



Lexical Rules in the Hierarchical Lexicon

Svenja Meyer, svemey@coli.uni-sb.de

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Overview

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- Summary



? Why do we need something like word classes in our lexicon ?



Word classes - Motivation

- much of the information of a fully specified lexical entry is not unique to it
 - much redundancy!
- grouping of the lexical items into classes supports:
 - elimination of a great part of this redundancy
 - generalizations about the elements of the lexicon
 - predictions about the behaviour and distribution of a lexical item



Lexical entries

- a lexical entry contains three distinct types of information:
 - phonological
 - syntactic*
 - semantic
- main focus on: syntactic information



Lexical entries (2)

- two kinds of syntactic properties:
 - set of features:
 - with atomic values (e.g. +/-, Verb (as a value of CAT))
 - with category values (set of feature-value-pairs, e.g. (CAT Verb), (LEXICAL +), (CASE Nominative))
 - set of subcategorization specifications:
 - complements (obligatory or optional)
 - adjuncts
- formal representation: attribute-value-pairs

Lexical entries (3)

- The subcategorization information specifies the syntactic restrictions imposed by the lexical item on its complements and adjuncts.
- Four parts of specifications indicated by Flickinger:
 1. partially ordered list of names of obligatory and optional complements
 2. unordered list of names of adjuncts
 3. descriptions of the complements and adjuncts, specifying both syntactic and semantic properties (but without making reference to subcategorization properties of their own)
 4. set of partial ordering statements that interact with phrase structure rules

Lexical entries – An Example

TRY-1-PAST ("Otto tried to make his football team win.") → subject-equi	
Spelling	"tried"
Phonology	/traɪd/
Semantics	(PAST (TRY agent:X prop:Y))
Syntax	
Atomic-features	(CAT Verb) (VFORM Finite) (LEXICAL +) (COMPLETE -) (INVERTED -)
Category-features	
Complements	Subject XComp
Subject-features	(CAT Noun) (COMPLETE +) (CASE Nominative) (→ Syntax)
Subject-index	X (→ Semantics)
XComp-features	(CAT Verb) (VFORM Infinitive) (LEXICAL -) (COMPLETE -)
XComp-index	Y
Adjuncts	...

? How would the lexical entry for “persuaded” look like ?

PERSUADE-1-PAST (“Otto persuaded Charistreas to score again.”) → obj-equi

Spelling	“persuaded”
Phonology	/p@rsweId@d/
Semantics	(PAST (PERSUADE agent:X patient:Y prop:Z))
Syntax	
Atomic-features	(CAT Verb) (VFORM Finite) (LEXICAL +) (COMPLETE -) (INVERTED -)
Category-features	
Complements	Subject DObject XComp
Subject-features	(CAT Noun) (COMPLETE +) (CASE Nominative) (→ Syntax)
Subject-index	X (→ Semantics)
DObject-features	(CAT Noun) (COMPLETE +) (CASE Accusative)
DObject-index	Y
XComp-features	(CAT Verb) (VFORM Infinitive) (LEXICAL -) (COMPLETE -)
XComp-index	Z
Adjuncts	...

PERSUADE-1-PAST (“Otto persuaded Charisteads to score again.”) → obj-equi

Spelling	“persuaded”
Phonology	/p@rsweId@d/
Semantics	(PAST (PERSUADE agent:X patient:Y prop:Z))
Syntax	
Atomic-features	(CAT Verb) (VFORM Finite) (LEXICAL +) (COMPLETE -) (INVERTED -)
Category-features	
Complements	Subject DObject XComp
Subject-features	(CAT Noun) (COMPLETE +) (CASE Nominative) (→ Syntax)
Subject-index	X (→ Semantics)
DObject-features	(CAT Noun) (COMPLETE +) (CASE Accusative)
DObject-index	Y
XComp-features	(CAT Verb) (VFORM Infinitive) (LEXICAL -) (COMPLETE -)
XComp-index	Z
Adjuncts	...

EQUI-VERB-CLASS (provisional)


Atomic-features	(CAT Verb) (LEXICAL +) (COMPLETE -) (INVERTED -)
Complements	Subject XComp
Subject-features	(CAT Noun) (COMPLETE +)
XComp-features	(CAT Verb) (VFORM Infinitive) (LEXICAL -) (COMPLETE -)
Adjuncts	...

PAST-CLASS (provisional)

Atomic-features	(VFORM Finite)
Complements	
Subject-features	(CASE Nominative)

OBJECT-EQUI-VERB-CLASS (provisional)

Superclass	EQUI-VERB-CLASS
Complements	DObject
DObject-features	(CAT Noun) (COMPLETE +) (CASE Accusative)



→ Now all of the syntactic properties of a lexical entry can be predicted via the word classes it belongs to:



TRY-1-PAST (preliminary)

Classes	EQUI-VERB-CLASS, PAST-CLASS
Spelling	“tried”
Phonology	/traɪd/
Semantics	(PAST (TRY agent:X prop:Y))
Subject-index	X
XComp-index	Y

PERSUADE-1-PAST (preliminary)

Classes	OBJ-EQUI-VERB-CLASS, PAST-CLASS
Spelling	“persuaded”
Phonology	/p@rsweɪd@d/
Semantics	(PAST (PERSUADE agent:X patient:Y prop:Z))
Subject-index	X
DObject-index	Y
XComp-index	Z



The word class hierarchy

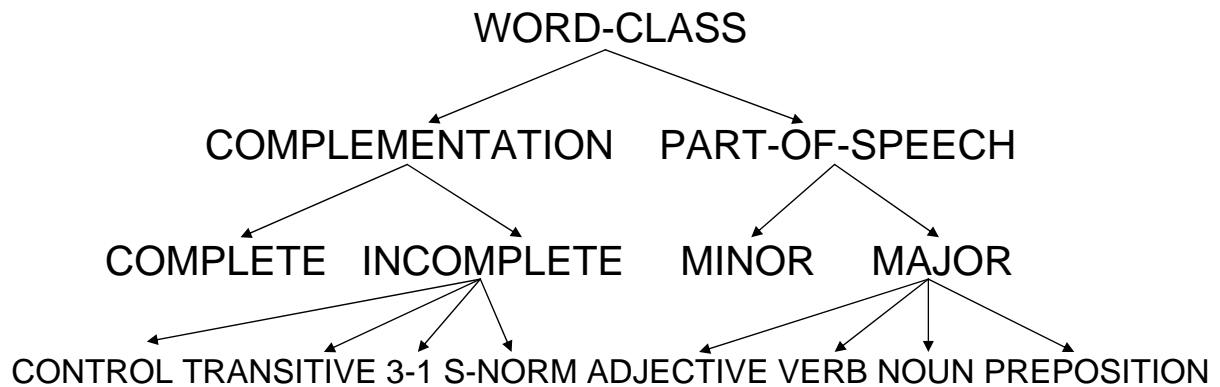
- To really avoid redundancy, each property should only be mentioned once in some single class.
 - a lexical item normally belongs to more than just one word class (e.g. transitive class, past class, ...)
- The hierarchy Flickinger develops is not a simple hierarchy but rather a collection of simple hierarchies.
 - cross classification



Word class hierarchy (2)

- Distinctions must often be made along more than one dimension for the members of a given word class (different grouping for separate properties).
 - e.g.: Nouns can be divided into groups on the basis of...
 - number (singular, plural, mass)
 - whether or not they may take a determiner (proper vs. common)
 - two partially independent ways of sub-dividing both holding for the full class of nouns
- need for the introduction of two types of links between classes in the hierarchy:
- subset link: joins a class and one of its proper subsets (e.g.: equi-verb-class \supset obj-equi-verb-class)
 - perspective link: joins a class with a node that names one dimension along which that class will be sub-divided

Word class hierarchy – The top level



The root class for the
lexicon hierarchy:

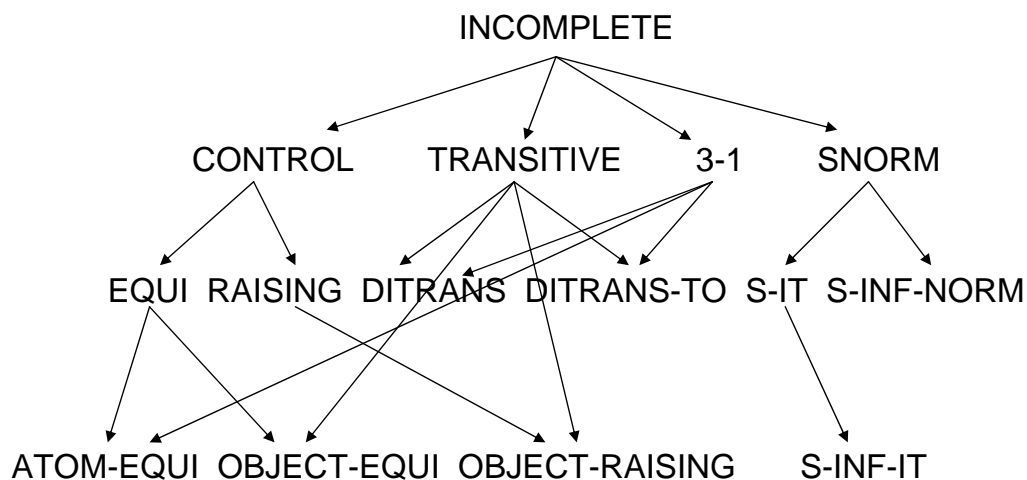
WORD-CLASS	
Atomic-features	(LEXICAL +)
Lexical-rules	

The body of a word class

- Specification of either the classes the given word class is a proper subset of or the class it partitions
- Properties shared as a default by members of the class
 - feature specifications (strictly syntactic)
 - subcategorization information (syntactic & semantic, where the semantic information is limited to thematic role assignment)

COMPLEMENTATION	
Partition-of	WORD-CLASS
Atomic-features	
Category-features	
Complements	
LP-constraints	Head [LEXICAL +] < Complement

(Sub-)Hierarchy of INCOMPLETE



Inheritance

- Building up a word class hierarchy would not make sense if there were no mechanisms making subclasses inherit information from their parent classes.

→ Inheritance Rule

Inheritance (2)

(1) Inheritance of values

The value assigned to a particular word class (or member) *W* for a given attribute is determined as follows:

- a. *For a single-valued attribute, the assigned value is either introduced directly in *W*, or is the one introduced in the most specific class to which *W* belongs. If there is no value introduced anywhere in the linked classes between *W* and the root WORD-CLASS, inclusively, no value is assigned to *W* for that attribute.*
- b. *For a multiple-valued attribute, the assigned values are the members of the set consisting of all distinct values introduced for that attribute in *W* and in any of the classes linking *W* with the root WORD-CLASS, inclusively.*

Inheritance – An Illustration

TRY-1-PAST (1. version)		TRY-1-PAST (revised)	
Classes	EQUI-VERB-CLASS, PAST-CLASS	Superclasses	MAIN-VERB, PAST, EQUI
Spelling	“tried”	Spelling	“tried”
Phonology	/traId/	Phonology	/traId/
Semantics	(PAST (TRY agent:X prop:Y))	Semantics	(PAST (TRY agent:X prop:Y))
Subject-index	X	Complements	
XComp-index	Y	Subject-index	X
		XComp-index	Y

Inheritance – An Illustration (2)

TRY-1-PAST (fully-specified)		Source class
Superclasses	MAIN-VERB PAST EQUI	(Local) (Local) (Local)
Spelling	“tried”	(Local)
Phonology	/traɪd/	(Local)
Semantics	(PAST (TRY agent:X prop:Y))	(Local)
Atomic-features	(CAT Verb) (VFORM Finite) (INVERTED -) (LEXICAL +) (COMPLETE -) (PREDICATIVE -)	VERB (via MAIN-VERB) FINITE (via PAST) MAIN-VERB WORD-CLASS INCOMPLETE (via EQUI) FINITE (via PAST)
Category-features		
Complements	Subject XComp	INCOMPLETE (via EQUI) CONTROL (via EQUI)
Subject-features	...	

Inheritance – An Illustration (3)

TRY-1-PAST		Source class
Subject-features	(CAT Noun) (COMPLETE +) (CASE Nominative)	INCOMPLETE (via EQUI) INCOMPLETE (via EQUI) FINITE (via EQUI)
Subject-index	X	(Local)
XComp-features	(CAT Verb) (VForm Infinitive) (LEXICAL -) (COMPLETE -)	CONTROL MAIN-VERB CONTROL CONTROL
XComp-index	Y	(Local)
Adjuncts	PP-Adjunct	MAJOR (via MAIN-VERB)
PP-Adjunct-features	(CAT Preposition) (COMPLETE -) (PForm Neutral)	MAJOR (via MAIN-VERB) MAJOR (via MAIN-VERB) MAJOR (via MAIN-VERB)
LP-constraints	...	COMPLEMENTATION

! The default values can be overwritten with more narrowly applicable values !



Word class hierarchy - Summary

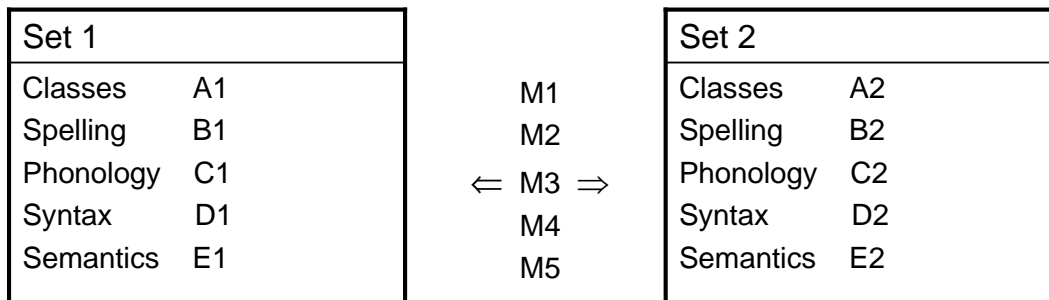
- Word classes...
 - represent generalizations on lexical entries
 - eliminate redundancy
 - allow predictions about lots of information within a specific lexical entry
 - are arranged in a non-trivial hierarchy
- The Inheritance Mechanism guarantees the correct transfer of information within the hierarchy.



Lexical Rules

- “Lexical rules express systematic relationships holding between two word classes, or – more precisely – between the members of one class and the members of another class.”
- Given a word belonging to one class, a lexical rule predicts the existence of a corresponding word belonging to another class.
- The differences and similarities between the two words are captured both in the formulation of the rule and in the definitions of each of the two classes.

Lexical Rules – How they look like



- a lexical rule consists of two parts:
 1. Identification of the sets of lexical entries being related (= Specification of the class or classes which define each of the two sets)
 2. Definition of the mappings M1-M5 which relate the information of Set1 to that of Set2 (Each of the mappings may be the identity relation, but not all of them at the same time!)
- Note that Flickinger assumes bi-directionality!

Lexical Rules (continued)

- Lexical rules hold for minimally specified lexical entries without having access to inherited predictable information.
- A lexical rule needs just two kinds of information:
 - a) the word classes that each of the two related entries belongs to
 - b) any idiosyncratic properties specified by either lexical entry
- The default relation for any attributes not mentioned in the rule is assumed to be the identity relation.
- Two constraints on the applicability of a lexical rule:
 1. The name of the rule must appear as the value of the Lexical-rules attribute for two word classes in the hierarchy.
 2. The rule may itself specify further constraints on applicability, effectively reducing its applicability to only a proper subset of a class that introduced the rule.

Lexical rules – An example

LR-PAST		
LE2-Classes – PAST	=	LE1-Classes – BASE
LE2-Spelling	=	(AFFIX-ED LE1-Spelling)
LE2-Phonology	=	...
LE2-Semantics	=	(PAST LE1-Semantics)

■ notation conventions:

- identity relation is not explicitly mentioned in the lexical rule
- identification of the two sets of lexical entries is just implicitly given by mentioning the relevant parent classes in the first statement of the rule

Lexical Rules – Explanation of the example

1. statement:
The classes that LE1 belongs to are the same as those that LE2 belongs to, except that where LE1 is a member of the BASE class, LE2 is a member of the PAST class.
 2. statement:
Take as the default relationship (which can be overwritten) between the spellings of LE1 and LE2 “AFFIX-ED”.
 3. statement: Not of any interest in this context.
 4. statement:
Take as the default relationship between the semantics of LE1 and LE2 “PAST”.
- Remember: Any properties that are not mentioned in the lexical rule conventionally have as a default the identity relation!
 - But: As a result of the inheritance mechanism some values e.g. of the syntactic features may differ between LE1 and LE2!




Lexical rules – Linking to word classes

PAST (revised)	
Superclasses	FINITE
Lexical-rules	LR-PAST

BASE	
Superclasses	VERB-FORM
Atomic-features	(VFORM Base) (PREDICATIVE -)
Lexical-rules	LR-PAST LR-PRES-3RD-SG LR-PAST-PART

- In those cases where a rule holds quite generally for a class (→ exceptions: later) it is introduced as a default property of that class by assigning it as a value to the Lexical-rules attribute.
- Unless a lexical item belonging to the class on which the lexical rule can be applied says something to the contrary, the generalization expressed in the rule holds for that item.



Lexical Rules - Exceptions

- To handle exceptions Flickinger introduces three types of idiosyncratic information that can be specified for a lexical rule appearing in a lexical entry. They affect the way in which the rule applies to that entry.
 - 1) The entry specifies an additional rule which applies only to that entry, but not generally for any of the entry's parent classes. (→ really rare)
 - 2) The entry blocks the application of a rule which otherwise holds for some class the given entry is a member of.
 - 3) The entry specifies unpredictable phonological, orthographic or semantic properties of the entry related to it by the lexical rule.



Lexical rules - Summary

■ Lexical rules

- express relations between the members of two word classes.
- are linked to the word classes via the Lexical rules feature.
- don't usually hold for every lexical entry belonging to the class it is linked to → mechanism for handling exception



Adjectival passives

■ Problem:

There is a class of adjectives in English which have the same morphological form as verbal passives showing the distribution of adjectives. (→ Siegel 1973, Wasow 1977)

■ examples:

- a. The books were **used** by the students. (→verb)
- b. Peter sold **used** books to the students. (→adjective)



Adjectival passives (2)

- more examples:

pay (=transitive):

a1. Peter did not **pay** his bills.

b1. The bills were not **paid**.

c1. The **unpaid** bills stacked up.

a2. Peter did not **pay** the waiter.

b2. The waiter was not **paid**.

c2. The **unpaid** waiters went on strike.



Adjectival passives (3)

send (=ditransitive):

DObject, to-PP

a3. Peter did not **send** the letter to his sister.

b3. The letter was not **sent** to his sister.

c3. The letter was not **sent**.

d3. The **unsent** letter lay on the table.

IndObject, DObject

a4. Peter did not **send** his sister the letter.

b4. His sister was not **sent** the letter.

c4. *His sister was not **sent**.

d4. *The **unsent** sister waited in vain.



Adjectival passives (4)

hand (=ditransitive):

DObject, to-PP

- a5. Peter did not **hand** the letter to his sister.
- b5. The letter was not **handed** to his sister.
- c5. *The letter was not **handed**.
- d5. *The **unhanded** letter stayed in Peter's pocket.

IndObject, DObject

- a6. Peter did not **hand** his sister the letter.
- b6. His sister was not **handed** the letter.
- c6. *His sister was not **handed**.
- d6. *The **unhanded** sister asked for the letter.



Adjectival passives (5)

convince: DObject, XComp

- a7. Peter **convinced** the senators that he was right.
- b7. The senators were **convinced** that he was right.
- c7. The senators were (easily) **convinced**.
- d7. The **convinced** senators voted for the bill.

allow: IndObject, XComp

- a8. Peter **allowed** the children to stay.
- b8. The children were **allowed** to stay.
- c8. *The children were **allowed**.
- d8. *The **allowed** children were happy.



Adjectival passives (6)

place: DObject, PP-Comp

- a9. Peter **placed** the report on the table.
- b9. The report was **placed** on the table.
- c9. *The report was **placed**.
- d9. *The **placed** report has tall lettering on the cover.

misplace: DObject

- a10. Peter **misplaced** the report.
- b10. The report was **misplaced**.
- c10. The **misplaced** report contained no surprises.



Adjectival passives (7)

- explanation of the obvious contrasts in the above examples proposed by Levin and Rappaport 1986 (based on subcategorization properties):

Verbs which have a corresponding adjectival passive	=	Verbs which have a transitive verbal passive with only one obligatory complement (the subject)
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Adjectival passives (2a)

- the examples revisited:

pay (=transitive):

a1. Peter did not **pay** his bills.

b1. The bills were not **paid**. (→verbal passive^{ar1*})

c1. The **unpaid** bills stacked up. (→adjectival passive)

a2. Peter did not **pay** the waiter.

b2. The waiter was not **paid**. (→verbal passive^{ar1})

c2. The **unpaid** waiters went on strike. (→adj. passive)

*ar1 stands for arity1 which means that this verbal passive has just one obligatory element, i.e. the subject

Adjectival passives (3a)

send (=ditransitive):

DObject, to-PP

a3. Peter did not **send** the letter to his sister.

b3. The letter was not **sent** to his sister.

c3. The letter was not **sent**. (→verbal passive^{ar1})

d3. The **unsent** letter sat on the table. (→adjectival passive)

IndObject, DObject

a4. Peter did not **send** his sister the letter.

b4. His sister was not **sent** the letter.

c4. *His sister was not **sent**.

d4. *The **unsent** sister waited in vain.



Adjectival passives (4a)

hand (=ditransitive):

DObject, to-PP

- a5. Peter did not **hand** the letter to his sister.
- b5. The letter was not **handed** to his sister.
- c5. *The letter was not **handed**.
- d5. *The **unhanded** letter stayed in Peter's pocket.

IndObject, DObject

- a6. Peter did not **hand** his sister the letter.
- b6. His sister was not **handed** the letter.
- c6. *His sister was not **handed**.
- d6. *The **unhanded** sister asked for the letter.



Adjectival passives (5a)

convince: DObject, XComp

- a7. Peter **convinced** the senators that he was right.
- b7. The senators were **convinced** that he was right.
- c7. The senators were (easily) **convinced**. (→verbal passive^{ar1})
- d7. The **convinced** senators voted for the bill. (→adjectival passive)

allow: IndObject, XComp

- a8. Peter **allowed** the children to stay.
- b8. The children were **allowed** to stay.
- c8. *The children were **allowed**.
- d8. *The **allowed** children were happy.

Adjectival passives (6a)

place: DObject, PP-Comp

- a9. Peter placed the report on the table.
- b9. The report was placed on the table.
- c9. *The report was placed.
- d9. *The placed report has tall lettering on the cover.

misplace: DObject

- a10. Peter misplaced the report.
- b10. The report was misplaced. (→verbal passive^{ar1})
- c10. The misplaced report contained no surprises. (→adj. passive)


Adjectival passives – Lexical Rule (1st version)

LR-ADJ-PASS	(INCOMPLETE!*)
LE2-Classes – ADJECTIVE	= LE1-Classes – PASSIVE
LE2-Semantics	= (STATE-OF LE1-Semantics)

*The "!" means that the rule holds only for immediate members if the INCOMPLETE class.

■ restrictions:

- The rule only applies to intransitive verbs.
- The intransitive verbs have to be passives.



Adjectival passives – Unergatives vs. Unaccusatives

- Problem:

There is another class of intransitive verbs with corresponding adjectives where the verbs are not passives:

unaccusative (ergative) verbs:

a11. fallen leaves (→The leaves fall.)

b11. wilted flowers (→The flowers wilt.)

c11. swollen feet (→The feet swell.)

unergative verbs:

a12. *cried children (→The children cry.)

b12. *yawned students (→The students yawn.)

c12. *slept babies (→The babies sleep.)



Adjectival passives (8)

- explanation of the different behaviour of intransitives provided by Levin & Rappaport:

restriction of the adjective-forming rule to unaccusative verbs in English (a11-c11), excluding unergative verbs (a12-c12)

Adjectival passives – Resultatives

- a second evidence for a distinction between unergative and unaccusative verbs: the permission of resultatives (Simpson 1983)

unaccusatives:

a13. The flowers wilted (completely limp).

b13. Her feet swelled (too large for her shoes).

unergatives:

a14. The old man coughed (*hoarse).

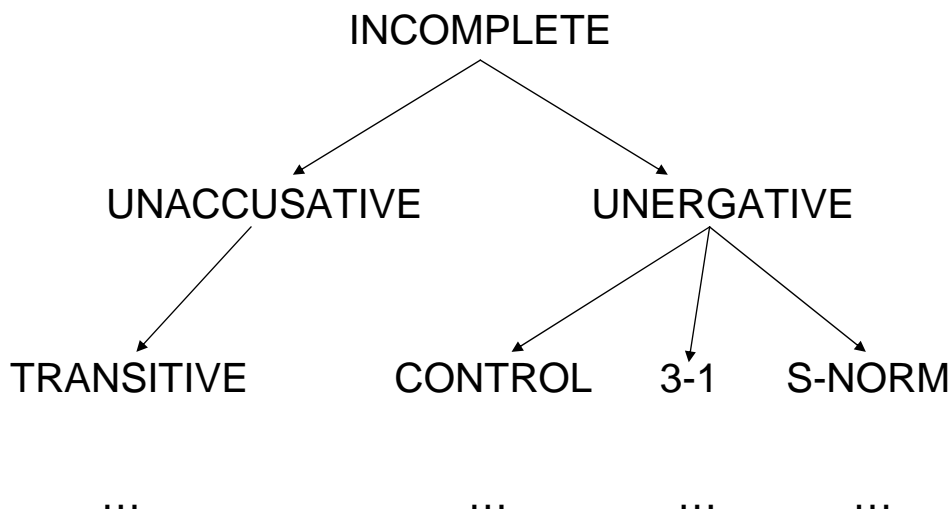
b14. The babies cried (*asleep).

transitives:

a15. He wiped the board (clean).

b15. He cut the mushrooms (small).

The INCOMPLETE class restructured



The UNACCUSATIVE word class

UNACCUSATIVE		
Superclasses	INCOMPLETE	
Complements	(Resultative)	(→optional)
Resultative-features	(PREDICATIVE +)	
Lexical-rules	LR-ADJ-PASS	

THE LR-ADJ-PASS (final formulation)

LR-ADJ-PASS	(UNACCUSATIVE!)
LE2-Classes – ADJECTIVE	= LE1-Classes – PAST PARTICIPLE
LE2-Semantics	= (STATE-OF LE1-Semantics)

- this final formulation expresses all the desired generalizations:
 - all intransitive passives should allow resultatives (since these passives are related to transitives)
 - all transitive verbs should – as a default – have corresponding adjectives with the same morphological form as the past participle of the verb (thematic role assigned to the adjective's head noun = thematic role of the passive verb's subject)



Problematic cases

- often it is not clear to which class a verb should be assigned: unergative or unaccusative?

a16. vanished: Peter studies vanished civilizations.
b16. disappeared: *Peter looks for disappeared people.
c16. appeared: *Peter studies appeared holes in the ozone layer.

a17. surfaced: Peter addressed the recently surfaced objections.
b17. arisen: *Peter addressed the recently arisen objections.
c17. risen: *Peter greeted the risen children.

a18. returned: Peter welcomed the returned monarch.
b18. remained: *Peter visited the remained monarch.



Summary

- Word classes provide effective means of minimization of redundancy within the lexicon.
- Lexical Rules relate lexical entries belonging to two different word classes.
- The discussion of the phenomenon of adjectival passives illustrated how interaction between word classes and lexical rules works.



Reference

Flickinger, Daniel Paul (1987): Lexical Rules in the Hierarchical Lexicon. Stanford University. Stanford, CA.