14 Generative-enumerative vs. model-theoretic approaches

Generative-enumerative approaches assume that a grammar generates a set of sequences of symbols (strings of words). This is where the term Generative Grammar comes from. Thus, it is possible to use the grammar on page 55, repeated here as (1), to derive the string *er das Buch dem Mann gibt* 'he the book the man gives'.

(1)

NP → D, N	NP → er	N → Buch
S → NP, NP, NP, V	D → das	N → Mann
	D → dem	V → gibt

Beginning with the start symbol (S), symbols are replaced until one reaches a sequence of symbols only containing words. The set of all strings derived in this way is the language described by the grammar.

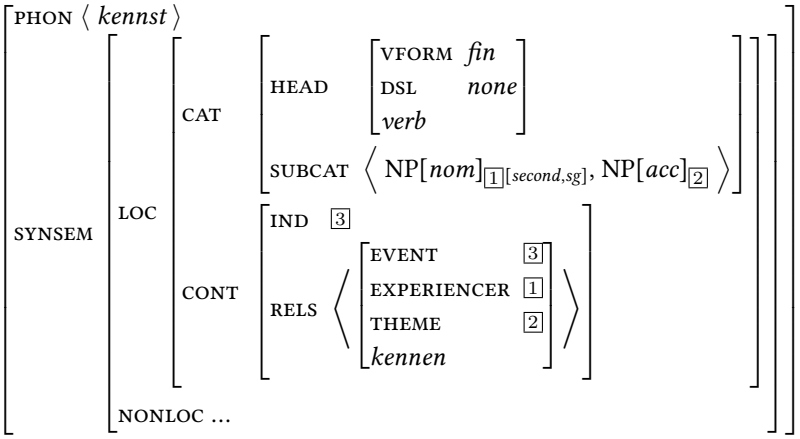
The following are classed as generative-enumerative approaches:

- all phrase structure grammars
- Transformational Grammars in almost all variants
- GPSG in the formalism of Gazdar, Klein, Pullum & Sag (1985)
- many variants of Categorial Grammar
- many variants of TAG
- Chomsky's Minimalist Grammars

LFG was also originally designed to be a generative grammar.

The opposite of such theories of grammar are model-theoretic or constraint-based approaches (MTA). MTAs formulate well-formedness conditions on the expressions that the grammar describes. In Section 6.7, we already discussed a model-theoretic approach for theories that use feature structures to model phenomena. To illustrate this point, I will discuss another HPSG example: (2) shows the lexical item for *kennst* 'know'.

(2) Lexical item for *kennst*:



In the description of (2), it is ensured that the PHON value of the relevant linguistic sign is ⟨ *kennst* ⟩, that is, this value of PHON is constrained. There are parallel restrictions for the features given in (2): the SYNSEM value is given. In SYNSEM, there are restrictions on the LOC and NONLOC value. In CAT, there are individual restrictions for HEAD and SUBCAT. The value of SUBCAT is a list with descriptions of dependent elements. The descriptions are given as abbreviations here, which actually stand for complex feature descriptions that also consist of feature-value pairs. For the first argument of *kennst*, a HEAD value of type *noun* is required, the PER value in the semantic index has to be *second* and the NUM value has to be *sg*. The structure sharings in (2) are a special kind of constraint. Values that are not specified in the descriptions of lexical entries can vary in accordance with the feature geometry given by the type system. In (2), neither the SLASH value of the nominative NP nor the one of the accusative NP is fixed. This means that SLASH can either be an empty or non-empty list.

The constraints in lexical items such as (2) interact with further constraints that hold for the signs of type *phrase*. For instance, in head-argument structures, the non-head daughter must correspond to an element from the SUBCAT list of the head daughter.

Generative-enumerative and model-theoretic approaches view the same problem from different sides: the generative side only allows what can be generated by a given set of rules, whereas the model-theoretic approach allows everything that is not ruled out by constraints.[1]

Pullum & Scholz (2001: 19–20) and Pullum (2007) list the following model-theoretic approaches:[2]

[1] Compare this to an old joke: in dictatorships, everything that is not allowed is banned, in democracies, everything that is not banned is allowed and in France, everything that is banned is allowed. Generative-enumerative approaches correspond to the dictatorships, model-theoretic approaches are the democracies and France is something that has no correlate in linguistics.

[2] See Pullum (2007) for a historical overview of Model Theoretic Syntax (MTS) and for further references.

- the non-procedural variant of Transformational Grammar of Lakoff, that formulates constraints on potential tree sequences,
- Johnson and Postal's formalization of Relational Grammar (1980)
- GPSG in the variants developed by Gazdar et al. (1988), Blackburn et al. (1993) and Rogers (1997),
- LFG in the formalization of Kaplan (1995)[3] and
- HPSG in the formalization of King (1999).

Categorial Grammars (Bouma & van Noord 1994), TAG (Rogers 1994) and Minimalist approaches (Veenstra 1998) can be formulated in model-theoretic terms.

Pullum & Scholz (2001) point out various differences between these points of view. In the following sections, I will focus on two of these differences.[4] Section 14.3 deals with ten Hacken's objection to the model-theoretic view.

14.1 Graded acceptability

Generative-enumerative approaches differ from model-theoretic approaches in how they deal with the varying degrees of acceptability of utterances. In generative-enumerative approaches, a particular string is either included in the set of well-formed expression or it is not. This means that it is not straightforwardly possible to say something about the degree of deviance: the first sentence in (3) is judged grammatical and the following three are equally ungrammatical.

(3) a. Du kennst diesen Aufsatz.
you know.2SG this.ACC essay

b. * Du kennen diesen Aufsatz.
you know.3PL this.ACC essay

c. * Du kennen dieser Aufsatz.
you know.3PL this.NOM essay

d. * Du kennen Aufsatz dieser.
you know.3PL essay this.NOM

At this point, critics of this view raise the objection that it is in fact possible to determine degrees of acceptability in (3b–d): in (3b), there is no agreement between the subject and the verb, in (3c), *dieser Aufsatz* 'this essay' has the wrong case in addition, and in (3d), *Aufsatz* 'essay' and *dieser* 'this' occur in the wrong order. Furthermore, the sentence in (4) violates grammatical rules of German, but is nevertheless still interpretable.

[3] According to Pullum (2013: Section 3.2), there seems to be a problem for model-theoretic formalizations of so-called *constraining equations*.

[4] The reader should take note here: there are differing views with regard to how generative-enumerative and MTS models are best formalized and not all of the assumptions discussed here are compatible with every formalism. The following sections mirror the important points in the general discussion.

(4) Studenten stürmen mit Flugblättern und Megafon die Mensa und rufen alle
students storm with flyers and megaphone the canteen and call all
auf zur Vollversammlung in der Glashalle *zum kommen. Vielen* bleibt das
up to plenary.meeting in the glass.hall to.the come many.DAT stays the
Essen im Mund stecken und *kommen sofort mit.*[5]
food in.the mouth stick and come immediately with
'Students stormed into the university canteen with flyers and a megaphone calling for everyone to come to a plenary meeting in the glass hall. For many, the food stuck in their throats and they immediately joined them.'

Chomsky (1975: Chapter 5; 1964b) tried to use a string distance function to determine the relative acceptability of utterances. This function compares the string of an ungrammatical expression with that of a grammatical expression and assigns an ungrammaticality score of 1, 2 or 3 according to certain criteria. This treatment is not adequate, however, as there are much more fine-grained differences in acceptability and the string distance function also makes incorrect predictions. For examples of this and technical problems with calculating the function, see Pullum & Scholz (2001: 29).

In model-theoretic approaches, grammar is understood as a system of well-formedness conditions. An expression becomes worse, the more well-formedness conditions it violates (Pullum & Scholz 2001: 26–27). In (3b), the person and number requirements of the lexical item for the verb *kennst* are violated. In addition, the case requirements for the object have not been fulfilled in (3c). There is a further violation of a linearization rule for the noun phrase in (3d).

Well-formedness conditions can be weighted in such a way as to explain why certain violations lead to more severe deviations than others. Furthermore, performance factors also play a role when judging sentences (for more on the distinction between performance and competence, see Chapter 15). As we will see in Chapter 15, constraint-based approaches work very well as performance-compatible grammar models. If we combine the relevant grammatical theory with performance models, we will arrive at explanations for graded acceptability differences owing to performance factors.

14.2 Utterance fragments

Pullum & Scholz (2001: Section 3.2) point out that generative-enumerative theories do not assign structure to fragments. For instance, neither the string *and of the* nor the string *the of and* would receive a structure since none of these sequences is well-formed as an utterance and they are therefore not elements of the set of sequences generated by the grammar. However, *and of the* can occur as part of the coordination of PPs in sentences such as (5) and would therefore have some structure in these cases, for example the one given in Figure 14.1 on the next page.

(5) That cat is afraid of the dog and of the parrot.

[5] Streikzeitung der Universität Bremen, 04.12.2003, p. 2. The emphasis is mine.

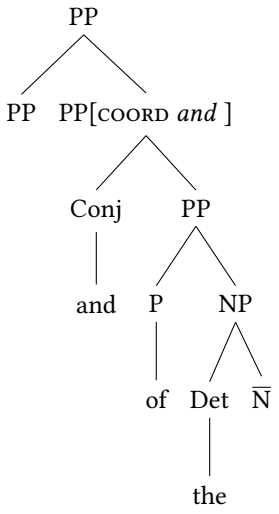


Figure 14.1: Structure of the fragment *and of the* following Pullum & Scholz (2001: 32)

As a result of the interaction of various constraints in a constraint-based grammar, it emerges that *the* is part of an NP and this NP is an argument of *of* and furthermore *and* is combined with the relevant *of*-PP. In symmetric coordination, the first conjunct has the same syntactic properties as the second, which is why the partial structure of *and of the* allows one to draw conclusions about the category of the conjunct despite it not being part of the string.

Ewan Klein noted that Categorial Grammar and Minimalist Grammars, which build up more complex expressions from simpler ones, can sometimes create these kind of fragments (Pullum 2013: 507). This is certainly the case for Categorial Grammars with composition rules, which allow one to combine any sequence of words to form a constituent. If one views derivations as logical proofs, as is common in some variants of Categorial Grammar, then the actual derivation is irrelevant. What matters is whether a proof can be found or not. However, if one is interested in the derived structures, then the argument brought forward by Pullum and Scholz is still valid. For some variants of Categorial Grammar that motivate the combination of constituents based on their prosodic and information-structural properties (Steedman 1991: Section 3), the problem persists since fragments have a structure independent of the structure of the entire utterance and independent of their information-structural properties within this complete structure. This structure of the fragment can be such that it is not possible to analyze it with type-raising rules and composition rules.

In any case, this argument holds for Minimalist theories since it is not possible to have a combination of *the* with a nominal constituent if this constituent was not already built up from lexical material by Merge.

14.3 A problem for model-theoretic approaches?

Ten Hacken (2007: 237–238) discusses the formal assumptions of HPSG. In HPSG, feature descriptions are used to describe feature structures. Feature structures must contain all the features belonging to a structure of a certain type. Additionally, the features have to have a maximally-specific value (see Section 6.7). Ten Hacken discusses gender properties of the English noun *cousin*. In English, gender is important in order to ensure the correct binding of pronouns (see page 276 for German):

(6) a. The man$_i$ sleeps. He$_i$ snores.
b. The woman$_i$ sleeps. He$_{*i}$ snores.

While *he* in (6a) can refer to *man*, *woman* is not a possible antecedent. Ten Hacken's problem is that *cousin* is not marked with respect to gender. Thus, it is possible to use it to refer to both male and female relatives. As was explained in the discussion of the case value of *Frau* 'woman' in Section 6.7, it is possible for a value in a description to remain unspecified. Thus, in the relevant feature structures, any appropriate and maximally specific value is possible. The case of *Frau* can therefore be nominative, genitive, dative or accusative in an actual feature structure. Similarly, there are two possible genders for *cousin* corresponding to the usages in (7).

(7) a. I have a cousin$_i$. He$_i$ is very smart.
b. I have a cousin$_i$. She$_i$ is very smart.

Ten Hacken refers to examples such as (8) and claims that these are problematic:

(8) a. Niels has two cousins.
b. How many cousins does Niels have?

In plural usage, it is not possible to assume that *cousins* is feminine or masculine since the set of relatives can contain either women or men. It is interesting to note that (9a) is possible in English, whereas German is forced to use (9b) to express the same meaning.

(9) a. Niels and Odette are cousins.
b. Niels und Odette sind Cousin und Cousine.
Niels and Odette are cousin.M and cousin.F

Ten Hacken concludes that the gender value has to remain unspecified and this shows, in his opinion, that model-theoretic analyses are unsuited to describing language.

If we consider what exactly ten Hacken noticed, then it becomes apparent how one can account for this in a model-theoretic approach: Ten Hacken claims that it does not make sense to specify a gender value for the plural form of *cousin*. In a model-theoretic approach, this can be captured in two ways. One can either assume that there are no gender features for referential indices in the plural, or that one can add a gender value that plural nouns can have.

The first approach is supported by the fact that there are no inflectional differences between the plural forms of pronouns with regard to gender. There is therefore no reason to distinguish genders in the plural.

(10) a. Niels and Odette are cousins. They are very smart.
b. The cousins/brothers/sisters are standing over there. They are very smart.

No distinctions are found in plural when it comes to nominal inflection (*brothers*, *sisters*, *books*). In German, this is different. There are differences with both nominal inflection and the reference of (some) noun phrases with regard to the sexus of the referent. Examples of this are the previously mentioned examples *Cousin* 'male cousin' and *Cousine* 'female cousin' as well as forms with the suffix *-in* as in *Kindergärtnerin* 'female nursery teacher'. However, gender is normally a grammatical notion that has nothing to do with sexus. An example is the neuter noun *Mitglied* 'member', which can refer to both female and male persons.

The question that one has to ask when discussing Ten Hacken's problem is the following: does gender play a role for pronominal binding in German? If this is not the case, then the gender feature is only relevant within the morphology component, and here the gender value is determined for each noun in the lexicon. For the binding of personal pronouns, there is no gender difference in German.

(11) Die Schwestern / Brüder / Vereinsmitglieder / Geschwister stehen dort. Sie
the sisters.F brothers.M club.members.N siblings stand there they
lächeln.
smile.
'The sisters/brothers/club members/siblings are standing there. They are smiling.'

Nevertheless, there are adverbials in German that agree in gender with the noun to which they refer (Höhle 1983: Chapter 6):

(12) a. Die Fenster wurden eins nach dem anderen geschlossen.
the windows.N were one.N after the other closed
'The windows were closed one after the other.'
b. Die Türen wurden eine nach der anderen geschlossen.
the doors.F were one.F after the other closed
'The doors were closed one after the other.'
c. Die Riegel wurden einer nach dem anderen zugeschoben.
the bolts.M were one.M after the other closed
'The bolts were closed one after the other.'

For animate nouns, it is possible to diverge from the gender of the noun in question and use a form of the adverbial that corresponds to the biological sex:

(13) a. Die Mitglieder des Politbüros wurden eines / einer nach dem anderen
the members.N of.the politburo were one.N one.M after the other
aus dem Saal getragen.
out.of the hall carried
'The members of the politburo were carried out of the hall one after another.'

b. Die Mitglieder des Frauentanzklubs verließen eines / eine nach dem
the members.N of.the women's.dance.club left one.N one.F after the.N
/ der anderen im Schutze der Dunkelheit den Keller.
the.F other in.the protection of.the dark the basement
'The members of the women's dance club left the basement one after another under cover of darkness.'

This deviation from gender in favor of sexus can also be seen with binding of personal and relative pronouns with nouns such as *Weib* 'woman' (pej.) and *Mädchen* 'girl':

(14) a. „Farbe bringt die meiste Knete!" verriet ein 14jähriges türkisches *Mädchen*,
color brings the most money revealed a 14-year.old Turkish girl.N
die die Mauerstückchen am Nachmittag am Checkpoint Charlie an
who.F the wall.pieces in.the afternoon at Checkpoint Charlie at
Japaner und US-Bürger verkauft.[6]
Japanese and US-citizens sells
' "Color gets the most money" said a 14-year old Turkish girl who sells pieces of the wall to Japanese and American citizens at Checkpoint Charlie.'

b. Es ist ein junges *Mädchen*, *die* auf der Suche nach CDs bei Bolzes
it is a young girl.N who.F on the search for CDs at Bolzes
reinschaut.[7]
stops.by
'It is a young girl looking for CDs that stops by Bolzes.'

For examples from Goethe, Kafka and Thomas Mann, see Müller (1999a: 417–418).

For inanimate nouns such as those in (12), agreement is obligatory. For the analysis of German, one therefore does in fact require a gender feature in the plural. In English, this is not the case since there are no parallel examples with pronouns inflecting for gender. One can therefore either assume that plural indices do not have a gender feature or that the gender value is *none*. In the latter case, the feature would have a value and hence fulfill the formal requirements. (15) shows the first solution: plural indices are modeled by feature structures of type *pl-ind* and the GENDER feature is just not appropriate for such objects.

(15) a. singular index:

$$\begin{bmatrix} \textsc{per} & per \\ \textsc{num} & sg \\ \textsc{gen} & gender \\ sg\text{-}ind & \end{bmatrix}$$

[6] taz, 14.06.1990, p. 6.
[7] taz, 13.03.1996, p. 11.

b. plural index:
$$\begin{bmatrix} \textsc{per} & per \\ \textsc{num} & pl \\ pl\text{-}ind & \end{bmatrix}$$

The second solution requires the type hierarchy in Figure 14.2 for the subtypes of *gender*. With such a type hierarchy *none* is a possible value of the GEN feature and no problem

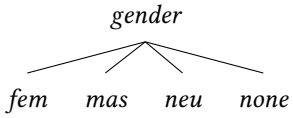


Figure 14.2: Type hierarchy for one of the solutions of ten Hacken's problem

will arise.

In general, it is clear that cases such as the one constructed by ten Hacken will never be a problem since there are either values that make sense, or there are contexts for which there is no value that makes sense and one therefore does not require the features.

So, while ten Hacken's problem is a non-issue, there are certain problems of a more technical nature. I have pointed out one such technical problem in Müller (1999a: Section 14.4). I show that spurious ambiguities arise for a particular analysis of verbal complexes in German when one resolves the values of a binary feature (FLIP). I also show how this problem can be avoided by the complicated stipulation of a value in certain contexts.