A Parametric Approach to Implemented Analyses

Valence-changing morphology in the LinGO Grammar Matrix

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2 Typology of valence change

3 HPSG and Feature Structures

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6 Evaluation

7 Conclusion

Background

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- Hypotheses
  - Typologically-informed set of valence-changing operations can cover meaningful portion of world languages that exhibit valence change
  - These operations can be built up from reusable, isolated component operations in a building-block fashion

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- Valence-increasing
  - Subject addition
  - Object addition
- Relationship-altering
  - Altering relationship between semantic and syntactic roles

Subject removal

Anticausative:

(1) a. Anne-m kapı-yı aç-tı
mother-1SG door-ACC open-PAST(3SG)
'My mother opened the door.' [tur]

b. Kapı aç-tı-dı
door open-ANTIC-PAST(3SG)
'The door opened.' [tur] (Haspelmath and Müller-Bardey 2004, p. 5)

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Passive:

(2) a. ma ch-ok t-b'iyo-'n Cheep kab' xjaa
PAST 3PL+O-DIRectional 3SG+A-hit-DIR José two person
'José hit two people.' [mam]

b. ma chi b'iy-eet kab' xjaa (t-u'n Cheep)
PAST 3PL+S hit-PASS two person 3SG-REL/AGENT José
'Two people were hit (by José).' [mam]
(England 1983, in Dixon and Aikhenvald 1997, p. 75)

Object removal

Deobjective:

(3) a. Sake a-ku
sake 1SG.TR-drink
'I drink sake.' [ain]

b. I-ku-an
DEOBJ-drink-1SG.INTR
'I drink.' [ain]

(Shibatani 1990, in Haspelmath and Müller-Bardey 2004, p. 3)

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Deaccusative/antipassive:

(4) a. Az orvos szán-ja a beteg-et
the doctor pity-3SG the patient-ACC
'The doctor pities the patient.' [hun]

b. Az orvos szán-akoz-ik a beteg-en
the doctor pity-DEACC-3SG the patient-SUPERESS
'The doctor feels pity for the patient.' [hun]

(Károly 1982, in Haspelmath and Müller-Bardey 2004, p. 4)

Subject addition

Causative (intransitive):

(5) a. nw nìi táa nìì
he enter in house
'He entered the house.' [bav]

b. m nìi-s nw táa nìì
I enter-CAUS him in house
'I made him enter the house.' [bav]
(Schaub 1982, in Haspelmath and Müller-Bardey 2004, p. 11)

Subject addition

Causative (transitive):

(6) a. Mama-m Mzia-s daanteb-in-a cecxli
father-ERG Mzia-DAT light-CAUS-AOR:3SG fire(ABS)
'Father made Mzia light the fire.' [kat]
(Harris 1981, in Haspelmath and Müller-Bardey 2004, p. 12)

b. Raamanu manga-gal-inda Siite-yannu huduki-si-danu
Rama(NOM) monkey-PL-INSTR Sita-ACC search-CAUS-3SG
'Rama had the monkeys search for Sita.' [kan]
(Cole and Sridhar 1977, in Haspelmath and Müller-Bardey 2004, p. 12)

c. Juzi-ka Juan-ta ruwana-ta awa-chi-rka
José Juan-ACC poncho-ACC weave-CAUS-3SG
'José made Juan weave a poncho.' [qvi]
(Cole 1982, in Haspelmath and Müller-Bardey 2004, p. 12)

Object addition

Applicative:

(7) a. Orang itu masak ikan untuk perempuan itu
man Def cook fish for woman Def
'The man cooked fish for the woman.' [ind]

b. Orang itu memasakan perempuan itu ikan
Orang itu me-masak-kan perempuan itu ikan
man Def Tr-cook-Ben woman Def fish
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Benefactive:

(8) a. Ali memi telefisi untuk ibu-nja
Ali TR.buy television for mother-his
'Ali bought a television for his mother.' [ind]

b. Ali mem-beli-kan ibu-nja telefisi
Ali TR-buy-APPL mother-his television
'Ali bought his mother a television.' [ind]
(Chung 1976, in Wunderlich 2015, p. 21)

Relationship-altering

Reflexive:

(9) a. O Axmed ksíri-s-e ton Péro
ART Ahmed shave-AOR-3SG ART Pedro
'Ahmed shaved Pedro.' [ell]

b. O Pero ksirí-s-tik-e
ART Pedro shave-AOR-REFL-3SG
'Pedro shaved (himself).' [ell]

(Haspelmath and Müller-Bardey 2004, p. 6)

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Passive:

(10) a. inu ga neko wo ot-ta
dog NOM cat ACC chase-PST
'The dog chased the cat.' [jpn]

b. neko ga inu ni o-ware-ta
cat NOM dog DAT chase-PASS-PST
'The cat was chased by the dog.' [jpn] (Bender 2013, p. 103)

Key Ideas[1] in HPSG

Head-driven Phrase Structure Grammar

- Monostratal theory of grammar
- Language as a system of signs
- Typed feature structures
- Unification
- Strong lexicalism
- Capturing generalizations at different granularities

[1] Bender and Flickinger 2017

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Example

$$\begin{bmatrix} \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{AGR} & \begin{bmatrix} \text{PER} & \textit{3rd} \\ \text{NUM} & \textit{sg} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Unification

HPSG Grammars consist of partial constraints on well-formed trees

- Lexical entries
- Phrase structure rules
- Lexical rules
- General principles
- Initial symbol

These constraints are combined via unification; any combination that succeeds licenses well-formed utterances

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Informally:

- Given two feature structures
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$$\begin{bmatrix}\text{PERS} & \textit{3rd}\end{bmatrix} \;\&\; \begin{bmatrix}\text{NUM} & \textit{sg}\end{bmatrix} \longrightarrow \begin{bmatrix}\text{PERS} & \textit{3rd}\\ \text{NUM} & \textit{sg}\end{bmatrix}$$

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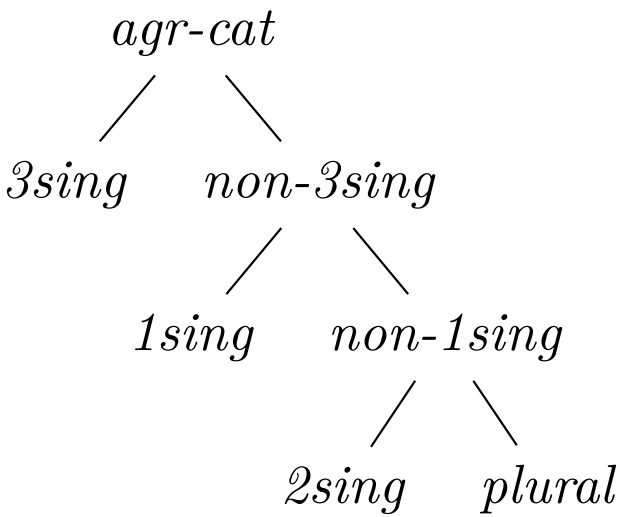
Example

$$\begin{bmatrix} \text{PERS} & \textit{3rd} \\ \text{NUM} & \textit{sg} \end{bmatrix} \;\&\; \begin{bmatrix} \text{PERS} & \textit{2nd} \end{bmatrix} \longrightarrow \varnothing$$

Typed feature structure unification



$$\begin{bmatrix} \textit{agr-cat} \\ \text{PER} & \{\textit{1st}, \textit{2nd}, \textit{3rd}\} \\ \text{NUM} & \{\textit{sg}, \textit{pl}\} \end{bmatrix}$$

$$\begin{bmatrix} \textit{3sing} \\ \text{PER} & \textit{3rd} \\ \text{NUM} & \textit{sg} \\ \text{GEND} & \{\textit{masc}, \textit{fem}, \textit{neut}\} \end{bmatrix}$$

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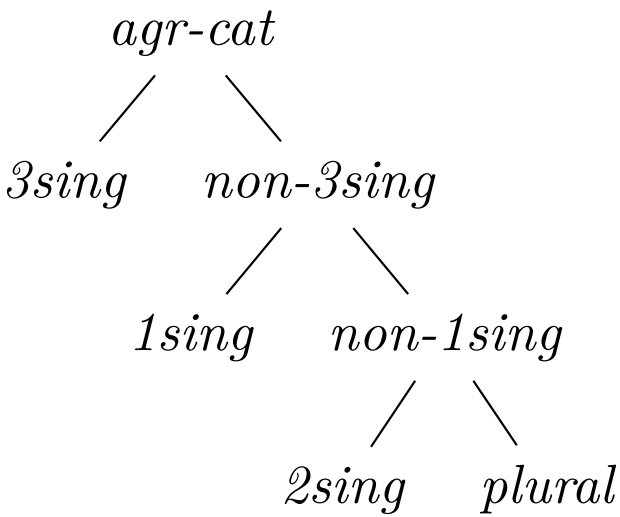

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$$\begin{bmatrix} \text{GEND} & \textit{fem} \end{bmatrix} \;\&\; \begin{bmatrix} \text{NUM} & \textit{pl} \end{bmatrix} \Longrightarrow \varnothing$$

Identity and unification

Phrase structure rules

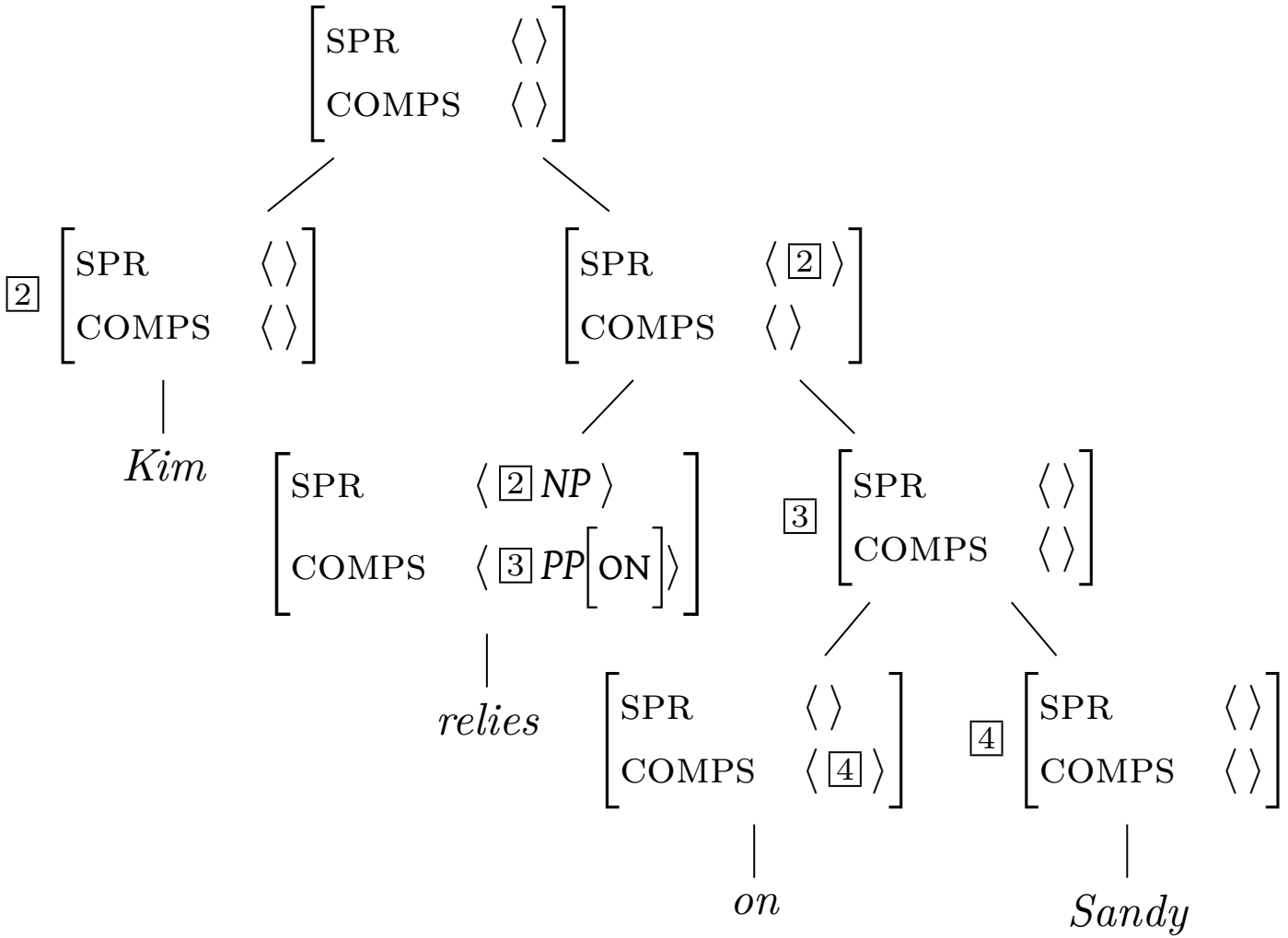
Head Complement Rule (English)

$$\begin{bmatrix} \textit{phrase} \\ \text{COMPS} \quad \langle\,\rangle \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{COMPS} \quad \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \quad \boxed{1}, \ldots, \boxed{n}$$

Head Specifier Rule (English)

$$\begin{bmatrix} \textit{phrase} \\ \text{SPR} \quad \langle\,\rangle \end{bmatrix} \rightarrow \boxed{1} \quad \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{SPR} \quad \langle \boxed{1} \rangle \end{bmatrix}$$

Phrase structure rules



Strong lexicalism

Lexical entries are rich:

$$\left\langle \text{rely} , \left[\text{SYN} \left[\begin{array}{ll} \text{HEAD} & \textit{verb} \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \left\langle \left[\begin{array}{ll} \text{NP} \\ \text{INDEX} & \text{x} \end{array} \right] \right\rangle \\ \text{COMPS} & \left\langle \left[\begin{array}{ll} \text{PP} \\ \text{FORM} & \text{on} \\ \text{INDEX} & \text{y} \end{array} \right] \right\rangle \end{array} \right] \end{array} \right] \right. \right. \\ \left. \left. \text{SEM} \left[\begin{array}{ll} \text{INDEX} & \text{e} \\ \text{RELS} & \left\langle \left[\begin{array}{ll} \text{PRED} & \text{rely\_on} \\ \text{ARG0} & \text{e} \\ \text{ARG1} & \text{x} \\ \text{ARG2} & \text{y} \end{array} \right] \right\rangle \end{array} \right] \right] \right\rangle$$

Lexical rules

3rd-Singular Verb Lexical Rule

$$\left[\begin{array}{ll} \text{INPUT} & \left\langle \boxed{1}, \textit{verb-lxm} \right\rangle \\ \text{OUTPUT} & \left\langle \text{F}_{3SG}(\boxed{1}), \left[\begin{array}{ll} \text{SYN} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \text{FORM} & \text{fin} \\ \text{AGR} & \textit{3sing} \end{array}\right] \\ \text{VAL} & \left[\text{SPR} \quad \left\langle \left[\text{CASE} \quad \text{nom}\right] \right\rangle\right] \end{array}\right] \\ \text{SEM} & \left[\text{INDEX} \quad \left[\text{TAM} \quad \text{pres}\right]\right] \end{array}\right] \right\rangle \end{array}\right]$$

Subject removal

Transitive:

(11)
$$\left[\begin{array}{l} \textit{subj-rem-op-tr-lex-rule} \\ \textsc{synsem} \mid \textsc{local} \mid \textsc{cat} \mid \textsc{val} \left[\begin{array}{ll} \textsc{subj} & \langle \left[\textsc{local} \mid \textsc{cont} \mid \textsc{hook} \mid \textsc{index} \ \boxed{1}\right] \rangle \\ \textsc{comps} & \boxed{2} \end{array}\right] \\ \textsc{c-cont} \mid \textsc{hook} \mid \textsc{xarg} \ \boxed{1} \\ \textsc{dtr} \mid \textsc{synsem} \mid \textsc{local} \mid \textsc{cat} \mid \textsc{val} \left[\begin{array}{ll} \textsc{subj} & \langle \textit{unexpressed} \rangle \\ \textsc{comps} & \left[\begin{array}{ll} \textsc{first} & \left[\textsc{local} \mid \textsc{cont} \mid \textsc{hook} \mid \textsc{index} \ \boxed{1}\right] \\ \textsc{rest} & \boxed{2} \end{array}\right] \end{array}\right] \end{array}\right]$$

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Intransitive:

(12)
$$\begin{bmatrix} \textit{subj-rem-op-itr-lex-rule} & \\ \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{SUBJ} & \langle\ \rangle \\ \text{DTR} \mid \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{SUBJ} & \langle \textit{ unexpressed } \rangle \end{bmatrix}$$

Object removal

(13)
$$\left[\begin{array}{l} \textit{obj-rem-op-lex-rule} \\ \textsc{synsem} \quad \left[\textsc{local} \mid \textsc{cat} \mid \textsc{val} \mid \textsc{comps} \quad \boxed{1}\right] \\ \textsc{dtr} \quad \left[\textsc{synsem} \mid \textsc{local} \mid \textsc{cat} \mid \textsc{val} \mid \textsc{comps} \quad \left[\begin{array}{ll} \textsc{first} & \textit{unexpressed} \\ \textsc{rest} & \boxed{1} \end{array}\right]\right] \end{array}\right]$$

unexpressed is a special type in the Grammar Matrix to support the threading analysis of Bouma et al. (2001).

Object addition

Returning to this example:

(14) Ali mem-beli-kan ibu-nja telefisi
Ali TR-buy-APPL mother-his television
'Ali bought his mother a television.' [ind]
(Chung 1976, in Wunderlich 2015, p. 21)

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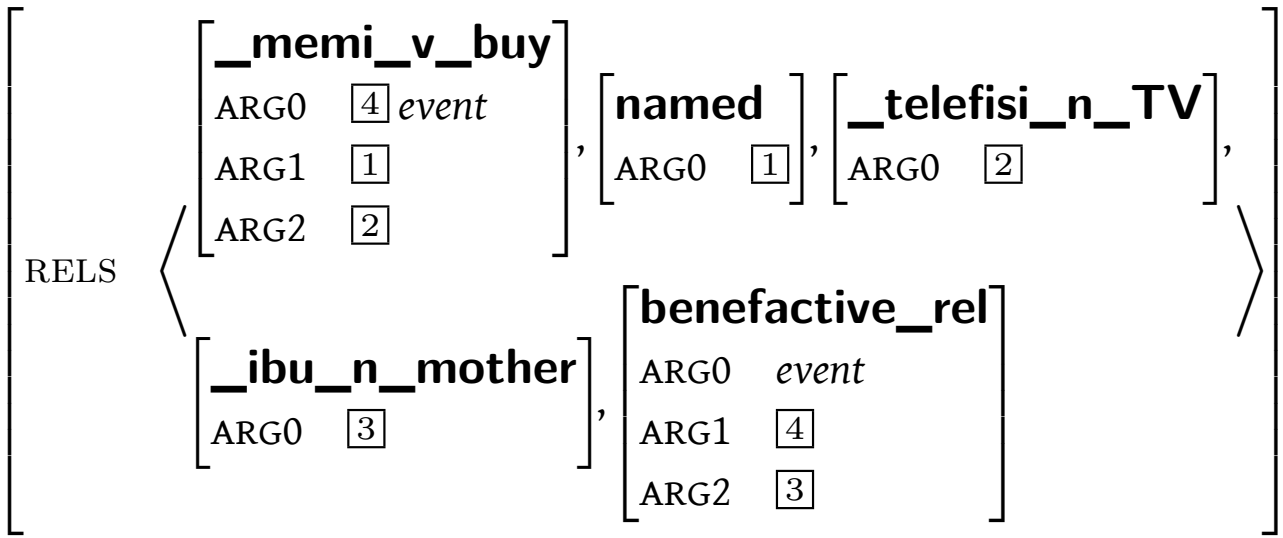
This is our desired MRS:

(15)



Object addition

Decomposing into underlying operations:

- adding an argument to the COMPS list;
- constraining the added argument (or promoted subject), e.g. to be an NP or PP (HEAD *noun* or *adp*), or applying a CASE constraint;
- appending the new argument's non-local dependencies to the rule mother's list;
- contributing an added elementary predication (EP) via C-CONT;
- linking the new EP's ARG1 to the daughter's INDEX; and
- linking the new EP's ARG2 to the new argument's INDEX.

Object addition

A (mostly) complete rule implementing the benefactive:

(16)

$$\left[\begin{array}{l}\textit{benefactive-lex-rule}\\ \textsc{synsem}\ \left[\begin{array}{l}\textsc{local}\mid\textsc{cat}\mid\textsc{val}\mid\textsc{comps}\ \left\langle \boxed{1}, \left[\textsc{local}\ \left[\textsc{cat}\ \left[\begin{array}{ll}\textsc{head} & \textit{noun}\\ \textsc{val} & \left[\begin{array}{ll}\textsc{spr} & \langle\ \rangle\\ \textsc{comps} & \langle\ \rangle\end{array}\right]\end{array}\right]\right]\right\rangle\\ \textsc{cont}\mid\textsc{hook}\mid\textsc{index}\ \boxed{2}\end{array}\right]\\ \textsc{c-cont}\ \left[\begin{array}{l}\textsc{rels}\ \left\langle !\ \left[\begin{array}{ll}\textit{event-relation}\\ \textsc{pred} & \textit{``benefactive''}\\ \textsc{arg1} & \boxed{6}\\ \textsc{arg2} & \boxed{2}\end{array}\right]\ !\right\rangle\\ \textsc{hcons}\ \langle !\ \ !\rangle\end{array}\right]\\ \textsc{dtr}\ \left[\begin{array}{l}\textit{verb-lex}\\ \textsc{synsem}\ \left[\textsc{local}\ \left[\begin{array}{ll}\textsc{cat}\mid\textsc{val}\mid\textsc{comps} & \boxed{1}\\ \textsc{cont}\mid\textsc{hook}\mid\textsc{index} & \boxed{6}\end{array}\right]\right]\end{array}\right]\end{array}\right]$$

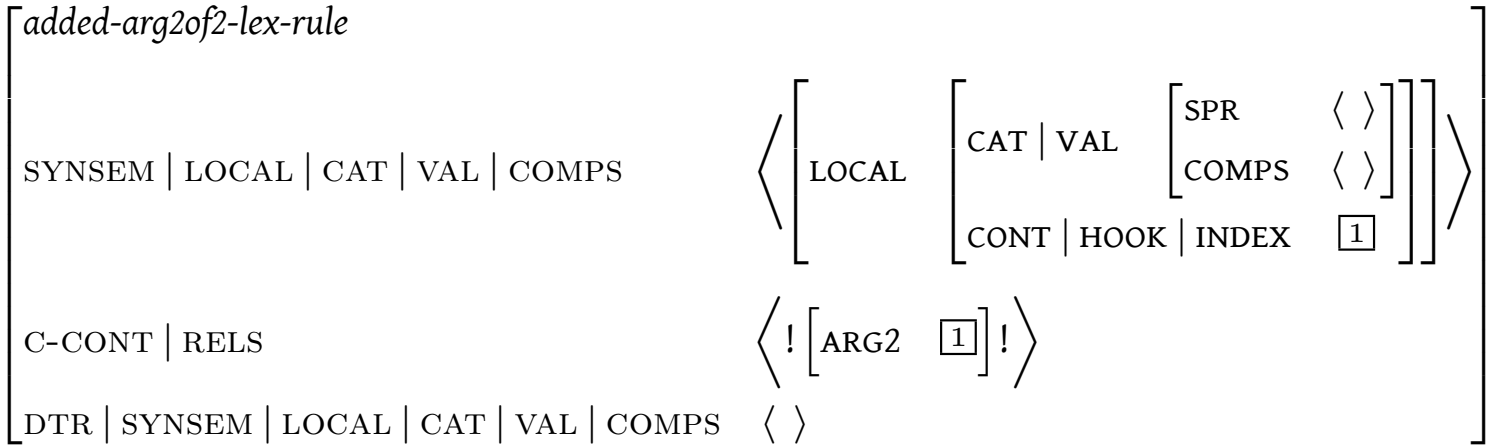
Rule component variation

This rule entails component operations that vary along independent axes:

rule component	**varies by**
added argument	position (obliqueness), number of existing args
constraint on new argument	position (obliqueness), constraint (*e.g.* case, head)
non-local dependencies	position (obliqueness)
new EP's PRED value	predicate
new EP's ARG1	does not vary
new EP's ARG2	position (obliqueness)

Example of variation

(17)



Example of variation

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$$\left[\textit{added-arg2of2-lex-rule}\right.$$

$$\left.\begin{array}{ll}
\text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{COMPS} & \left\langle \left[\text{LOCAL} \left[\text{CAT} \mid \text{VAL} \left[\begin{array}{ll}\text{SPR} & \langle\,\rangle \\ \text{COMPS} & \langle\,\rangle\end{array}\right] \right.\right.\right. \\
 & \left.\left.\left. \text{CONT} \mid \text{HOOK} \mid \text{INDEX} \quad \boxed{1} \right]\right]\right\rangle \\
\text{C-CONT} \mid \text{RELS} & \left\langle ! \left[\text{ARG2} \quad \boxed{1}\right] ! \right\rangle \\
\text{DTR} \mid \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{COMPS} & \langle\,\rangle
\end{array}\right]$$

(18)

$$\left[\textit{added-arg2of3-lex-rule}\right.$$

$$\left.\begin{array}{ll}
\text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{COMPS} & \left\langle \left[\text{LOCAL} \left[\text{CAT} \mid \text{VAL} \left[\begin{array}{ll}\text{SPR} & \langle\,\rangle \\ \text{COMPS} & \langle\,\rangle\end{array}\right] \right.\right.\right. \\
 & \left.\left.\left. \text{CONT} \mid \text{HOOK} \mid \text{INDEX} \quad \boxed{1} \right]\right], \boxed{2}\right\rangle \\
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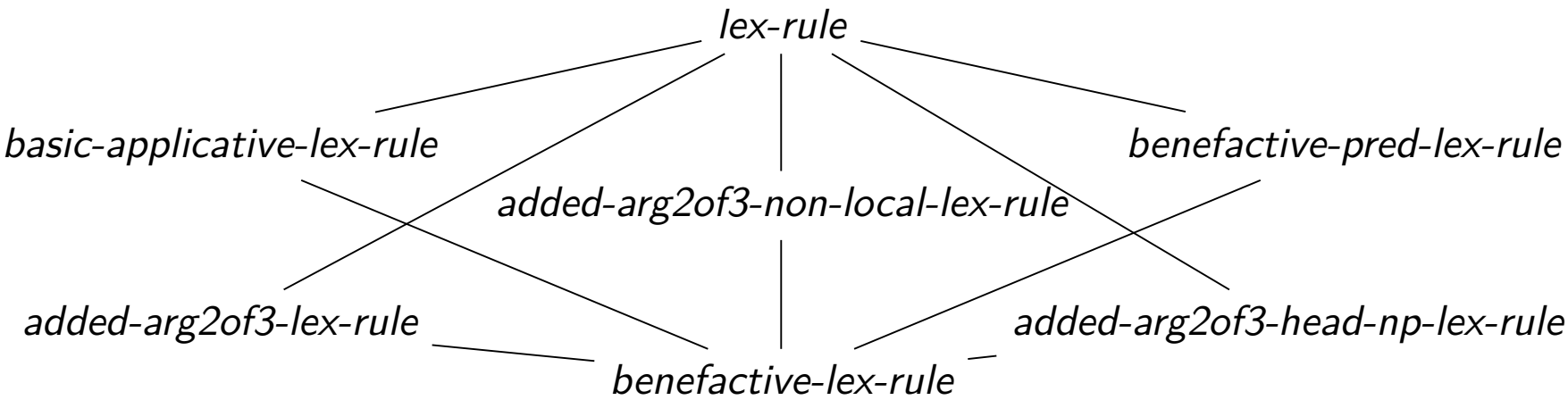
\text{DTR} \mid \text{SYNSEM} \mid \text{LOCAL} \mid \text{CAT} \mid \text{VAL} \mid \text{COMPS} & \langle \boxed{2} \rangle
\end{array}\right]$$

Rule component type hierarchy



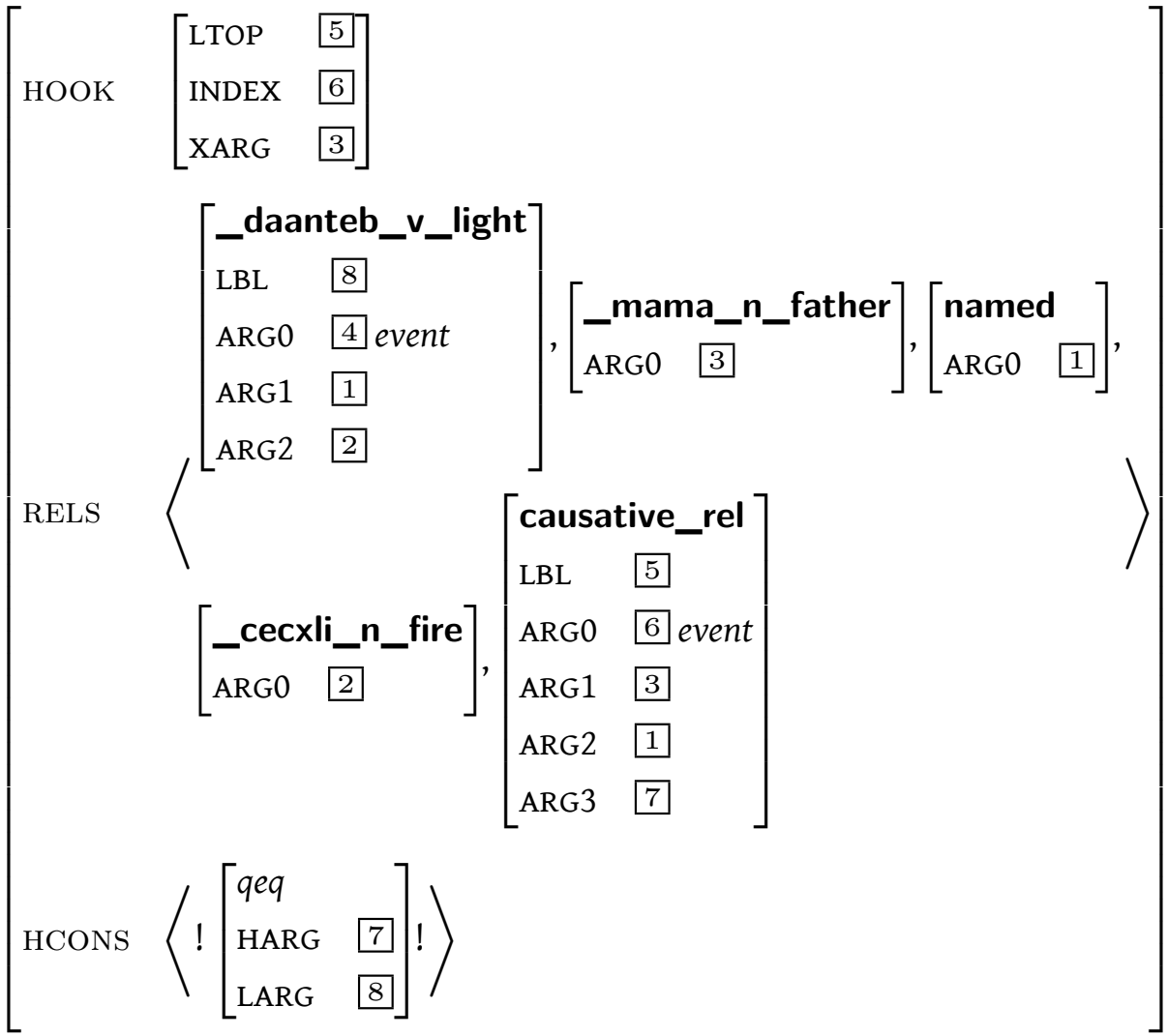
Subject addition

Subject addition (e.g., causative):

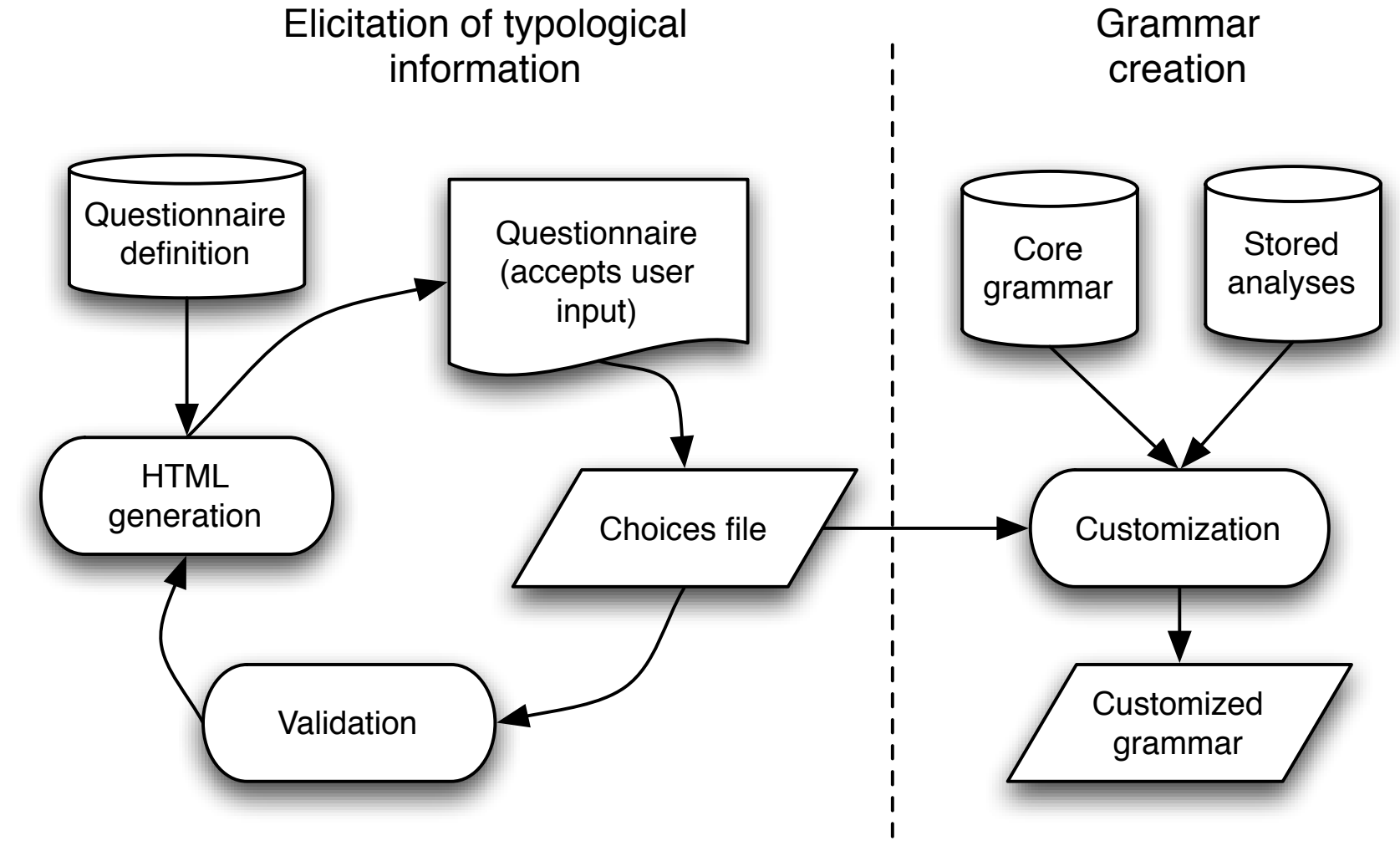
- Similar to applicative, the need to add a new EP
- This EP introduces a new argument in S role
- Analyze new EP as scopal: underlying verb's EP is outscoped
  - Expressed via handle constraint: equality modulo qualifiers ($=_q$)
- Erstwhile subject is moved into another position

Example of causative MRS

(19)

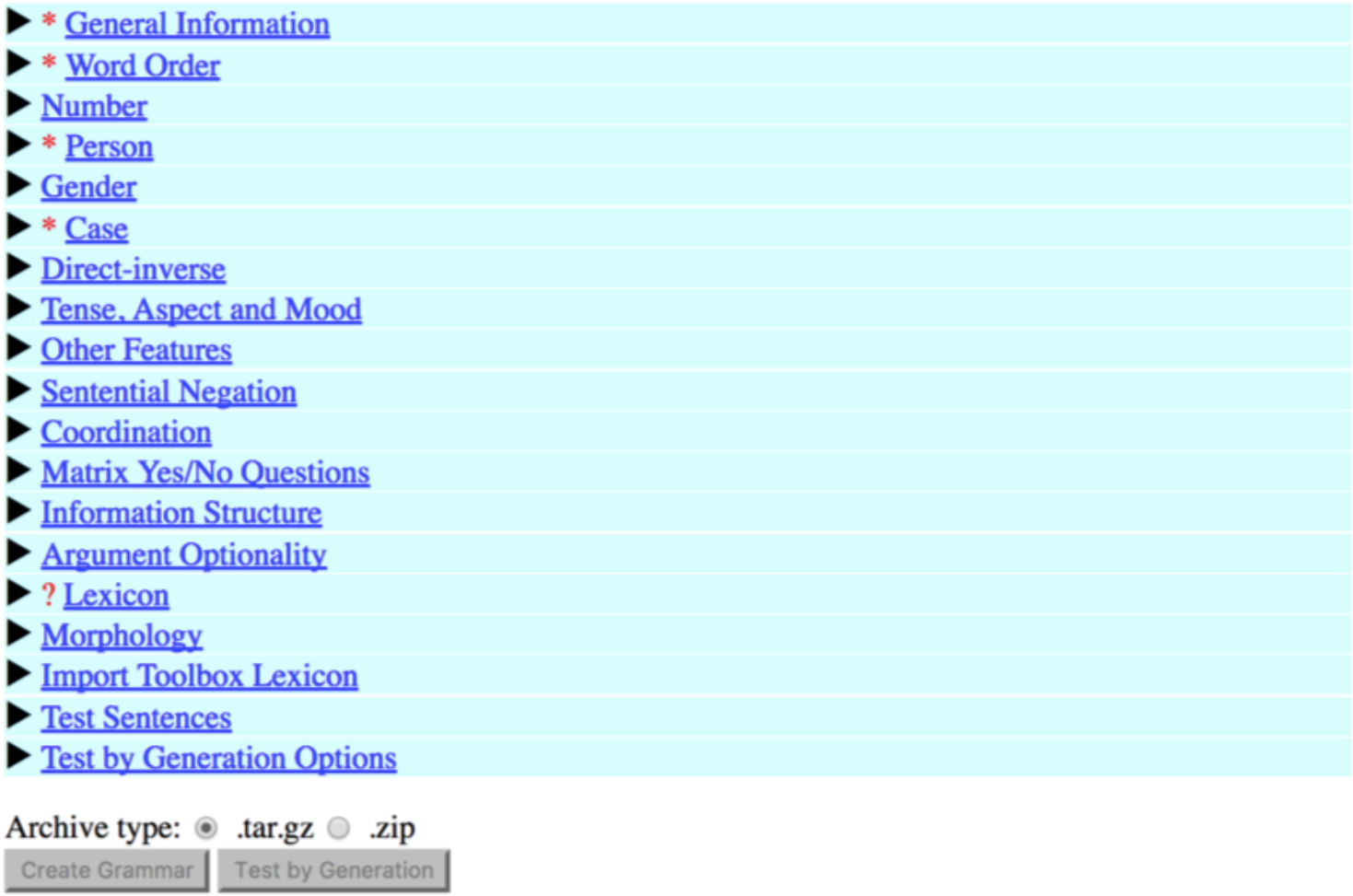


The Grammar Matrix customization system



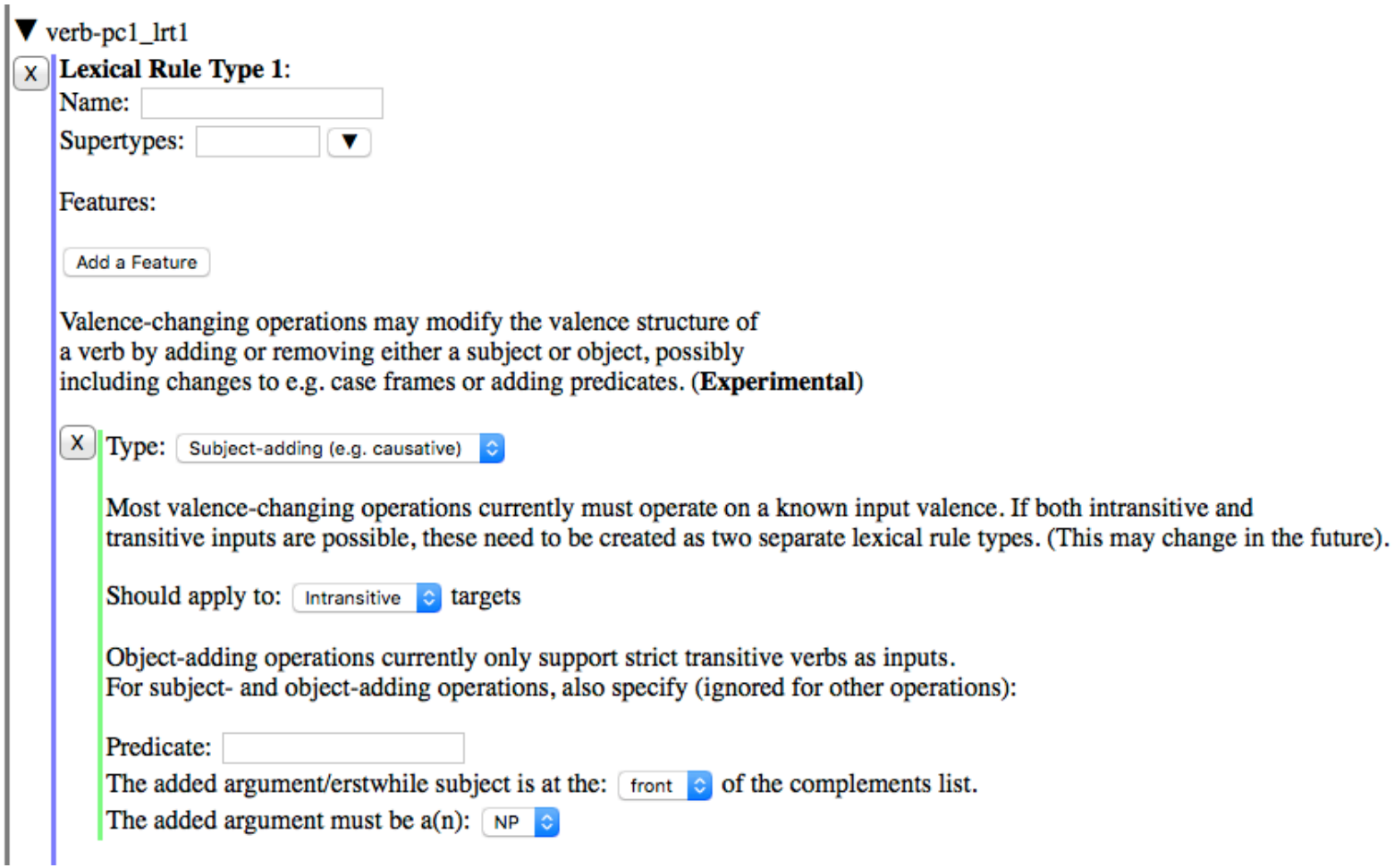
Bender, Drellishak, et al. 2010, p. 31.

Elicitation (Questionnaire)



`http://matrix.ling.washington.edu/index.html`

Elicitation (Questionnaire)



Choices file

(20)
```
section=morphology
  verb-pc1_order=suffix
  verb-pc1_inputs=verb
    verb-pc1_lrt1_name=subjrem-itr
      verb-pc1_lrt1_valchg1_operation=subj-rem
      verb-pc1_lrt1_valchg1_inputs=intrans
      verb-pc1_lrt1_lri1_inflecting=yes
      verb-pc1_lrt1_lri1_orth=-nosubjitr
    verb-pc1_lrt2_name=subjrem-tr
      verb-pc1_lrt2_valchg1_operation=subj-rem
      verb-pc1_lrt2_valchg1_inputs=trans
      verb-pc1_lrt2_lri1_inflecting=yes
      verb-pc1_lrt2_lri1_orth=-nosubjtr
```

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- Development process
  - Developed pseudolanguage test suites (choices file and test items) of specific operations and combinations

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  - Variable rule components modeled as functions, e.g.: $f : tr \in \{intrans, trans\} \times pos \in \{front, end\} \rightarrow lrt.$

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- Test suites built, but only using library as implemented

Evaluation results

	examples		performance				
Language	positive	negative	parses	coverage	overgeneration	sp.	ambig.
Tsez [ddo]	11	8	10	91%	0%		0%
West Greenlandic [kal]	15	14	12	73%	0%		0%
Awa Pit [kwi]	7	7	5	71%	0%		0%
Rawang [raw]	11	6	6	55%	0%		0%
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Total	57	43	45	**79%**	**2%**		**0%**

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Conclusions and future work

- Positive conclusions
  - Very good coverage across language families with relatively small set of basic operations
  - Building-block approach was very effective
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- Positive conclusions
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  - Building-block approach was very effective
  - Implementation via enerating functions further captures generalizations and simplifies coding
- Future improvements
  - Reflexives (coindexation capability more generally) would resolve nearly all coverage issues seen
  - Elicitation interface could be enhanced to allow more flexibility
  - Richer rule composition mechanisms needed to avoid theoretically-awkward constructions