rel} \\ \textit{LBL} \quad \text{h16} \quad h \\ \textit{ARG0} \quad \text{x15} \\ \textit{RSTR} \quad \text{h18} \quad h \\ \textit{BODY} \quad \text{h17} \quad h \end{array} \right] \right\rangle,$
	$\left[\begin{array}{l} \textit{_pedro_n_rel} \\ \textit{LBL} \quad \text{h19} \quad h \\ \textit{ARG0} \quad \text{x15} \end{array} \right], \left[\begin{array}{l} \textit{_cow_n_rel} \\ \textit{LBL} \quad \text{h13} \\ \textit{ARG0} \quad \text{x9} \end{array} \right]$
	$\left\langle \left[\begin{array}{l} \textit{qeq} \\ \textit{HARG} \quad \text{h6} \\ \textit{LARG} \quad \text{h7} \end{array} \right], \left[\begin{array}{l} \textit{qeq} \\ \textit{HARG} \quad \text{h12} \\ \textit{LARG} \quad \text{h13} \end{array} \right], \left[\begin{array}{l} \textit{qeq} \\ \textit{HARG} \quad \text{h18} \\ \textit{LARG} \quad \text{h19} \end{array} \right] \right\rangle$

Promotion NI | Possessor Raising | Rule



Promotion NI | Oblique

tumg-e ekək kaynə-nmə-nen

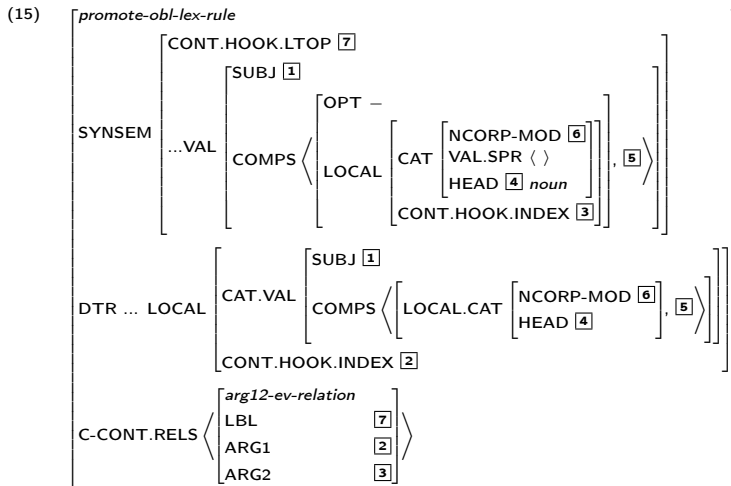
friend-ERG son-(ABS) bear-kill-AOR.3SG.3SG

‘The friend killed the bear for his son.’ [ckt] (Polinsky, 1990 via
Gerds, 1998:91)

Promotion NI | Oblique | MRS

$$\left[\begin{array}{l}
 \text{mrs} \\
 \text{LTOP} \quad \boxed{h1} \ h \\
 \text{INDEX} \quad \boxed{e2} \ e \\
 \\
 \text{RELS} \quad \left\langle \begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h3} \ h \\ \text{ARG0} \quad \boxed{x5} \ x \\ \text{RSTR} \quad \boxed{h6} \ h \\ \text{BODY} \quad \boxed{h4} \ h \end{array} , \begin{array}{l} \text{_friend_n_rel} \\ \text{LBL} \quad \boxed{h7} \ h \\ \text{ARG0} \quad \boxed{x5} \end{array} , \begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h8} \ h \\ \text{ARG0} \quad \boxed{x10} \ x \\ \text{RSTR} \quad \boxed{h11} \ h \\ \text{BODY} \quad \boxed{h9} \ h \end{array} , \right. \\
 \\
 \begin{array}{l} \text{_son_n_rel} \\ \text{LBL} \quad \boxed{h12} \ h \\ \text{ARG0} \quad \boxed{x10} \end{array} , \begin{array}{l} \text{_kill_v_rel} \\ \text{LBL} \quad \boxed{h13} \ h \\ \text{ARG0} \quad \boxed{e2} \\ \text{ARG1} \quad \boxed{x5} \\ \text{ARG2} \quad \boxed{x14} \ x \end{array} , \begin{array}{l} \text{_bear_n_rel} \\ \text{LBL} \quad \boxed{h15} \ h \\ \text{ARG0} \quad \boxed{x14} \end{array} \left. \right\rangle \\
 \\
 \begin{array}{l} \text{exist_q_rel} \\ \text{LBL} \quad \boxed{h16} \ h \\ \text{ARG0} \quad \boxed{x14} \\ \text{RSTR} \quad \boxed{h18} \ h \\ \text{BODY} \quad \boxed{h17} \ h \end{array} , \begin{array}{l} \text{benefactive_rel} \\ \text{LBL} \quad \boxed{h19} \ h \\ \text{ARG0} \quad \boxed{e20} \ e \\ \text{ARG1} \quad \boxed{e2} \\ \text{ARG2} \quad \boxed{x10} \end{array} \\
 \\
 \text{HCONS} \quad \left\langle \begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h6} \\ \text{LARG} \quad \boxed{h7} \end{array} , \begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h11} \\ \text{LARG} \quad \boxed{h12} \end{array} , \begin{array}{l} \text{qeq} \\ \text{HARG} \quad \boxed{h18} \\ \text{LARG} \quad \boxed{h15} \end{array} \right\rangle
 \end{array} \right]$$

Promotion NI | Oblique | Rule



Modifier NI | Doubling

sha'teku ni-kuti rabahbót wa-hv-[i]tsy-a-hninu-' *ki*
eight PART-ZPLS bullhead FACT-MSGS-fish-Ø-buy-PUNC this
rake-'niha

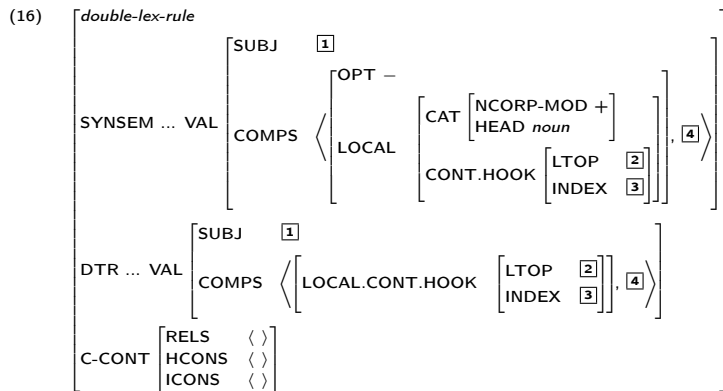
my-father

'My father (fish-)bought eight bullheads.' [moh] (Baker, 1996:310
via Baker et al., 2005:149)

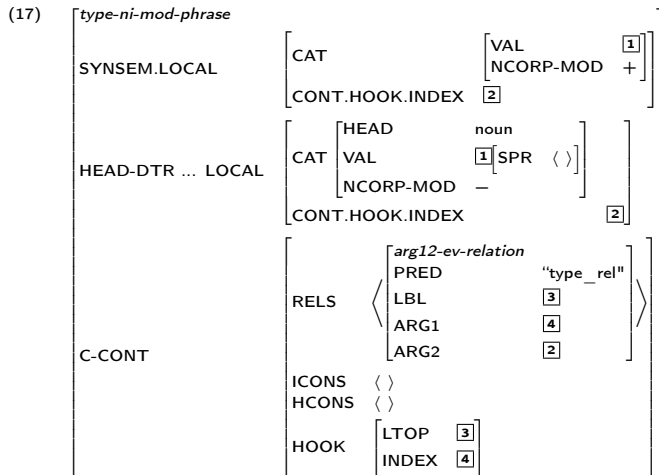
Modifier NI | Doubling | MRS

<i>mrs</i> LTOP h1 <i>h</i> INDEX e2 <i>e</i>			
	$\begin{bmatrix} \textit{type_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h3}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{e4}} \quad \textit{e} \\ \textit{ARG1} \quad \textstyle\boxed{\text{x6}} \quad \textit{x} \\ \textit{ARG2} \quad \textstyle\boxed{\text{x5}} \quad \textit{x} \end{bmatrix},$	$\begin{bmatrix} \textit{exist_q_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h7}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x5}} \\ \textit{RSTR} \quad \textstyle\boxed{\text{h9}} \quad \textit{h} \\ \textit{BODY} \quad \textstyle\boxed{\text{h8}} \quad \textit{h} \end{bmatrix},$	$\begin{bmatrix} \textit{eight_a_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h10}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{e11}} \quad \textit{e} \\ \textit{ARG1} \quad \textstyle\boxed{\text{x5}} \end{bmatrix},$
RELS	$\left\langle \begin{bmatrix} \textit{bullhead_n_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h10}} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x5}} \end{bmatrix}, \begin{bmatrix} \textit{buy_v_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h12}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{e2}} \\ \textit{ARG1} \quad \textstyle\boxed{\text{x13}} \quad \textit{x} \\ \textit{ARG2} \quad \textstyle\boxed{\text{x6}} \end{bmatrix}, \begin{bmatrix} \textit{exist_q_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h14}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x6}} \\ \textit{RSTR} \quad \textstyle\boxed{\text{h16}} \quad \textit{h} \\ \textit{BODY} \quad \textstyle\boxed{\text{h15}} \quad \textit{h} \end{bmatrix} \right\rangle,$		
	$\begin{bmatrix} \textit{fish_n_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h3}} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x6}} \end{bmatrix},$	$\begin{bmatrix} \textit{father_n_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h17}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x13}} \end{bmatrix},$	$\begin{bmatrix} \textit{pron_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h18}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x19}} \quad \textit{x} \end{bmatrix},$
	$\begin{bmatrix} \textit{exist_q_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h20}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x13}} \\ \textit{RSTR} \quad \textstyle\boxed{\text{h22}} \quad \textit{h} \\ \textit{BODY} \quad \textstyle\boxed{\text{h21}} \quad \textit{h} \end{bmatrix},$	$\begin{bmatrix} \textit{poss_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h17}} \\ \textit{ARG0} \quad \textstyle\boxed{\text{e23}} \quad \textit{e} \\ \textit{ARG1} \quad \textstyle\boxed{\text{x13}} \\ \textit{ARG2} \quad \textstyle\boxed{\text{x19}} \end{bmatrix},$	$\begin{bmatrix} \textit{exist_q_rel} \\ \textit{LBL} \quad \textstyle\boxed{\text{h24}} \quad \textit{h} \\ \textit{ARG0} \quad \textstyle\boxed{\text{x19}} \\ \textit{RSTR} \quad \textstyle\boxed{\text{h26}} \quad \textit{h} \\ \textit{BODY} \quad \textstyle\boxed{\text{h25}} \quad \textit{h} \end{bmatrix}$
HCONS	$\left\langle \begin{bmatrix} \textit{qeq} \\ \textit{HARG} \quad \textstyle\boxed{\text{h9}} \\ \textit{LARG} \quad \textstyle\boxed{\text{h10}} \end{bmatrix}, \begin{bmatrix} \textit{qeq} \\ \textit{HARG} \quad \textstyle\boxed{\text{h16}} \\ \textit{LARG} \quad \textstyle\boxed{\text{h3}} \end{bmatrix}, \begin{bmatrix} \textit{qeq} \\ \textit{HARG} \quad \textstyle\boxed{\text{h22}} \\ \textit{LARG} \quad \textstyle\boxed{\text{h17}} \end{bmatrix}, \begin{bmatrix} \textit{qeq} \\ \textit{HARG} \quad \textstyle\boxed{\text{h26}} \\ \textit{LARG} \quad \textstyle\boxed{\text{h18}} \end{bmatrix} \right\rangle$		

Modifier NI | Doubling | Lexical Rule



Modifier NI | Doubling | Phrase Structure Rule



Illustrative Languages

Language	Reduction NI			Promotion NI		Modifier NI	
	trans	intrans same	intrans different	promote poss	promote obl	strand	double
Chukchi			✓	✓	✓		
S. Tiwa	✓					✓	
Mapudungun		✓		✓			
Mohawk		✓			✓	✓	✓
Tongan			✓			✓	

Illustrative language choices on NI subpage

Illustrative Languages

Language	WO	case system	subj/obj agreement	transitivity marking	valchange ops
Chukchi	free	erg/abs, locative	subj+obj	no	applicative
S. Tiwa	free	(nom/acc), locative	subj+obj	no	passive
Mapudungun	SVO	none	subj, obj	no	applicative
Mohawk	free	none	subj+obj	no	
Tongan	free	erg/abs	none	no	

Illustrative language additional choices for testing library interaction

Illustrative Languages

Language	Coverage	Overgeneration	Ambiguity
Chukchi	100%	0%	1.43
S. Tiwa	92.3%	0%	1.58
Mapudungun	100%	25%	1
Mohawk	100%	50%	1.4
Tongan	100%	0%	1

Illustrative language grammar performance

Pseudo-languages

Language	Reduction NI			Promotion NI		Modifier NI	
	trans	intrans same	intrans different	promote poss	promote obl	strand	double
PL1	✓			✓	✓	✓	✓
PL2		✓		✓	✓	✓	✓
PL3			✓	✓	✓	✓	✓
PL4	✓			✓	✓	✓	✓
PL5			✓	✓	✓	✓	✓
PL6	✓			✓	✓	✓	✓

Pseudo-language choices on NI subpage

Pseudo-languages

Language	WO	case system	subj/obj agreement	transitivity marking	valchange ops
PL1	SOV	erg/abs	subj, obj	yes	
PL2	SVO	nom/acc	subj, obj	yes	
PL3	VSO	erg/abs	subj, obj	yes	
PL4	OSV	tripartite	subj+obj	yes	
PL5	OVS	tripartite	subj, obj	yes	
PL6	VOS	(nom/acc), benefactive, instrumental, causative	subj+obj	no	passive, applicative, causative

Pseudo-language additional choices for testing library interaction

Pseudo-languages

Language	Coverage	Overgeneration	Ambiguity
PL1	100%	5%	1.5
PL2	100%	0%	1.57
PL3	100%	0%	1.57
PL4	100%	5%	1.43
PL5	100%	0%	1.57
PL6	100%	0%	2.5

Pseudo-language grammar performance

Held-out Languages

Language	Reduction NI			Promotion NI		Modifier NI	
	trans	intrans same	intrans different	promote poss	promote obl	strand	double
Apurinã	✓			✓		✓	✓
Bribri			✓	✓	✓		
Inuktitut			✓		✓	✓	✓
Moloko		✓					
Yaqui		✓					

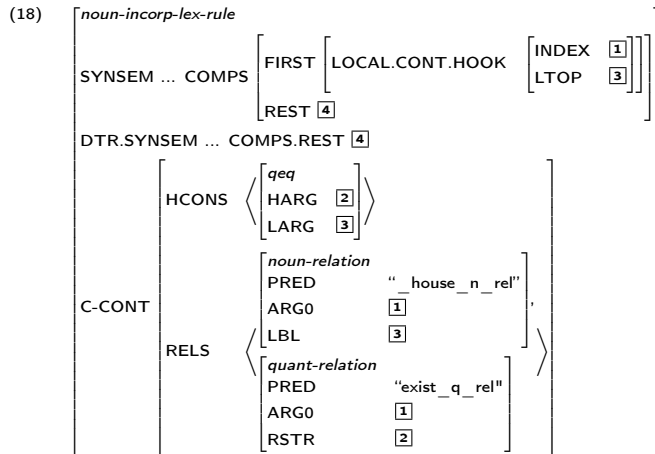
Held-out language choices on NI subpage

Held-out Languages

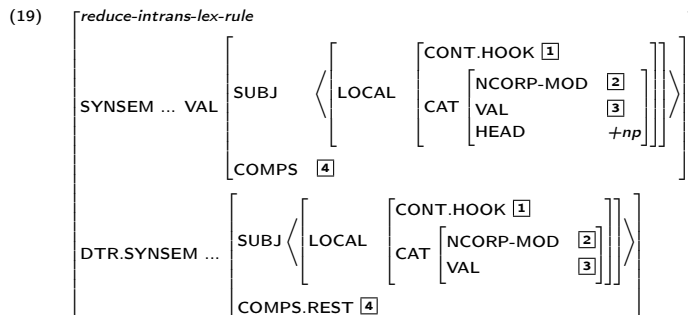
Language	WO	case system	subj/obj agreement	transitivity	valchange ops
Apurinā	VSO	(nom/acc), goal	subj, obj	no	
Bribri	free	erg/abs, intrs, com, loc, ben	none	imperfective	obj-add
Inuktitut	SOV	erg/abs, mod, allat	subj+obj	no	passive, antipassive
Moloko	SVO	(nom/acc), loc, dat	subj, ind obj	no	obj-add
Yaqui	SOV	nom/acc	none	yes	passive

Held-out language additional choices for testing library interaction

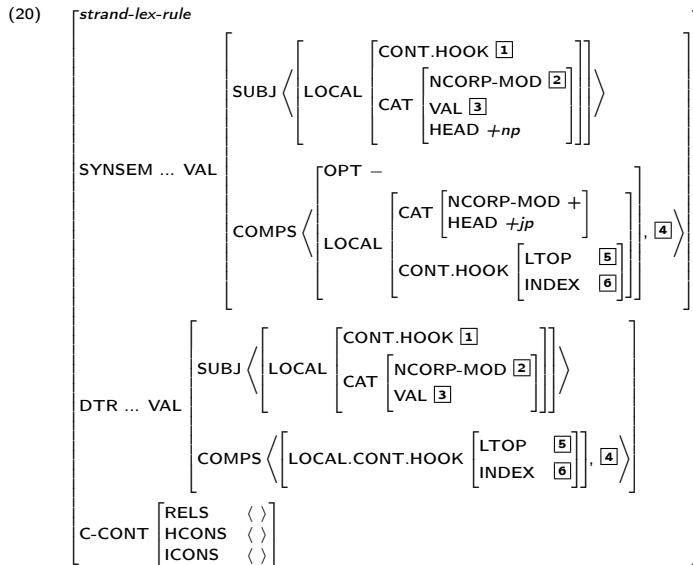
Frame Title



Reduction NI | Intransitive | Rule



Modifier NI | Stranding | Lexical Rule



$$(21) \left[\begin{array}{l} \textit{adj-ni-mod-phrase} \\ \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{NCORP-MOD} + \\ \\ \text{HEAD-DTR} \dots \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{HEAD} \left[\begin{array}{l} \textit{adj} \\ \text{MOD} \dots \text{INDEX} \boxed{4} \end{array} \right] \\ \text{NCORP-MOD} - \end{array} \right] \\ \text{CONT} \mid \text{HOOK} \mid \text{LTOP} \boxed{5} \end{array} \right] \\ \\ \text{C-CONT} \left[\begin{array}{l} \text{HOOK} \left[\begin{array}{l} \text{LTOP} \boxed{5} \\ \text{INDEX} \boxed{4} \end{array} \right] \end{array} \right] \end{array} \right]
 \end{array} \right]$$