**IGRA 02: Morphology II**

**Defaults**

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## 1. DATR: A Language for Lexical Knowledge Representation

### *1.1. Basic Notions*

*Lit.*:
Evans & Gazdar (1996), Hippisley (2007)

*Core feature of DATR*: Default inheritance

(1) *Default Inheritance* (Hippisley (2007), after Evans & Gazdar):
In addition to conventional inference, DATR has a nonmonotonic notion of inference by default: Each definitional sentence about some node/path combination implicitly determines additional sentences about all the extensions to the path at that node for which no more specific definitional sentences exists in the theory.

(2) *Ontology*:

a. *Node*:
There is a a network of nodes. A node is a collection of closely related information. (Nodes begin with capital letters.)

b. *Path/Value pairs*:
Each node has associated with it a set of path/value pairs.

c. *Path*:
Sequence of *atoms* (atoms are primitives). Paths are enclosed in angle brackets: $< >$.

d. *Attributes*:
Atoms in paths.

e. *Value*:
Sequence of *atoms*.

f. *DATR descriptions*:
Consist of *sentences*.

g. *Sentences*:
Consist of *statements*.

h. *Statements*:
Statements are equations consisting of node, path, and value information.

(i) *Extensional statements*:
Low-level facts about the knowledge representation system, using the *equality operator* =, derivable from:

(ii) *Definitional statements*:
Higher-level generalization expressed by the *equality operator* ==.

I think that an extensional statement describes some existing object whereas a definitional statement determines the conditions under which some object can exist.

*A case study*: English verb inflection.



### *1.2. Analysis A*

```
Word1:
 <syn cat>  = verb
 <syn type> = main
 <syn form> = present participle
 <mor form> = love ing.
```

*Note*:
Values can be atomic or consist of sequences of atoms.

```
Word2:
 <syn cat>  = verb
 <syn type> = main
 <syn form> = passive participle
 <mor form> = love ed.
```

*Problem*:
This looks like an adequate description of the facts, but it does not capture *generalizations*, and it *duplicates* information.

*Assumption*:
Extensional statements (=) as in Word1 and Word2 can be derived from more general definitional statements (==).

### *1.3. Analysis B*

```
Word1:
 <syn cat>  == verb
 <syn type> == main
 <syn form> == present participle
 <mor form> == love ing.
Word2:
 <syn cat>  == verb
 <syn type> == main
 <syn form> == passive participle
 <mor form> == love ed.
```

*Problem*:
Not a lot is gained. If some value is defined for a path with a definitional statement, the corresponding extensional statement also holds. (In one case, an object is described, in the other case, a possible object is described.) But now the door is open: Generalization can take place.

### *1.4. Analysis C*

*Note*:
Now there can be other ways of describing values, rather than just simply specifying them: Values can be captured by *descriptors* that bring about *inheritance* of properties.

```
Verb:
 <syn cat>  == verb
 <syn type> == main.
Word1:
 <syn cat>  == Verb:<syn cat>
 <syn type> == Verb:<syn type>
 <syn form> == present participle
 <mor form> == love ing.
Word2:
 <syn cat>  == Verb:<syn cat>
 <syn type> == Verb:<syn type>
 <syn form> == passive participle
 <mor form> == love ed.
```

*Note*:
The right-hand side of the `<syn cat>` statement is not a direct value specification, but an inheritance descriptor: The value associated with `<syn cat>` at `Word1` is the same as the value associated with `<syn cat>` at `Verb`.

*Problem*:
Now the analysis is actually longer than the original one. However, it can be improved in two ways: first, as regards notation (“a syntactic trick”); second, by integrating defaults.

### *1.5. Analysis D*

*Notational simplification*:
If the path on the right-hand side is the same as the path on the left-hand side, it can be omitted.

```
Verb:
 <syn cat>  == verb
 <syn type> == main.
Word1:
 <syn cat>  == Verb
 <syn type> == Verb
 <syn form> == present participle
 <mor form> == love ing.
Word2:
 <syn cat>  == Verb
 <syn type> == Verb
 <syn form> == passive participle
 <mor form> == love ed.
```

*Note*:
In the same way, notation can be simplified if the path on the right-hand side is different but the node is identical.



```
Come:
 <mor root> == come
 <mor past participle> == Come:<mor root>.
```

This becomes:

```
Come:
 <mor root> == come
 <mor past participle> == <mor root>.
```

### *1.6. Analysis E*

*Defaults*:
Paths are sequences of attributes. Path *extension*: $P_1$ extends $P_2$ iff the attributes of $P_1$ occur in the same order at the left-hand end of $P_2$.

(3) *Two cases*:
For some path $P_1$ not defined at node N, there are two possible scenarios:

a. $P_1$ is not the extension of some path defined at N: There is no definition for $P_1$ at N.

b. $P_1$ is the extension of some path defined at N: $P_1$ extends some $P_2$ which is defined at N. Here, $P_1$ assumes a definition by default.
(If $P_1$ extends several paths defined at N, it takes its definition from the most specific – the longest – of the paths that it extends.)

```
Verb:
 <syn cat>  == verb
 <syn type> == main.
Word1:
 <syn>      == Verb
 <syn form> == present participle
 <mor form> == love ing.
Word2:
 <syn>      == Verb
 <syn form> == passive participle
 <mor form> == love ed.
```

*Note*:
Extensions of `<syn form>` obtain their definitions from `<syn form>` rather than from `<syn>`; here the default inheritance is overriden by the more specific path.

### *1.7. Analysis F*

*Further generalization*: empty paths ($<\ >$).

*Observation*:
One can assume that not just `<syn>` information, but *all* information is inherited from `Verb`, except where it is overriden by more specific statements holding for a node.

```
Verb:
 <syn cat>  == verb
 <syn type> == main.
Word1:
 < >        == Verb
 <syn form> == present participle
 <mor form> == love ing.
Word2:
 < >        == Verb
 <syn form> == passive participle
 <mor form> == love ed.
```

### 1.8. *Analysis G*

*Yet more generalization*:
`Word1` and `Word2` characterize the form of word forms of the same lexical item *love*. If there is a node for lexical items like *love*, redundant information about `<mor form>` can be avoided.

```
Verb:
 <syn cat>  == verb
 <syn type> == main.
Love:
 < > == Verb
 <mor root> == love.
Word1:
 < >        == Love
 <syn form> == present participle
 <mor form> == <mor root> ing.
Word2:
 < >        == Love
 <syn form> == passive participle
 <mor form> == <mor root> ed.
```

### 1.9. *Analysis H*

*Problem*:
The analysis is still not general enough. `<mor form> == <mor root> ing` (`<mor form> == <mor root> ed`) will have to occur in every present participle (passive participle) form of every verb. However, this problem cannot be avoided with the current theoretical machinery. (4-b) is what one wants, (4-a) is what one gets if the statement is simply stated for the `Verb` node.

(4) a. `Verb:<mor form> == Verb:<mor root> ing`
    b. `Verb:<mor form> == Word1:<mor root> ing`

*Note*:
(i) So far, all inheritance has been *local*.
(ii) Now we also want inheritance to be *global*. Global inheritance is indicated by using quoted (" ...") descriptors.

("The problem is that the inheritance mechanism we have been using is local, in the sense that it can only be used to inheriet either from a specifically named node (and/or path), or relative to the local context of the node (and/or path) at which it is defined. What we need is a way of specifying inheritance relative to the *original* node/path specification whose value we are trying to determine, rather than the one we have reached by following inheritance links. We shall refer to this original specification as the *query* we are attempting to evaluate, and the node and path associated with this query as the *global context*.")

```
Verb:
 <syn cat>  == verb
 <syn type> == main
 <mor form> == "<mor root>" ing.
Love:
 < > == Verb
 <mor root> == love.
Word1:
 < >        == Love
 <syn form> == present participle.
Word2:
 < >        == Love
 <syn form> == passive participle.
```

*Problem*:
This analysis does not work because the present participle should now be the default value of `<mor form>` for all verbs, which is clearly absurd (and does not help with the passive participle). This problem can be dealt with by getting rid of the path `<mor form>` in favour of finer-grained specifications.

```
Verb:
 <syn cat>                        == verb
 <syn type>                       == main
 <mor past>                       == "<mor root>" ed
 <mor passive>                    == "<more past>"
 <mor present>                    == "<mor root>"
 <mor present participle>         == "<mor root>" ing
 <mor present tense sing three>  == "<mor root>" s.
Love:
 < > == Verb
 <mor root> == love.
Word1:
 < >        == Love
 <syn form> == present participle.
Word2:
 < >        == Love
 <syn form> == passive participle.
```

*Note*:
Now we can derive extensional statements (=) in an obvious way, both for nodes like `Love`

(yielding all word forms of Love) and for nodes like Word1 (yielding the present participle form of *love*).

### 1.10. *Analysis I*

*Final problem*:
There is no longer a unique path representing morphological form. (The morphological form of Word1 is given by <mor present particple>; the morphological form of Word2 is given by <mor passive particple>.)

*Way out*:
There are *evaluable paths*: The right-hand side consists of a global path specification, one of whose component attributes is itself a descriptor that must be evaluated before the outer path can be.

```
Verb:
 <syn cat>                         == verb
 <syn type>                        == main
 <mor form>                        == ‘‘<mor ‘‘<syn form>’’>’’
 <mor past>                        == ‘‘<mor root>’’ ed
 <mor passive>                     == ‘‘<more past>’’
 <mor present>                     == ‘‘<mor root>’’
 <mor present participle>          == ‘‘<mor root>’’ ing
 <mor present tense sing three>    == ‘‘<mor root>’’ s.
Love:
 < > == Verb
 <mor root> == love.
Word1:
 < >        == Verb
 <syn form> == present participle.
Word2:
 < >        == Verb
 <syn form> == passive participle.
```

### 1.11. *Subregular and Irregular Lexemes*

```
En-Verb:
 < >                      == Verb
 <mor past participle> == ‘‘<mor root>’’ en.
Mow:
 < >        == En-Verb
 <mor root> == mow.
Do:
 < >                               == Verb
 <mor root>                        == do
 <mor past>                        == did
 <mor past participle>             == done
 <mor present tense sing three>    == does.
```



```
Be:
 < >                               == be
 <mor present tense sing one>      == am
 <mor present tense sing three>    == is
 <mor present tense plur>          == are
 <mor past tense sing one>         == <mor past tense sing three>
 <mor past tense sing three>       == was
 <mor past tense plur>             == were.
```

## 2. Network Morphology

*Lit.*:
Corbett & Fraser 1993, Baerman, Brown & Corbett (2005), Brown & Hippisley (2012)

*Basic assumptions*:

- Morphology is lexeme-based. (The rules of morphology are functions from lexical items into sets of inflected forms.)
- Morphology is inferential-realizational. (Inflection markers are not lexical entries.)
- Morphology relies on default inheritance. (DATR is used.)
- Morphological rules involve underspecification relative to the fully specified morphosyntactic paradigm.
- Generlized referral:
  1. One feature specification may refer to another feature specification for its realization.
  2. Referrals may be underspecified.
  3. Extensions of the referring specification will be realized by extensions of the referred-to specification.

*A case study: A DATR fragment for Russian*

*$P_1$: Inflection class I, Sg.: masc*

| | I | | |
|---|---|---|---|
| | *zavod*$_m$ (‘factory’) | *student*$_m$ (‘student’) | *žitel*$_m$ (‘inhabitant’) |
| nom/sg | zavod-Ø | student-Ø | žitel’-Ø |
| acc/sg | zavod-Ø | student-a | žitel-ja |
| dat/sg | zavod-u | student-u | žitel-ju |
| gen/sg | zavod-a | student-a | žitel-ja |
| inst/sg | zavod-om | student-om | žitel-em |
| loc/sg | zavod-e | student-e | žitel-e |

$P_2$: *Inflection class II, Sg.: fem, masc*

| | II | | | |
|---|---|---|---|---|
| | *komnat*$_f$ ('room') | *učitel'nic*$_f$ ('teacher') | *nedel'*$_f$ ('week') | *mužčin*$_m$ ('man') |
| nom/sg | komnat-a | učitel'nic-a | nedel-ja | mužčin-a |
| acc/sg | komnat-u | učitel'nic-u | nedel-ju | mužčin-u |
| dat/sg | komnat-e | učitel'nic-e | nedel-e | mužčin-e |
| gen/sg | komnat-y | učitel'nic-y | nedel-i | mužčin-y |
| inst/sg | komnat-oj(u) | učitel'nic-ej(u) | nedel-ej(u) | mužčin-oj(u) |
| loc/sg | komnat-e | učitel'nic-e | nedel-e | mužčin-e |

$P_3$: *Inflection class III, Sg.: fem*

| | III | | |
|---|---|---|---|
| | *tetrad'*$_f$ ('notebook') | *myš'*$_f$ ('mouse') | *doč'*$_f$ ('daughter') |
| nom/sg | tetrad'-Ø | myš'-Ø | doč'-Ø |
| acc/sg | tetrad'-Ø | myš'-Ø | doč'-Ø |
| dat/sg | tetrad-i | myš-i | doč-er-i |
| gen/sg | tetrad-i | myš-i | doč-er-i |
| inst/sg | tetrad'-ju | myš'-ju | doč-er'-ju |
| loc/sg | tetrad-i | myš-i | doč-er-i |

$P_4$: *Inflection class IV, Sg.: neut*

| | IV | | | |
|---|---|---|---|---|
| | *mest*$_n$ ('place') | *jablok*$_n$ ('apple') | *suščestv*$_n$ ('creature') | *pol'*$_n$ ('field') |
| nom/sg | mest-o | jablok-o | suščestv-o | pol-e |
| acc/sg | mest-o | jablok-o | suščestv-o | pol-e |
| dat/sg | mest-u | jablok-u | suščestv-u | pol-ju |
| gen/sg | mest-a | jablok-a | suščestv-a | pol-ja |
| inst/sg | mest-om | jablok-om | suščestv-om | pol-em |
| loc/sg | mest-e | jablok-e | suščestv-e | pol-e |

```
Mor-nominal:
 < >           == Mor-word
 <mor sg acc>  == Accusative:<sg ‘‘<syn gender>’’ ‘‘<syn animacy>’’>
 <mor pl acc>  == Accusative:<pl ‘‘ <syn animacy>’’>
 <mor pl nom>  == ‘‘<stem pl nom>’’ i ‘‘<stress pl nom>’’
 <mor pl gen>  == ‘‘<mor pl loc>’’
 <mor pl dat>  == ‘‘<stem pl>’’ ‘‘<mor theme-vowel>’’ ‘‘<stress pl>’’ m
 <mor pl inst> == ‘‘<stem pl>’’ ‘‘<mor theme-vowel>’’ ‘‘<stress pl>’’ m'i
 <mor pl loc>  == ‘‘<stem pl>’’ ‘‘<mor theme-vowel>’’ ‘‘<stress pl>’’ x.
Mor-noun:
 < >               == Mor-nominal
 <mor sg dat>      == ‘‘<mor sg loc>’’
 <mor sg loc>      == ‘‘<stem sg>’’ e ‘‘<stress sg>’’
 <mor pl gen>      == Mgp:<‘‘mor stem hardness>’’ pl gen>
 <mor theme-vowel> == a.
```



$P_5$ *Inflection classes I-IV in the plural*

| | I | II | III | IV |
|---|---|---|---|---|
| | *zavod*$_m$ ('factory') | *komnat*$_f$ ('room') | *tetrad'*$_f$ ('notebook') | *mest*$_n$ ('place') |
| nom/pl | zavod-y | komnat-y | tetrad-i | mest-a |
| acc/pl | zavod-y | komnat-y | tetrad-i | mest-a |
| dat/pl | zavod-am | komnat-am | tetrad-jam | mest-am |
| gen/pl | zavod-ov | komnat-Ø | tetrad-ej | mest-Ø |
| inst/pl | zavod-ami | komnat-ami | tetrad-jami | mest-ami |
| loc/pl | zavod-ax | komnat-ax | tetrad-jax | mest-ax |

```
N-0:
 < >            == Mor-noun
 <mor sg gen>  == ‘‘<stem sg gen>’’ a ‘‘<stress sg>’’
 <mor sg dat>  == ‘‘<stem sg>’’ u ‘‘<stress sg>’’
 <mor sg inst> == ‘‘<stem sg>’’ om ‘‘<stress sg>’’.
N-I:
 < >                 == N-0
 <mor formal gender> == m
 <mor pl nom>        == Nom-pl:<‘‘<index>’’>
 <mor hard pl gen>   == ‘‘<stem pl>’’ ov ‘‘<stress pl>’’.
N-IV:
 < >                 == N-0
 <mor formal gender> == n
 <mor sg nom>        == ‘‘<stem sg nom>’’ o ‘‘<stress sg>’’
 <mor pl nom>        == ‘‘<stem pl>’’ a ‘‘<stress pl nom>’’
 <mor pl gen>        == Gen-pl:<‘‘<stem pl final>’’>
N-II:
 < >                 == Mor-noun
 <mor formal gender> == f
 <mor sg nom>        == ‘‘<stem sg nom>’’ a ‘‘<stress sg>’’
 <mor sg acc>        == ‘‘<stem sg>’’ u ‘‘<stress sg acc>’’
 <mor sg gen>        == ‘‘<stem sg>’’ i ‘‘<stress sg>’’
 <mor sg inst>       == ‘‘<stem sg inst>’’ ‘‘<mor vowel sg>’’ ‘‘<stress sg>’’ j′ (′u′)′
 <mor pl gen>        == Stemstress:  <’’<mor stem hardness>’’ ‘‘<stress pl>’’>.
N-III:
 < >                 == Mor-noun
 <mor stem hardness> == soft
 <mor sg gen>        == N-II
 <mor sg loc>        == ‘‘<mor sg gen>’’
 <mor sg inst>       == ‘‘<stem sg inst>’’ ju
 <mor formal gender> == f.
```

## 3. Distributed Morphology (& Similar Approaches)

*Note*:
In Distributed Morphology (Halle & Marantz (1993; 1994)) and related frameworks, defaults are captured by *underspecification*: Elsewhere markers are strict defaults, and underspecified markers are relativized defaults.

(5) *Decomposition of gender features in German* (Bierwisch (1967) – note that this differs subtly from the last handout):
- a. masculine = [+masc,–fem]
- b. feminine = [–masc,+fem]
- c. neuter = [–masc,–fem]
- d. [ ] = [+masc,+fem]

(6) *Decomposition of case features in German* (Bierwisch (1967)):
- a. nominative = [–obj,–obl]
- b. accusative = [+obj,–obl]
- c. dative = [+obj,+obl]
- d. genitive = [–obj,+obl]

*Morphological Realization: Specificity and Compatibility*

(7) *Inventory of exponents for pronominal inflection* (based on Blevins (1995))

| | | | |
|---|---|---|---|
| a. | /n/ ↔ [+pl,+obj,+obl] | | (dat.pl.) |
| b. | /m/ ↔ [–fem,+obj,+obl] | | (dat.masc.sg./neut.sg.) |
| c. | /s/ ↔ [–fem,+obl] | | (gen.masc.sg./neut.sg.) |
| d. | /r/ ↔ [+obl] | | (dat./gen.fem.sg., gen.pl.) |
| e. | /n/ ↔ [+masc,–fem,+obj,–obl] | | (acc.masc.sg.) |
| f. | /r/ ↔ [+masc,–fem] | | (nom.masc.sg.) |
| g. | /s/ ↔ [–fem] | | (nom./acc.neut.sg.) |
| h. | /e/ ↔ [ ] | | (nom./acc.fem.sg./pl.) |

(8) *Morphological Realization* ('Panini's Principle', 'Subset Principle', 'Elsewhere Principle', 'Proper Inclusion Principle', 'Blocking Principle'):
A morphological exponent M is chosen for a syntactic context (or paradigm cell) S if (a) and (b) hold.
- a. M is compatible with S.
- b. M is the most specific exponent among those that satisfy (8-a).

(9) *Compatibility*:
A morphological exponent M is compatible with a syntactic context (or paradigm cell) S if M realizes a *subset* of the morpho-syntactic feature/value pairs of S.

(10) *Specificity*:
A morphological exponent $M_1$ is more specific than a morphological exponent $M_2$ if $M_1$ realizes *more* features than $M_2$.

*A Neurophysiological Study*:
The Event-Related Potential Violation Paradigm



Opitz, Regel, Müller & Friederici (2013):

- If underspecification is real, *Compatibility* vs. *Specificity* should also be an inherent part of the language processing system. One should therefore be able to observe separable effects for the violation of each of the criteria.
- The *Event-Related Potential (ERP)* violation paradigm can be used to test this hypothesis in the domain of strong adjective inflection in German.
- *Prediction*: There should be differences in brain potentials between two incorrect conditions whenever they represented different types of violation (of Compatibility and Specificity).
- *Result*: The findings strongly support underspecification: An ERP-component related to morpho-syntactic integration (viz., *left anterior negativity; LAN*) was modulated by violations of Specificity versus Compatibility.
- Furthermore: The neurophysiological evidence helps to distinguish between two kinds of morphological underspecification that have been proposed: It argues for *maximal* rather than *minimal* underspecification.

### *3.1. Experiment*

*Premise*:

- Since pronominal inflection involves only closed-class items which are presumably stored as full forms in the mental lexicon, the experimental design made the choice of the strong adjective paradigm mandatory.
- This is unproblematic since the two paradigms are identical except for genitive masculine/neuter singular contexts, where pronominal inflection has an exponent *-es* and strong adjective inflection has an exponent *-en*, with exactly the same role in the system.
- The study focuses on accusative exponents where there is no difference; one can thus look at underspecification-based analyses of pronominal inflection as analyses of strong adjective inflection by extension.

(11) *Material: PPs with accusative NPs of all three genders*

| | | | |
|---|---|---|---|
| a. | durch | schlicht-e | Struktur |
| | by | plain- FEM.SG.ACC | structure. FEM |
| b. | durch | schlicht-en | Geschmack |
| | by | plain- MASC.SG.ACC | taste. MASC |
| c. | durch | schlicht-es | Design |
| | by | plain- NEUT.SG.ACC | design.neut |

*Maximal vs. Minimal Underspecfication*
Two kinds of (extensionally equivalent) underspecification approaches:

- *Maximal underspecification*: minimal number of features on a morphological exponent; reduces complexity of the lexical component.

- *Minimal underspecification*: maximal number of features on a morphological exponent that still accounts for syncretism; might reduce complexity of the processing component; simple learning algorithms exist (Harley (2001), Pertsova (2007), based on *intersecting* the sets of the different (fully specified) environments; as soon as a minimally underspecified exponent can be postulated, the algorithm stops).

*Prediction*:

1. With maximal underspecification, ungrammatical exponents will, as a tendency, more often be blocked by Specificity.
2. With minimal underspecifiction, ungrammatical exponents will, as a tendency, more often be blocked by Compatibility.
3. Exponents that are blocked in the same way in one approach may therefore be blocked in different ways in the other approach.
4. We expect an identical ERP profile in the first case but not in the second case.

(12) *Inventory of exponents in Blevins (1995), with maximal underspecification*

| | | | |
|---|---|---|---|
| a. | /n/ ↔ [+pl,+obj,+obl] | | (dat.pl.) |
| b. | /m/ ↔ [–fem,+obj,+obl] | | (dat.masc.sg./neut.sg.) |
| c. | /s/ ↔ [–fem,+obl] | | (gen.masc.sg./neut.sg.) |
| d. | /r/ ↔ [+obl] | | (dat./gen.fem.sg., gen.pl.) |
| e. | */n/* ↔ [+masc,–fem,+obj,–obl] | | (acc.masc.sg.) |
| f. | /r/ ↔ [+masc,–fem] | | (nom.masc.sg.) |
| g. | */s/* ↔ [–fem] | | (nom./acc.neut.sg.) |
| h. | */e/* ↔ [ ] | | (nom./acc.fem.sg./pl.) |

(13) *Inventory of exponents in Blevins (1995), with minimal underspecification*

| | | | |
|---|---|---|---|
| a. | /n/ ↔ [+pl,+obj,+obl] | | (dat.pl.) |
| b. | /m/ ↔ [–fem,+obj,+obl,*–pl*] | | (dat.masc.sg./neut.sg.) |
| c. | /s/ ↔ [–fem,+obl,*–obj*,*–pl*] | | (gen.masc.sg./neut.sg.) |
| d. | /r/ ↔ [+obl] | | (dat./gen.fem.sg., gen.pl.) |
| e. | */n/* ↔ [+masc,–fem,+obj,–obl,*–pl*] | | (acc.masc.sg.) |
| f. | /r/ ↔ [+masc,–fem,*–obl*,*–obj*,*–pl*] | | (nom.masc.sg.) |
| g. | */s/* ↔ [*–masc*,–fem,*–obl*,*–pl*] | | (nom./acc.neut.sg.) |
| h. | */e/* ↔ [*–obl*] | | |

*Predictions under Maximal Underspecification*

(14) *Two types of illicit agreement, with maximal underspecification (as in (12))*:

a. for feminine phrases:
*identical* kind of violation (Compatibility)

| | | |
|---|---|---|
| context features: | | [–masc, +fem, –obl, +obj] |
| correct marker: | -e | [ ] |
| incompatible (incorr.1): | -(e)n | [**+masc, –fem**, –obl, +obj] |
| incompatible (incorr.2): | -(e)s | [**–fem**] |

b. for masculine phrases:
*identical* kind of violation (Specificity)

| | | |
|---|---|---|
| context features: | | [+masc, –fem, –obl, +obj] |
| correct: | -(e)n | [+masc, –fem, –obl, +obj] |
| compatible (incorr.1): | -(e)s | [–fem] |
| compatible (incorr.2): | -e | [ ] |

c. for neuter phrases:
*different* kind of violation (Compatibility vs. Specificity)

| | | |
|---|---|---|
| context features: | | [–masc, –fem, –obl, +obj] |
| correct: | -(e)s | [–fem] |
| incompatible (incorr.1): | -(e)n | [**+masc**, –fem, –obl, +obj] |
| compatible (incorr.2): | -e | [ ] |

*Predictions under Minimal Underspecification*

(15) *Two types of illicit agreement, with minimal underspecification (as in (13))*:

a. for feminine phrases:
*identical* kind of violation (Compatibility)

| | | |
|---|---|---|
| context features: | | [–masc, +fem, –obl, +obj, –pl] |
| correct marker: | -e | [–obl] |
| incompatible (incorr.1): | -(e)n | [**+masc, –fem**, –obl, +obj, –pl] |
| incompatible (incorr.2): | -(e)s | [–masc, **–fem**, –obl, –pl] |

b. for masculine phrases:
*different* kind of violation (Compatibility vs. Specificity)

| | | |
|---|---|---|
| context features: | | [+masc, –fem, –obl, +obj, –pl] |
| correct: | -(e)n | [+masc, –fem, –obl, +obj, –pl] |
| incompatible (incorr.1): | -(e)s | [**–masc**, –fem, –obl, –pl] |
| compatible (incorr.2): | -e | [–obl] |

c. for neuter phrases:
*different* kind of violation (Compatibility vs. Specificity)

| | | |
|---|---|---|
| context features: | | [–masc, –fem, –obl, +obj, –pl] |
| correct: | -(e)s | [–masc, –fem, –obl, –pl] |
| incompatible (incorr.1): | -(e)n | [**+masc**, –fem, –obl, +obj, –pl] |
| compatible (incorr.2): | -e | [–obl] |

*Predictions:*
*(A) No, (B) Maximal, (C) Minimal Underspecification*

(16) *Predictions: assumed processing differences for different incorrect markers*

| noun gender | | model: without underspec. categorical | with underspecification: maximal | with underspecification: minimal |
|---|---|---|---|---|
| feminine | (*corr. e*) | s = n | $s^2 = n^2$ | $s^2 = n^2$ |
| neuter | (*corr. s*) | e = n | $e^1 < n^2$ | $e^1 < n^2$ |
| masculine | (*corr. n*) | e = s | $e^1 = s^1$ | $e^1 < s^2$ |

*Notational conventions*:
[1] signals a violation of Specificity; [2] signals a violation of Compatibility; $\alpha=\beta$ indicates the same type of violation/the same processing; and $\alpha<\beta$ indicates a different type of violation/different processing

## Method

*Items:*

- 180 nouns (60 masculine, 60 feminine, 60 neuter)
- matched for length, frequency, plausibility, familiarity, derived/non-derived
- each item in 3 different correctness conditions (correct, incorrect1, incorrect2)
- = 540 experimental items
- 3 randomized lists, 240 items each list:
  - all 180 nouns (60 correct, 60 incorr1, 60 incorr2)
  - 60 correct fillers

(17) *Experimental design/conditions*

| | masculine NP 'without new discount' | neuter NP 'without new genre' | feminine NP 'without new probe' |
|---|---|---|---|
| correct | ohne neuen Rabatt | ohne neues Genre | ohne neue Sonde |
| incorrect 1 | ohne neues Rabatt | ohne neuen Genre | ohne neuen Sonde |
| incorrect 2 | ohne neue Rabatt | ohne neue Genre | ohne neues Sonde |

*Participants*

- 42 German native speakers
- 21 male, 21 female
- all right-handed

*Procedure*

- visual word-by-word presentation:
  400ms each word, 300ms ISI
- recording of EEG (51 electrodes according to the international 10-20 system)
- compared ERP for the processing of the noun (establishing/validation of agreement)
- grammaticality judgement after each trial (producing behavioural data)



*Technical details*

- grand averages were obtained for 1200ms epochs beginning 200 ms prior to the presentation of the critical stimuli (i.e., the nouns)
- time windows for analysis: 300-550ms; 600-900ms
- 4 Regions Of Interest (ROI), each containing 6 electrodes:
  left anterior: F5, F3, FC5, FC3, C5, C3
  right anterior: F4, F6, FC4, FC6, C4, C6
  left posterior: CP5, CP3, P5, P3, PO7, PO3
  right posterior: CP4, CP6, P4, P6, PO4, PO8
  (midline)

*Presentation*

| (18) | -*- | [ ] | prep | [ ] | adj | [ ] | noun | [ ] |
|---|---|---|---|---|---|---|---|---|
| | 500ms | 300ms | 400ms | 300ms | 400ms | 300ms | 400ms | 800ms |

**Results: Electrophysiological Data; Left-Anterior Negativity**

| | Anterior Sites: left anterior df | F | right anterior df | F | Posterior Sites df | F | Midline Sites df | F |
|---|---|---|---|---|---|---|---|---|
| Marker | 2,82 | 14.23*** | 2,82 | 17.71*** | 2,82 | 11.26** | 2,82 | 14.25*** |
| Gender x Marker | 4,164 | 6.13** | 4,164 | 2.49(*) | 4,164 | 2.37(*) | 4,164 | 2.39(*) |
| **Feminine** | | | | | | | | |
| Marker | 2,82 | 8.44*** | 2,82 | 6.19** | 2.82 | 5.01** | 2,82 | 3.02(*) |
| cor vs incor1 | 1,41 | 13.9*** | 1,41 | 8.64** | 1,41 | n.s. | 1,41 | n.s. |
| cor vs incor2 | 1,41 | 6.40* | 1,41 | 8.74** | 1,41 | 8.41** | 1,41 | n.s |
| incor1 vs incor2 | 1,41 | n.s. | 1,41 | n.s. | 1,41 | n.s. | 1,41 | n.s. |
| **Neuter** | | | | | | | | |
| Marker | 2,82 | 17.49*** | 2.82 | 11.53*** | 2,82 | 7.87*** | 2,82 | 12.93*** |
| cor vs incor1 | 1,41 | 36.59*** | 1,41 | 25.54*** | 1,41 | 10.71** | 1,41 | 19.41*** |
| cor vs incor2 | 1,41 | 12.78** | 1,41 | 9.47** | 1,41 | 10.12** | 1,41 | 16.16** |
| incor1 vs incor2 | 1,41 | 4.17* | 1.41 | n.s. | 1.41 | n.s. | 1,41 | n.s. |
| **Masculine** | | | | | | | | |
| Marker | 2,82 | n.s. | 2,82 | n.s. | 2,82 | n.s. | 2,82 | n.s. |

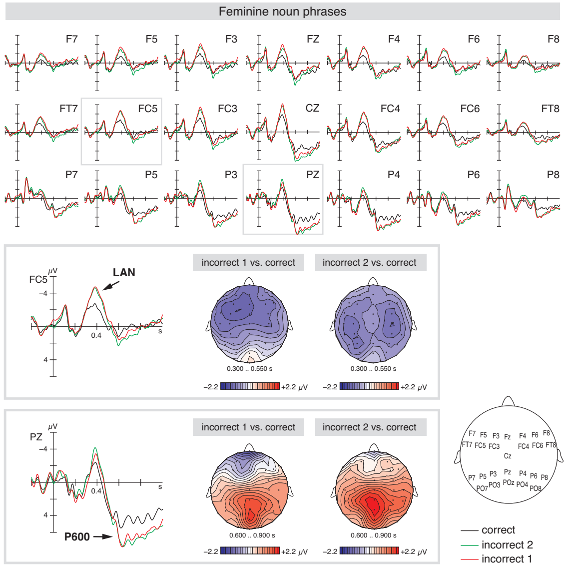
Table 1: *Effects of the step-down ANOVAs for anterior and posterior sites and the ANOVAs for the midline sites of the 300–550 ms latency window*

Abbreviations used in this table: cor = correct; incor1 = incorrect1; incor2 = incorrect2; (*) = p<.10; * = p<.05; ** = p<.01; *** = p<.001; n.s. = not significant.

**Results: Electrophysiological Data; P600**

| | Anterior Sites df | Anterior Sites F | Posterior Sites df | Posterior Sites F | Midline Sites df | Midline Sites F |
|---|---|---|---|---|---|---|
| Marker | 2,82 | n.s. | 2,82 | 10.07*** | 2,82 | 6.146** |
| Gender | 2,82 | n.s. | 2,82 | 3.45* | 2,82 | 2.62(*) |
| Gender x Marker | 4,164 | 3.72** | 4,164 | n.s. | 4,164 | 2.44(*) |
| **Feminine** | | | | | | |
| Marker | 2,82 | 2.71(*) | | | 2,82 | 5.42** |
| cor vs incor1 | 1,41 | n.s. | | | 1,41 | n.s. |
| cor vs incor2 | 1,41 | n.s. | | | 1,41 | 9.40** |
| incor1 vs incor2 | 1,41 | n.s. | | | 1,41 | n.s. |
| **Neuter** | | | | | | |
| Marker | 2,82 | n.s. | | | 2,82 | n.s. |
| **Masculine** | | | | | | |
| Marker | 2,82 | 4.88** | | | 2,82 | 5.21** |
| cor vs incor1 | 1,41 | 9.25** | | | 1,41 | 12.73*** |
| cor vs incor2 | 1,41 | n.s. | | | 1,41 | n.s. |
| incor1 vs incor2 | 1,41 | n.s. | | | 1,41 | n.s. |

Table 2: *Effects of the step-down ANOVAs for anterior and posterior sites and the ANOVAs for the midline sites of the 600-900 ms latency window*

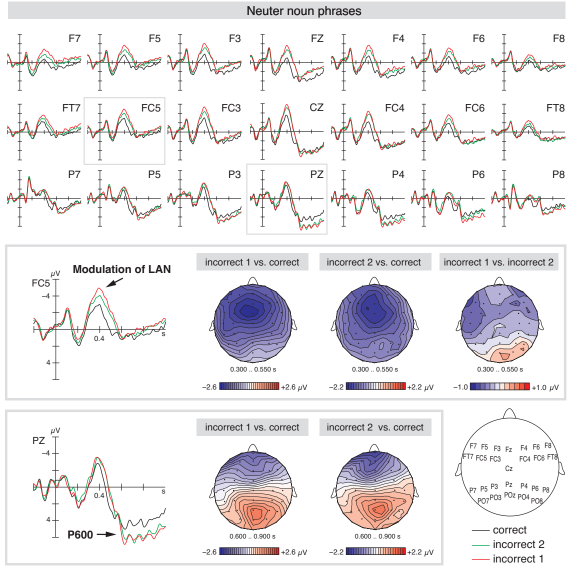


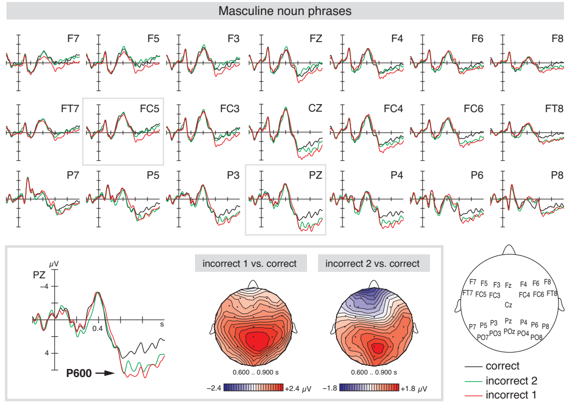

*3.2. Discussion*

**Two Main Results**

(19) Background






a. Left-Anterior Negativity (LAN): indicative of morpho-syntactic violations (but see below for a qualification)

b. P600: indicative of reanalysis and repair

- LAN:
  1. In *feminine* contexts, where /e/ is correct, the two incorrect exponents /n/ and /s/ produce the same effect.
  2. In *neuter* contexts, where /s/ is correct, the two incorrect exponents /s/ and /e/ produce different effects. (This is the main result of the study.)
  3. In *masculine* contexts, where /n/ is correct, the two incorrect exponents /s/ and /e/ produce the same effect. Surprisingly, the *correct* marker /n/ also produces this effect. (This is also an interesting result.)
- P600: This effect showed up in the same way with all incorrect exponents.

- The LAN effects with *incorrect* forms in *neuter* contexts gives rise to a direct argument for underspecification.
- The LAN effect with *correct* forms in *masculine* contexts gives rise to a more indirect argument for underspecification.

### I: Comparing Incorrect Conditions for Each Gender

(20) *Predictions and results*

| | Predictions | | | Results | |
|---|---|---|---|---|---|
| | without underspec. | with underspecification | | | |
| noun gender | categorical | maximal | minimal | LAN | P600 |
| feminine | s = n | $s^2 = n^2$ | $s^2 = n^2$ | s = n | s = n |
| neuter | e = n | $e^1 < n^2$ | $e^1 < n^2$ | e < n* | e = n |
| masculine | e = s | $e^1 = s^1$ | $e^1 < s^2$ | e = s | e = s |

*Conclusions*:

- The different LAN effect with /e/ and /n/ in neuter contexts strongly argues for the reality of a difference between *Compatibility* and *Specificity*, i.e., for underspecification.
- The absence of a LAN effect with /e/ and /s/ in masculine contexts strongly argues for *maximal* rather than *minimal* underspecification.

*II: An Effect of Feature Matching*
*Question*:
Why is there a LAN effect for correct masculine forms that is indistinguishable from the LAN effect for the two incorrect forms?
*Answer*: This is an effect of feature matching.

(21) *Proposal*:

a. $[_{PP}$ P $[_{NP}$ A N ]] is parsed incrementally.
b. P is read in; [+obj,–obl] (= acc) is available at this point.
c. A is encountered. Gender information on A becomes available (if there is any): [+masc,–fem] with /n/, [–fem] with /s/, and no gender feature with /e/; A's case specification (if there is any) is now accessible. P-A agreement is carried out, comparing the case features of P and A. If there are no conflicts, potentially missing case features of the preposition are copied onto the adjective, yielding full case specifications on A.
d. N enters the structure. It has specified gender information and fully specified number information, but no case information whatsoever yet. A-N agreement is carried out; the morpho-syntactic features of N are matched with the morpho-syntactic features of A.

*Agreement Evaluation*

(22) *Sizes of feature sets in well-formed NPs before A-N agreement*

a. durch / by / $[-obl, +obj]$ — schlichten / plain.MASC / $\begin{bmatrix} +masc, -fem \\ -obl, +obj \end{bmatrix}$ — Geschmack / taste.MASC / $[+masc, -fem]$
← *most features compared:* 4/2

b. durch / by / $[-obl, +obj]$ — schlichtes / plain.NEUT / $\begin{bmatrix} -fem \\ \underline{-obl}, \underline{+obj} \end{bmatrix}$ — Design / design.NEUT / $[-masc, -fem]$
← *fewer features compared:* 3/2



c. durch / by / $[-obl, +obj]$ — schlichte / plain.FEM / $\begin{bmatrix} \\ \underline{-obl}, \underline{+obj} \end{bmatrix}$ — Struktur / structure.FEM / $[-masc, +fem]$
← *fewest features compared:* 2/2

*Conclusions*:

- The LAN effect with correct masculine forms is due to the fact that the most features need to be compared in incremental agreement, outweighing the LAN effect with the incorrect forms here.
- This provides a second, albeit indirect, argument for morphological underspecification: Underspecification actually facilitates processing (as it facilitates lexical storage).

## 4. Paradigm Function Morphology

*Lit.*: Stump (2001)

(23) *Grundannahme*:
Die Verknüpfung eines Wortes mit einer bestimmten Menge von morphosyntaktischen Eigenschaften determiniert eine Kette von Regelanwendungen, die die Flexionsform des Wortes bestimmen.

(24) Traditionelle Terminologie:

a. *Wort* ('Wort', 'Lexem'): z.B. BUCH; Wörter haben Paradigmen.
b. *Wortform* ('Flexionsform des Wortes'): z.B. *Buches*; Wortformen sind Teile von Paradigmen.

(25) *Paradigmen* (Behauptung):
In dieser Theorie sind Paradigmen keine Epiphänomene; vielmehr "konstituieren sie ein zentrales Prinzip der morphologischen Organisation". Paradigmen sind das Ergebnis von *Paradigmenfunktionen*

(26) Drei Typen morphologischer Ausdrücke:

a. *Wurzel* ('root'): die "ultimative Default-Form" eines Lexems (Wortes).
b. *Stamm* ('stem'): ein Ausdruck, an den Flexionsexponenten angefügt werden können (jede Wurzel ist ein Stamm, nicht jeder Stamm ist eine Wurzel).
c. *Wortform* ('word'(!)): eine freie, voll flektierte Form, die eine Paradigmenzelle besetzt

(27) *Realisierungsregeln*:
Paradigmenfunktionen werden durch speziellere Realisierungsregeln definiert.

(28) Informelles Beispiel:
Der Wert der Paradigmenfunktion (<*Mutter*-,{dativ,plural}>) ergibt sich aus dem Ergebnis der Anwendung zweier Realisationsregeln – einer, die die Umlautvariante des Stamms wählt, und einer, die *-n* suffigiert.

Terminologie:
<*Mutter*-,{dativ,plural}> ist ein *FPSP* ('form/property-set pairing').

(29) *Regelblöcke*:

a. Die Realisierungsregeln einer Sprache sind in Blöcke organisiert.
b. Regeln im selben Blick konkurrieren miteinander; nur die spezifischste Regel kann applizieren (Paninis Prinzip; Spezifizitätsprinzip).

c. Regeln in verschieden Blöcken konkurrieren nicht; so treten in einer Wortform verschiedene Exponenten hintereinander.

Bemerkung:
Die Exponenten kommen durch Regeln in eine Wortform und haben keinen eigenständigen Status. Die Theorie ist also *amorphematisch* (vgl. Anderson (1992)).
Slogan: *Paradigmenfunktionen sind statische Wohlgeformtheitsbedingungen für Zellen.*

(30) *Wohlgeformte Menge morphosyntaktischer Eigenschaften*:
Eine Menge $\tau$ von morphosyntaktischen Eigenschaften für ein Lexem der Kategorie C ist wohlgeformt in einer Sprache L nur dann, wenn $\tau$ die folgenden Bedinungen in L erfüllt.

a. Für jede Eigenschaft F:v$\in\tau$ gilt: F:v ist für Lexeme der Kategorie C zugänglich und v ist ein erlaubter Wert für F.
b. Für jedes morphosyntaktische Merkmal F, das $v_1$, $v_2$ als mögliche Werte hat, gilt: Wenn $v_1 \neq v_2$ und F:$v_1\in\tau$, dann F:$v_2\notin\tau$.

(31) *Extension*:
Falls $\sigma$ und $\tau$ wohlgeformte Mengen morphosyntaktischer Eigenschaften sind, ist $\sigma$ eine Extension von $\tau$ gdw. (a) und (b) gelten.

a. Für jedes atomwertige Merkmal F und jeden erlaubten Wert v für F gilt: Wenn F:v$\in\tau$, dann F:v$\in\sigma$.
b. Für jedes mengenwertige Merkmal F und jeden erlaubten Wert p für F gilt: Wenn F:p$\in\tau$, dann F:p$'\in\tau$, wobei p$'$ eine Extension von p ist.

(32) *Unifikation*:
Falls $\sigma$ und $\tau$ wohlgeformte Mengen morphosyntaktischer Merkmale sind, ist die Unifikation $\rho$ von $\sigma$ und $\tau$ die kleinste wohlgeformte Menge von morphosyntaktischen Eigenschaften, so dass $\rho$ eine Extension sowohl von $\sigma$, als auch von $\tau$ ist.

(33) a. {TNS:pres,AGR:{PER:1,NUM:pl}} ist Extension von {AGR:{PER:1,NUM:pl}}, {AGR:{NUM:pl}}, { }, usw.
b. {TNS:pres,MOOD:ind,AGR:{PER:1,NUM:pl}} ist die Unifikation von {TNS:pres,AGR:{PER:1}} und {TNS:pres,MOOD:ind,AGR:{NUM:pl}}

(34) *Eigenschaftskookkurrenzrestriktionen* (bulgarische Verbformen; Ausschnitt):
Eine Menge $\tau$ von morphosyntaktischen Eigenschaften für ein Lexem der Kategorie V ist wohlgeformt nur, wenn $\tau$ eine wohlgeformte Extension $\sigma$ hat, so dass gilt:

a. $\sigma$ ist eine Extension von {VFORM:fin} gdw. für ein zulässiges $\alpha$ gilt: $\sigma$ ist eine Extension von {MOOD:$\alpha$}. (wenn Finitheit, dann Modus (Ind oder Konj))
b. Wenn $\sigma$ eine Extension ist von {MOOD:impv}, dann ist $\sigma$ eine Extension von {AGR:{PER:2}. (wenn Imperativ, dann 2. Person)
c. Für jedes zulässige $\alpha$ gilt: $\sigma$ ist eine Extension von {TNS:$\alpha$} gdw. $\sigma$ eine Extension ist von {MOOD:indic} oder von {VFORM:pple}. (V hat Tempus wenn es Ind. oder Partizip ist)
d. Für jedes zulässige $\alpha$ gilt: $\sigma$ ist eine Extension von {AGR:{GEN:$\alpha$}} gdw. $\sigma$ eine Extension ist von {VFORM:pple}, und $\sigma$ ist eine Extension von {AGR:{PERS:$\alpha$}} gdw. $\sigma$ eine Extension ist von {VFORM:fin}. (Wenn Genus, dann Partizip; wenn Person, dann Finitheit)

(35) *Vollständigkeit* von Mengen morphosyntaktischer Merkmale:
Eine Menge $\sigma$ von morphosyntaktischen Merkmalen für ein Lexem einer Kategorie ist vollständig gdw. (a) und (b) gelten:

a. $\sigma$ ist wohlgeformt.



b. Für jede Menge morphosyntaktischer Merkmale $\tau$ (so dass $\sigma$ nicht eine Extension von $\tau$ ist) gilt: die Unifikation von $\tau$ und $\sigma$ ist nicht wohlgeformt.

*Definitionen 3*
*Paradigmenfunktionen*:
Eine Paradigmenfunktion ist eine Funktion in der Menge der FPSPs, die auf einem *Wurzelpaar* $\langle$X,$\sigma\rangle$ appliziert (wobei X die Wurzel eines Lexems L ist und $\sigma$ eine vollständige Menge morphosyntaktischer Eigenschaften für L ist) und eine $\sigma$-Zelle $\langle$Y,$\sigma\rangle$ im Paradigma von L ergibt.

(36) *Format von Paradigmenfunktionen*:
PF($\langle$X,$\sigma\rangle$) = $\langle$Y,$\sigma\rangle$

*Realisierungsregeln* ('realization rules', 'rules of exponence'):
Eine Realisierungsregel ist eine Funktion in der Menge der FPSPs. Im Unterschied zu einer Paradigmenfunktion muss aber das Argument nicht unbedingt ein Wurzelpaar sein, und der Wert muss nicht unbedingt eine Paradigmenzelle sein.

(37) *Format von Realisierungsregeln*:
$\mathrm{RR}_{n,\tau,C}(\langle X,\sigma\rangle) = \langle Y',\sigma\rangle$

Terminologie:

- $n$: Blockindex
- $\tau$: Eigenschaftsmengenindex (die wohlgeformte Menge morphosyntaktischer Eigenschaften, die die Regel durch ihre Anwendung realisiert; $\sigma$ muss Extension von $\tau$ sein $\rightarrow$ *Unterspezifikation*)
- C: Klassenindex (Klasse der Lexeme, deren Paradigmen die Regel mit definieren kann)
- Y$'$: im Default Y, aber Möglichkeit der Überschreibung durch morphonologische Regeln

*Bulgarische Verbflexion*

(38) *Vier imperfektive Verben im Bulgarischen*:
a. KRAD ('stehlen'): 1.St. = *krad*, 2.St. = *krád*
b. IGRÁJ ('spielen'): 1.St. = *igráj*, 2.St. = *igrá*
c. KOVA ('fälschen'): 1.St. = *kov*, 2.St. = *kova*
d. DÁVA ('geben'): 1.St. = *dáva*, 2.St. = *dáva*

Zwei Stämme:
1. Stamm: Präsens, Imperfekt
2. Stamm: Aorist

Zwei abstrakte binäre Flexionsklassenmerkmale: [±t(runcating)], [±c(onsonantal)]:
[–t]: 1./2. Stamm: identisch zur Wurzel
[+t]: 1. Stamm: C, 2. Stamm: V
Auf diese Flexionsklassenmerkmale (auch unterspezifiziert) wird in Realisierungsregeln und morphonologischen Regeln Bezug genommen.

(39) a. KRAD ('stehlen'): [–t,+c]
b. IGRÁJ ('spielen'): [+t,+c]
c. KOVA ('fälschen'): [+t,–c]
d. DÁVA ('geben'): [–t,–c]

(40) *Abstrakte Paradigmen des Indikativs ohne morphonologische Regeln*:

| Konjugation | | KRAD [–t,+c] | DÁVA [–t,–c] | IGRÁJ [+t,+c] | KOVA [+t,–c] |
|---|---|---|---|---|---|
| Präsens | 1sg | *krad-e-ə* | *dáva-e-m* | *igráj-e-ə* | *kov-e-ə* |
| | 2sg | *krad-e-š* | *dáva-e-š* | *igráj-e-š* | *kov-e-š* |
| | 3sg | *krad-e–e* | *dáva-e-e* | *igráj-e-e* | *kov-e-e* |
| | 1pl | *krad-e-m* | *dáva-e-me* | *igráj-e-m* | *kov-e-m* |
| | 2pl | *krad-e-te* | *dáva-e-te* | *igráj-e-te* | *kov-e-te* |
| | 3pl | *krad-e-ət* | *dáva-e-ət* | *igráj-e-ət* | *kov-e-ət* |
| Imperfekt | 1sg | *krad-A-x* | *dáva-A-x* | *igráj-A-x* | *kov-A-x* |
| | 2sg | *krad-A-x-e* | *dáva-A-x-e* | *igráj-A-x-e* | *kov-A-x-e* |
| | 3sg | *krad-A-x-e* | *dáva-A-x-e* | *igráj-A-x-e* | *kov-A-x-e* |
| | 1pl | *krad-A-x-me* | *dáva-A-x-me* | *igráj-A-x-me* | *kov-A-x-me* |
| | 2pl | *krad-A-x-te* | *dáva-A-x-te* | *igráj-A-x-te* | *kov-A-x-te* |
| | 3pl | *krad-A-x-a* | *dáva-A-x-a* | *igráj-A-x-a* | *kov-A-x-a* |
| Aorist | 1sg | *krád-o-x* | *dáva-o-x* | *igrá-o-x* | *kova-o-x* |
| | 2sg | *krád-e* | *dáva-e* | *igrá-e* | *kova-e* |
| | 3sg | *krád-e* | *dáva-e* | *igrá-e* | *kova-e* |
| | 1pl | *krád-o-x-me* | *dáva-o-x-me* | *igrá-o-x-me* | *kova-o-x-me* |
| | 2pl | *krád-o-x-te* | *dáva-o-x-te* | *igrá-o-x-te* | *kova-o-x-te* |
| | 3pl | *krád-o-x-a* | *dáva-o-x-a* | *igrá-o-x-a* | *kova-o-x-a* |

*Realisierungsregeln*

(41) a. *Block A*:

**A1** $\mathrm{RR}_{\mathrm{A},\{\mathrm{TNS:aor}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{Y}',\sigma>$, wobei Y der 2. Stamm von X ist.

**A2** $\mathrm{RR}_{\mathrm{A},\{\ \},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{Y}',\sigma>$, wobei Y der 1. Stamm von X ist.

b. *Block B & Block C*:

**B1** $\mathrm{RR}_{\mathrm{B},\{\mathrm{TNS:pres}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}e',\sigma>$

**B2** $\mathrm{RR}_{\mathrm{B},\{\mathrm{TNS:impf}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}A',\sigma>$

**B3** $\mathrm{RR}_{\mathrm{B},\{\mathrm{TNS:aor,PRET:yes}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}o',\sigma>$

**B4/C1** Wenn $n$ = **B** oder **C**:

$\mathrm{RR}_{n,\{\mathrm{TNS:aor,PRET:yes,AGR:\{PER:3,NUM:sg\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}',\sigma>$

**C2** $\mathrm{RR}_{\mathrm{C},\{\mathrm{PRET:yes}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}x',\sigma>$

c. *Block D*:

**D1** $\mathrm{RR}_{\mathrm{D},\{\mathrm{TNS:pres,AGR:\{PER:1,NUM:sg\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}ə',\sigma>$

**D2** $\mathrm{RR}_{\mathrm{D},\{\mathrm{TNS:pres,AGR:\{PER:1,NUM:sg\}}\},[\mathrm{CONJ}:-\mathrm{T},-\mathrm{C}]}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}m',\sigma>$

**D3** $\mathrm{RR}_{\mathrm{D},\{\mathrm{TNS:pres,AGR:\{PER:2,NUM:sg\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}\check{s}',\sigma>$

**D4** $\mathrm{RR}_{\mathrm{D},\{\mathrm{AGR:\{PER:3,NUM:sg\}}\}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}e',\sigma>$

**D5** $\mathrm{RR}_{\mathrm{D},\{\mathrm{TNS:pres,AGR:\{PER:1,NUM:pl\}}\},([\mathrm{CONJ:+T}]\cup[\mathrm{CONJ:+C}])}(<\mathrm{X},\sigma>)=_{def} <\mathrm{X}m',\sigma>$

**D6** $\mathrm{RR}_{\mathrm{D},\{\mathrm{AGR:\{PER:1,NUM:pl\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}me',\sigma>$

**D7** $\mathrm{RR}_{\mathrm{D},\{\mathrm{AGR:\{PER:2,NUM:pl\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}te',\sigma>$

**D8** $\mathrm{RR}_{\mathrm{D},\{\mathrm{TNS:pres,AGR:\{PER:3,NUM:pl\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}ət',\sigma>$

**D9** $\mathrm{RR}_{\mathrm{D},\{\mathrm{AGR:\{PER:3,NUM:pl\}}\},\mathrm{V}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X}a',\sigma>$

(42) *Verweisregel* (‘rule of referral’; informelle Variante):
Im Präteritum (Aorist und Imperfekt) richtet sich die 2.Pers.Sg. nach der 3.Pers.Sg.





(43) *Paninis Prinzip*:
Es sei $\sigma$ eine vollständige Menge von morphosyntaktischen Eigenschaften für Lexeme der Kategorie V. Dann ist $\mathrm{PF}(<\mathrm{X},\sigma>) =_{def} \mathrm{Nar}_D(\mathrm{Nar}_C(\mathrm{Nar}_B(\mathrm{Nar}_A(<\mathrm{X},\sigma>))))$

(44) *$Nar_n$-Notation*:
Falls $\mathrm{RR}_{n,\tau,\mathrm{C}}$ die **engste** Regel in Block $n$ ist, die auf $<\mathrm{X},\sigma>$ **anwendbar** ist, so repräsentiert ‘$\mathrm{Nar}_n(<\mathrm{X},\sigma>)$’ das Resultat der Anwendung von $\mathrm{RR}_{n,\tau,\mathrm{C}}$ auf $<\mathrm{X},\sigma>$.

(45) *Enge und Anwendbarkeit* (vereinfacht):

a. $\mathrm{RR}_{n,\sigma,C}$ ist enger als $\mathrm{RR}_{n,\tau,C}$ gdw. $\sigma$ eine Extension von $\tau$ ist und $\sigma \neq \tau$.
b. $\mathrm{RR}_{n,\tau,C}$ ist anwendbar auf $<\mathrm{X},\sigma>$ gdw. $\mathrm{RR}_{n\tau,C}(<\mathrm{X},\sigma>$ definiert ist.

(46) *Regel-Argument-Kohärenz*:
$\mathrm{RR}_{n\tau,C}(<\mathrm{X},\sigma>$ ist definiert gdw. (a) $\sigma$ eine Extension von $\tau$ ist (s.o.); (b) L-Index(X) $\in$ C ist; und (c) $\sigma$ eine wohlgeformte Menge von morphosyntaktischen Eigenschaften für L-Index(X) ist.

*Regelanwendung 2: Identitätsfunktion*

(47) *Default der Identitätsfunktion*:

| $\mathrm{RR}_{n,\{\ \},\mathrm{U}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{X},\sigma>$ |
|---|

Bemerkung:
Dies ist so etwas wie ein Nullmarker, der als minimal spezifische Regel in jedem Block ($n$ ist eine Variable über allen Regelblöcken, U über allen Lexemklassen) zur Verfügung steht und dafür sorgt, dass es immer weiter geht. Beispiel:

(48) Beispiel:

a. $\sigma = \{$VFORM:fin, VCE:act, TNS:pres, PRET:no, MOOD:indic, AGR:{PER:1,NUM:pl}$\}$
b. $\mathrm{Nar}_C(<\textit{kradé},\sigma>) = \mathrm{RR}_{C,\{\ \},U}(<\textit{kradé},\sigma>) = <\textit{kradé},\sigma>$

*Regelanwendung 3: Verweisregeln und Synkretismus*
Manche Synkretismen kann man im Prinzip durch *Unterspezifikation*, auch bzgl. *abstrakter morphosyntaktischer Merkmale* ableiten ([pret:yes/no] ist ein solches); oder durch vollständige Unterspezifikation bzgl. einer grammatischen Kategorisierung (vgl. den Synkretismus bei der 3.Pers.Pl. im Aorist und Imperfekt: D9 vs. D8). Es gibt aber auch andere Synkretismen, wo Stump nicht diesen Weg geht: Bisher hatten wir die folgende informelle Version einer Verweisregel, die einen systematischen Synkretismus bei der 2.Pers.Sg. und der 3.Pers.Sg. ableitet.

(49) *Verweisregel* (informelle Variante):
Im Präteritum (Aorist und Imperfekt) richtet sich die 2.Pers.Sg. nach der 3.Pers.Sg.

Jetzt kann die Regel präziser formuliert werden:

(50) *Verweisregel* (saubere Variante):
Angenommen, (a)–(c) sind der Fall:

a. $\tau$ ist eine beliebige vollständige Extension von {PRET:yes, AGR:{PERS:2,NUM:sg}}.
b. $n$ ist ein beliebiger Regelblock in A-D.
c. $\sigma' = \sigma/$\{AGR:{PER:3}\}. (lies: $\sigma$ modifiziert durch {AGR:{PER:3}})

Dann gilt:
$\mathrm{RR}_{n,\tau,V}(<\mathrm{X},\sigma>) =_{def} <\mathrm{Y},\sigma>$, wobei $\mathrm{Nar}_n(<\mathrm{X},\sigma'>) = <\mathrm{Y},\sigma'>$

*Konkrete Paradigmen des Indikativs inkl. Morphonologie*

| Konjugation | | KRAD [–t,+c] | DÁVA [–t,–c] | IGRÁJ [+t,+c] | KOVA [+t,–c] |
|---|---|---|---|---|---|
| Präsens | 1sg | *krad-ə́* | *dáva-m* | *igráj-ə* | *kov-ə́* |
| | 2sg | *krad-é-š* | *dáva-š* | *igrá-e-š* | *kov-é-š* |
| | 3sg | *krad-é* | *dáva* | *igrá-e* | *kov-é* |
| | 1pl | *krad-é-m* | *dáva-me* | *igrá-e-m* | *kov-é-m* |
| | 2pl | *krad-é-te* | *dáva-te* | *igrá-e-te* | *kov-é-te* |
| | 3pl | *krad-ə́t* | *dáva-t* | *igráj-ət* | *kov-ə́t* |
| Imperfekt | 1sg | *krad-'á-x* | *dáva-x* | *igrá–ex* | *kov-'á-x* |
| | 2sg | *krad-é-š-e* | *dáva-š-e* | *igrá-e-š-e* | *kov-é-š-e* |
| | 3sg | *krad-é-š-e* | *dáva-š-e* | *igrá-e-š-e* | *kov-é-š-e* |
| | 1pl | *krad-'á-x-me* | *dáva-x-me* | *igrá-e-x-me* | *kov-'á-x-me* |
| | 2pl | *krad-'á-x-te* | *dáva-x-te* | *igrá-e-x-te* | *kov-'á-x-te* |
| | 3pl | *krad-'á-x-a* | *dáva-x-a* | *igrá-e-x-a* | *kov-'á-x-a* |
| Aorist | 1sg | *krád-o-x* | *dáva-x* | *igrá-x* | *ková-x* |
| | 2sg | *krád-e* | *dáva* | *igrá* | *ková* |
| | 3sg | *krád-e* | *dáva* | *igrá* | *ková* |
| | 1pl | *krád-o-x-me* | *dáva-x-me* | *igrá-x-me* | *ková-x-me* |
| | 2pl | *krád-o-x-te* | *dáva-x-te* | *igrá-x-te* | *ková-x-te* |
| | 3pl | *krád-o-x-a* | *dáva-x-a* | *igrá-x-a* | *ková-x-a* |

*Annahme*:
Für jede Realisierungsregel gibt es eine ungeordnete Menge $\Phi_R$ von morphonologischen Regeln, die bei jeder Anwendung die Evaluation der Realisierungsregel beschränken.
*Morphonologische Regeln und Metageneralisierungen*

(51) *Regeln* ($\Phi_R$): Falls $\mathrm{RR}_{n,\tau,\mathrm{C}}(<\mathrm{X},\sigma>) =_{def} <\mathrm{Y}',\sigma>$, so gilt:

a. Wenn der L-Index(X) $\in$ [CONJ:–T,–C] und Y = X[Vokal]Z, dann fehlt [Vokal] in Y′.
b. Wenn X = W[$\text{Vokal}_1$] und Y = X[$\text{Vokal}_2$]Z, dann fehlt [$\text{Vokal}_1$] in Y′, und [$\text{Vokal}_2$] wird betont in Y′ gdw. [$\text{Vokal}_1$] in Y betont wird.
c. Wenn X = W[$\text{Vokal}_1$] und Y = X[$\text{Vokal}_2$]Z, dann fehlt [$\text{Vokal}_2$] in Y′.
d. Wenn Y unbetont ist, dann wird Y′ auf seiner letzten Silbe betont.
e. Wenn X = WC (C ein Velar mit Č als alveopalatalem Gegenstück), Y = XVZ, und V ein vorderer Vokal, dann hat Y′ Č anstelle von C.
f. Wenn Y = WĂZ, dann hat Y′ ein *e* anstelle von Ă.
g. Wenn Y = W*Á*$\mathrm{C}_1$VZ und V ist ein vorderer Vokal, dann hat Y′ ein *é* anstelle von *Á*.
h. Wenn Y = W*Á*Z, dann hat Y′ *á* (mit Palatalisierung eines unmittelbar vorangehenden Konsonanten) anstelle von *Á*.

(52) *Metageneralisierungen*:

a. Für jede Regel R in Block **B**, **C** oder **D** gilt: (51-ae) $\in \Phi_R$.
b. Für jede Regel R in Block **B**, **C** oder **D** gilt: (51-b) $\in \Phi_R$ gdw. R eine Extension von {TNS:pres} realisiert; ansonsten: (51-c) $\in \Phi_R$.
c. Falls R in Block **B** ist, gilt: (51-d) $\in \Phi_R$.
d. Falls R in Block **D** ist, gilt: (51-fh) $\in \Phi_R$.
e. (51-g) $\in \Phi_{\mathbf{D4}}, \Phi_{\mathbf{B1}}$.



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