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Resolving unexpected case concord in German A–N–N compounds

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Abstract German A(djective)–N(oun)–N(oun) compounds exhibit unexpected internal inflection. The main purpose of this paper is to account for the interesting fact that the adjective in German A–N–N compounds shows several options to inflect for case. It can either agree with the first noun, with the second noun, or with neither of them. A production-task experiment confirms the existence of all three patterns. This is an important result since from a theoretical perspective, agreement of the adjective with the second noun is unexpected because it seems to violate standard locality conditons. Our claim is that the semantic relation in A–N–N compounds is always represented correctly. As a consequence, the different observed inflection strategies are not due to different structures (contra Lawrenz in Deutsch als Fremdsprache 32(1):39–42, 1995). We rather argue that the observed diversity is a consequence of the order of syntactic operations that apply: In German A–N–N compounds, adjectival inflection depends on (i) the order of the operations Agree and Insertion and on (ii) the interaction of these operations with the Strict Cycle Condition and the Minimal Link Condition.

Keywords Compounds · Case concord · Bracketing paradox · Rule ordering · German · Adjectival inflection

1 Introduction

A(djective)–N(oun)–N(oun) compounds are compounds that consist of an adjective and two nouns. The adjective modifies the first noun (N_1). This [A N_1]-part in turn

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modifies the second noun (N_2). This paper deals with A–N–N compounds in German where they are a productive word formation pattern. Examples are given in (1).

(1) Attested A–N–N compounds (taken from Lawrenz 1995: 39)[1]

a. das Verdrängt-e-Aggressionen-Syndrom
the suppressed-INFL-*aggression-syndrome*
'the suppressed agression syndrome'

b. der Grau-e-Schläfen-Effekt
the gray-INFL-*temples-effect*
'the gray (hair on the) temples effect'

c. das Heil-e-Bergwelt-Image
the idyllic-INFL-*mountain.landscape-image*
'the image of unspoilt mountains'

d. die Brav-e-Kind-Haltung
the honest-INFL-*child-attitude*
'the behaving like a good child'

e. Ober-e-Mittelklasse-Wagen
upper-INFL-*middle.sized.class-car*
'upper mid-range car'

f. Höher-e-Töchter-Manieren
higher-INFL-*daughters-manners*
'lady-like manners'

The interesting fact about German A–N–N compounds is that they show internal case concord. If case is assigned to an A–N–N compound, there are four different options for adjectival agreement. As can be seen in (2), where genitive case is assigned by a preposition, the adjective can agree with N_1 (see (2a)). N_1 always appears in the nominative, the genitive surfaces at N_2 (no overt genitive marker in the case of *Schwester*). The second option is agreement of the adjective with N_2 (see (2b)). Last but not least, the adjective may not show agreement with either of the two nouns. In this last case the adjective is either not marked at all (see (2c)) or it is marked with an *-e* (see (2d)). In the following examples, the four resulting endings on the adjective are shown in bold face.

(2) a. wegen d-er Rot-**es** Kreuz
because the-F.SG.GEN *red*-STRG.N.SG.NOM *cross*.N.SG.NOM
Schwester
nurse.F.SG.GEN
'because of the Red Cross nurse'[2] (agreement of A and N_1)

[1] All examples without reference are our own. The following abbreviations are used: DAT – dative, F – feminine, GEN – genitive, INFL – inflection, M – masculine, N – neuter, NOM – nominative, PL – plural, SG – singular, STRG – strong inflection, WK – weak inflection.

[2] In order to avoid confusion with bound morphemes, in all upcoming examples hyphens between the parts of A–N–N compounds are omitted.

b. wegen d-er Rot-**en** Kreuz Schwester
because the-F.SG.GEN *red*-WK.F.SG.GEN *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse' (agreement of A and N_2)

c. wegen d-er Rot-**Ø** Kreuz Schwester
because.of the-F.SG.GEN *red* *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse' (no agreement, Ø-marking)

d. wegen d-er Rot-**e** Kreuz Schwester
because.of the-F.SG.GEN *red*-DEFAULT *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse' (no agreement, *e*-marker)

Assuming that the semantically motivated structure $[_N\ [_{NP}\ A\ N_1]\ N_2]$ underlies A–N–N compounds (see Sect. 2.3 for justification), the following two questions arise:

(3) a. Why does the adjective not always agree with N_1?
According to the *Earliness Requirement* (Pesetsky 1989) the operations *Agree* and *Merge* must apply as soon as their context is met. In the case of A–N–N compounds, this requirement seems to be violated: as soon as A and N_1 are merged, one would expect A to agree with N_1 immediately.

b. What triggers the adjective to agree with N_2?
Agreement of A and N_2 seems to violate the *Minimal Link Condition* (Chomsky 1995, 2000): if there is any interaction of A with one of the nouns, it follows under the assumption of bottom-up structure building that one would expect A to agree with the closer N_1.

The aim of this article is to model the four different concord strategies within A–N–N compounds theoretically. It is the primary goal to provide an account for the unexpected case concord with N_2 which seems to violate the Earliness Requirement and the Minimal Link Condition. Our analysis is based on the model of syntax-morphology interactions proposed by Ackema and Neeleman (2004). We claim that in the case of German A–N–N compounds, adjectival inflection is not due to different structures (see Lawrenz 1995). Instead, we propose that all A–N–N compounds have the same structure and that (i) the different observed concord patterns are due to a conflict between the operations *Agree* and *Insertion* and (ii) that they furthermore depend on the interaction of these operations with the Strict Cycle Condition and the Minimal Link Condition.

The article is organized as follows: In Sect. 2, we discuss the general properties of A–N–N compounds. We will present evidence in favour of the compound status of the A–N–N construction and provide evidence why the structure $[_N\ [_{NP}\ A\ N_1]\ N_2]$ is the correct one. In Sect. 3, we will present the first production task experiment to our knowledge concerning the phenomenon of internal case concord in German A–N–N compounds. Our study confirms the existence of all four strategies and reveals factors that influence the choice of strategy. In Sect. 4, we briefly introduce the analysis of unexpected definiteness agreement in Dutch A–N–N compounds proposed by De Belder and van Koppen (2014). After discussing why this analysis cannot account for case concord in German A–N–N compounds, we will present a proposal which derives the correct empirical results for German. In Sect. 5, we discuss implications and predictions of our theory. Section 6 concludes.

2 Properties of German A–N–N compounds

In this section, first we will discuss the four different strategies of adjectival inflection in detail. Secondly, evidence will be presented in favour of the compound status of the A–N–N construction and the internal structure of A–N–N compounds will be discussed.

2.1 Adjectival inflection

In this section we will discuss the four different patterns of adjectival inflection. In German the attributive adjective generally agrees with the following noun in case, number and gender. In the German DP we get *monoinflection* (see Helbig and Buscha 2001: 274). This means that gender, number and case are only expressed once, either on the determiner or on the adjective. If the adjective is preceded by a determiner that does not indicate these categories, e.g., the indefinite article *ein* 'a' (see (4a)) or the possessor *sein* 'his', the so called strong paradigm is used (see Table 1). The same holds if there is no determiner present (see (4b)). If the adjective is preceded by a determiner which *does* indicate the categories number, gender and case, e.g., the definite article *d-er/d-ie/d-as* 'the' (see (4c)) or the demonstratives *dies-e/dies-er/dies-es* 'this', the weak paradigm is used (see Table 2).

(4) a. **ein** brav-**es** Mädchen
a good-STRG.N.SG.NOM *girl*.N.SG.NOM
'a good girl'

b. **Ø** brav-**es** Mädchen
good-STRG.N.SG.NOM *girl*.N.SG.NOM
'good girl'

c. **d-as** brav-**e** Mädchen
the-N.SG.NOM *good*-WK.N.SG.NOM *girl*.N.SG.NOM
'the good girl'

Table 1 Strong adjectival inflection paradigm

	masc	fem	neut
Nom	-er	-e	-es
Acc	-en	-e	-es
Dat	-em	-er	-em
Gen	-en	-er	-en

Table 2 Weak adjectival inflection paradigm

	masc	fem	neut
Nom	-e	-e	-e
Acc	-en	-e	-e
Dat	-en	-en	-en
Gen	-en	-en	-en

If case is assigned to a DP, the determiner, the adjective and the noun are all case marked (concord). This is illustrated in (5). In (5a) the preposition assigns genitive case, which is overtly marked on the determiner, on the adjective and on the noun (on the noun the *-s* indicates genitive). In (5b) the preposition assigns dative case, which is again marked on the determiner and the adjective. In this example, the noun obligatorily lacks overt marking for dative case, as most of the German nouns do.

(5) a. wegen d**-es** brav**-en** Mädchen**-s**
because.of the-N.SG.GEN *good*-WK.N.SG.GEN *girl*-N.SG.GEN
'because of the good girl'
b. mit d**-em** brav**-en** **Mädchen**
with the-N.SG.DAT *good*-WK.N.SG.DAT *girl*.N.SG.DAT
'with the good girl'

Different adjectival inflection in German A–N–N compounds was first discussed by Lawrenz (1995). In this paper, we will focus on case concord within A–N–N compounds. In (6b) and (7b), the first strategy of case concord is presented: agreement of the adjective with the first noun, which is nominative in the examples (agreeing elements are shown in bold face).

(6) a. **blond-e** **Frau**
blonde-STRG.F.SG.NOM *woman*.F.SG.NOM
'blonde woman'
b. wegen *d-es* **Blond-e** **Frau**
because the-M.SG.GEN *blonde*-STRG.F.SG.NOM *woman*.F.SG.NOM
Trick-s
trick-M.SG.GEN
'because of the blonde woman trick'

(7) a. **traurig-es** **Kind**
sad-STRG.N.SG.NOM *child*.N.SG.NOM
'sad child'
b. mit *d-er* **Traurig-es** **Kind** *Nummer*
with the-F.SG.DAT *sad*-STRG.N.SG.NOM *child*.N.SG.NOM *number*.F.SG.DAT
'with the attitude of a sad child'

(6a) and (7a) again show the strong adjectival inflection in the context of a bare noun. The adjective in (6a) shows the marker *-e* for a feminine noun and the one in (7a) the marker *-es* for a neuter noun (see the paradigm in Table 1). In (6b) and (7b) an A–N–N compound is assigned case by a preposition. In (6b), we see that the determiner and the second noun receive genitive case by this preposition (italicized). The adjective, on the other hand, shows the marker *-e*, which indicates that the adjective does not bear genitive case. If there was genitive concord between the adjective and the feminine N_1, the adjective would either be marked with *-er* (strong) or with *-en* (weak).

How can we make sure that the adjective does not agree with N_2? Such a derivation can be excluded by looking at example (7b), where N_1 is neuter and N_2 is feminine. In this case, on the adjective we get *-es*, which only appears in the strong inflection paradigm for neuter. Due to syncretism, the *-es* marker could either indicate nominative

or accusative case (see Table 1). Since there is no element present in the phrase which could assign accusative case, there is no obvious reason to assume a marker indicating accusative. Obviously, the adjective and N_1 bear nominative case, which is the unmarked case in German (see Bhatt 1990).

Summarizing, we have seen (i) that the adjective agrees with N_1 (as shown in (6) and (7)), (ii) that both adjective and N_1 are nominative case marked and (iii) that the strong adjectival inflection paradigm is used. Furthermore, the determiner agrees with N_2. Both determiner and N_2 receive case from an external head (the preposition).

In (8b) and (9b) we see the second pattern of case concord in A–N–N compounds: agreement of the adjective with the second noun.

(8) a. wegen **d-er** **blond-en** **Frau**
because.of the-F.SG.GEN *blonde*-WK.F.SG.GEN *woman.*F.SG.GEN
'because of the blonde woman'

b. wegen **d-es** **Blond-en** Frau
because the-M.SG.GEN *blonde*-WK.M.SG.GEN *woman.*F.SG.NOM
Trick-s
trick-M.SG.GEN
'because of the blonde woman trick'

(9) a. mit **d-em** **traurig-en** **Kind**
with the-N.SG.DAT *sad*-WK.N.SG.DAT *child.*N.SG.DAT
'with the sad child'

b. mit **d-er** **Traurig-en** Kind **Nummer**
with the-F.SG.DAT *sad*-WK.F.SG.DAT *child.*N.SG.NOM *number.*F.SG.DAT
'with the attitude of a sad child'

(8a) and (9a) illustrate case assignment to a DP with only one noun. Determiner, adjective and noun are all assigned case by the preposition (concord). In (8a) it is genitive case, in (9a) dative case. Since there is a self-inflecting determiner present, the adjective is marked with a marker of the weak inflectional paradigm in both examples, which is *-en* for genitive as well as for dative case. In (8b) and (9b), case is assigned to an A–N–N compound. In these examples we see that the adjective is also marked with *-en*. As can be seen from the two paradigms given in Tables 1 and 2, there is syncretism again. So how can we know that it is the weak inflectional paradigm here and not the strong one as in (6b) and (7b)? In the strong adjectival paradigm *-en* is used for genitive agreement with neuter nouns. In (8b) *-en* is present, but no neuter noun. Furthermore, *-en* is used for accusative and genitive agreement with masculine nouns. Accusative agreement can be excluded, because the prepositions in (8b) and (9b) assign dative/genitive case, not accusative. Still, the possibility remains that *-en* indicates strong genitive agreement with a masculine noun. If this assumption were correct, the adjective in (8b) would have to agree with N_2, because this is the only masculine noun in this example. If the adjective were marked with a marker of the strong paradigm, it should show the appropriate dative marker when N_2 is marked for dative case. The strong adjectival dative marker for masculines is *-em*. As shown in (10) this is not grammatical.

(10) mit **d-em** **Blond-(*em)** Frau **Trick**
with the-M.SG.DAT *blonde*-STRG.M.SG.DAT *woman*.F.SG.NOM *trick*.M.SG.DAT
'with the blonde woman trick'

So we can conclude that the *-en* is taken from the weak inflectional paradigm, indicating dative/genitive case.

But how can we know that the determiner and the adjective do definitely agree with N_2 rather than with N_1? If the preposition assigns genitive case, we see the genitive case marker *-(e)s* on N_2, as in (8b). If N_1 also got genitive case, we would expect to see the genitive marker *-(e)s* on N_1 as well. However, this is always ungrammatical. This observation goes back to Lawrenz (1995) and is illustrated in (11), (12) and (13). The a-examples show the obligatory genitive markers in DPs with only one noun. The b-examples show the ungrammatical genitive markers on N_1 in A–N–N compounds.

(11) a. wegen **d-es** **traurig-en** **Kind-(e)s**
because.of the-N.SG.GEN *sad*-WK.N.SG.GEN *child*-N.SG.GEN
'because of the sad child'

b. wegen **d-er** **Traurig-en** **Kind(*-(e)s)**
because.of the-F.SG.GEN *sad*-WK.F.SG.GEN *child*-N.SG.GEN
Nummer
number.F.SG- GEN
'because of the attitude of a sad child'

(12) a. aufgrund **d-es** **brav-en** **Mädchen-s**
because.of the-N.SG.GEN *good*-WK.N.SG.GEN *girl*-N.SG.GEN
'because of the good girl'

b. aufgrund **d-es** **Brav-en** **Mädchen(*-s)**
because.of the-N.SG.GEN *good*-WK.N.SG.GEN *girl*-N.SG.GEN
Images-s
image-N.SG- GEN
'because of her good girl image'

(13) a. wegen **d-es** **Rot-en** **Kreuz-es**
because.of the-N.SG.GEN *red*-WK.N.SG.GEN *cross*-N.SG.GEN
'because of the Red Cross'

b. wegen **d-er** **Rot-en** **Kreuz(*-es)**
because.of the-F.SG.GEN *red*-WK.F.SG.GEN *cross*-N.SG.GEN
Schwester
nurse.F.SG.GEN
'because of the Red Cross nurse'

This means that the adjective agrees with N_2 and that N_1 always appears in the unmarked nominative case.

Summarizing, we have shown that there is a second pattern of case concord in German A–N–N compounds: (i) the adjective agrees in case with the second noun, (ii) the weak adjectival inflection paradigm holds, and (iii) N_1 is marked with the unmarked nominative case.

Now, we will turn to the third strategy of case concord in A–N–N compounds. It is also possible that the adjective in an A–N–N compound does not show any inflectional marker. Examples are given in (14).

(14) a. wegen *d-er* Rot-**Ø** Kreuz *Schwester*
because.of the-F.SG.GEN *red* *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse'

b. neben *d-er* Schön-**Ø** Wetter *Wolke*
next.to the-F.SG.DAT *nice* *weather*.N.SG.NOM *cloud*.F.SG.DAT
'next to the nice weather cloud'

There is a less productive, but also grammatical, fourth pattern: the adjective does not agree with any of the nouns, but it is marked with an *-e*, as can be seen in (15).

(15) a. wegen *d-er* Rot-**e** Kreuz *Schwester*
because.of the-F.SG.GEN *red*-INFL *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse'

b. wegen *d-es* Wütend-**e** Kind *Geschrei-s*
because.of the-N.SG.GEN *angry*-INFL *child*.N.SG.NOM *yelling*-N.SG.GEN
'because of the yelling of an angry child'

If the adjective in (15a) and (15b) agreed with N_1, we would expect the strong marker for neuters, which is *-es* (Pattern 1). Since there are syncretic forms, there is one candidate left for the *-e* we see in (15). N_1 in (15a) and (15b) is neuter and the weak marker for a nominative marked neuter is *-e* as well. Nevertheless, it can be shown that this is not the marker we see in (15): the weak paradigm is only used when there is agreement with an inflecting determiner. Both determiners in (15a) and (15b) inflect for genitive case, which always triggers weak genitive inflection on the adjective (*-en*, see (16a) and (16b)). As shown in (16c) and (16d), it is not possible to have a weak nominative *-e* after a determiner that inflects for genitive.

(16) a. wegen d-es Rot-**en** Kreuz-es
because.of the-N.SG.GEN *red*-WK.N.SG.GEN *cross*-N.SG.GEN
'because of the Red Cross'

b. wegen d-es Wütend-**en** Kind-(e)s
because.of the-N.SG.GEN *angry*-WK.N.SG.GEN *child*-N.SG.GEN
'because of the angry child'

c. wegen d-es Rot-***e** Kreuz-es
because.of the-N.SG.GEN *red*-WK.N.SG.NOM *cross*-N.SG.GEN
'because of the Red Cross'

d. wegen d-es Wütend-***e** Kind-(e)s
because.of the-N.SG.GEN *angry*-WK.N.SG.NOM *child*-N.SG.GEN
'because of the angry child'

If there was agreement of the adjectives with the genitive marked N_2 in (15), the weak marker *-en* for genitive should appear (Pattern 2). In (15b), N_2 is neuter and overtly genitive marked. From this example it follows that the marker on the adjective

cannot be the strong genitive marker for a neuter, since this would be *-en* as well. Concluding, we have shown that there is a fourth pattern of case concord in German A–N–N compounds: (i) the adjective neither agrees with N_1 nor with N_2 and (ii) it is marked with an *-e* marker.[3] In (17), we sum up all patterns of case concord that appear in German A–N–N compounds:

(17) *Summary: Case concord in German A–N–N compounds*

a. *Strategy 1:*
The adjective agrees with N_1. Both appear in nominative case. The marker on the adjective belongs to the strong inflectional paradigm. The determiner agrees with N_2, both receive case from an external head.

b. *Strategy 2:*
The adjective agrees with N_2. The marker on the adjective belongs to the weak inflectional paradigm. The determiner also agrees with the adjective and N_2. All three receive case from an external head. N_1 bears the unmarked nominative case.

c. *Strategy 3:*
The adjective does not agree with any of the nouns. It is not marked at all.

d. *Strategy 4:*
The adjective does not agree with any of the nouns. It is marked with an *-e*.

2.2 Evidence for compound status

In the following section, we will discuss the compound status of the A–N–N construction. Normally, the first part of a German compound never shows internal inflection (see, e.g., Sternefeld 2006: 95) as is exemplified in (18). Genitive inflection obligatorily appears on the second part of the compound.

(18) a. d-es [Haus] [eingang-s]
the-M.GEN *house*.N *entrance*-M.GEN
'the entrance of a house'

b. d-es [Haus-*es] [eingang]
the-M.GEN *house*-N.GEN *entrance*.M
'the entrance of a house'

c. d-es [Haus-*es] [eingang-s]
the-M.GEN *house*-N.GEN *entrance*-M.GEN
'the entrance of a house'

As we have seen, this generalization does not hold for A–N–N compounds since the adjective does (or at least can) inflect. This is why the following question arises: should the A–N–N construction be classified as a compound at all? We will present typical properties of compounds and show that the A–N–N construction exhibits the same properties.

[3] In the paradigms in Tables 1 and 2 it can be seen that *-e* is quite a common marker in the German adjectival inflectional paradigm. Note that the contexts where *-e* appears do not form a natural class.

One property that regular N+N-compounds share with A–N–N compounds is headedness. The right-hand noun in regular German N+N-compounds is always the head, which means that it determines the properties of the whole compound (*Right Hand Head Rule*, see, e.g., Sternefeld 2006: 7). In A–N_1–N_2-compounds N_2 is also the head. Example (19) shows that when N_2 is neuter, the whole construction can only be neuter.

(19) a. die Laune
the.F *mood*.F
'the mood'
b. das Wetter
the.N *weather*.N
'the weather'
c. das/*die Super Laune Wetter
the.N/**the*.F *super mood*.F *weather*.N
'weather to be in good spirits'

Secondly, parts of compounds normally are opaque for anaphoric processes (so-called *anaphoric islands*, see Postal 1969 and Sternefeld 2006: 330 for German). (20a) shows that N_1 cannot be referred to in a regular N_1+N_2-compound. The neuter pronoun *es* can only refer to the second noun *Tier*, but never to the first one *Haus*. Since *Haus* and *Tier* are both neuter, the lacking reference is not due to a gender mismatch. The same property holds for A–N–N compounds. As can be seen in (20b), the plural pronoun *sie* can only refer to the second noun *Tricks*, but never to the first noun *Frauen* (both are plural).[4]

(20) a. Ich habe ein $[_N[_N$ Haus$_i][_N$tier$_j]]$. Ich mag es$_{j/*i}$ sehr.
I have a house.animal I like it very
'I have a pet. I like it a lot.'

b. [[Blonde-Frauen]$_i$–Tricks$_j$] mag ich nicht. Aber ich kenne sie$_{j/*i}$.
Blonde-women-tricks like I not But I know them
'I don't like blonde women tricks. But I know them.'

Furthermore, in a regular N_1+N_2-compound N_1 is opaque for syntactic processes like movement (Sternefeld 2006: 330). This is shown in (21b), where we try to extract N_1 from an N_1+N_2-compound.

(21) a. Ich habe viele $[_N[_N$ Haus$][_N$tiere]].
I have many house.animals
'I have lots of pets.'

b. *$[_N$ Tiere$]_1$ habe ich viele $[_N[_N$ Haus $][_N$ $t_1]]$.
animals have I many house
'intended: As for pets, I have a lot.'

[4] As a reviewer pointed out, opacity for anaphoric reference holds for most compounds, but note that on the one hand there are indeed counterexamples, as Lieber (1992) shows, and that on the other hand there are also bare NPs that cannot be antecedents for anaphoric reference even though they are phrasal. This is why we admit that the anaphoric reference test indeed points in a direction in favour of the compound status of A–N–Ns, but that it is definitely not a sufficiently satisfying one.

In contrast, extraction from a phrase, for example from an NP like in (22), is grammatical.

(22) a. Ich kenne viele $[_{NP}$ blonde Frauen].
I know many blonde women
'I know many blonde women.'

b. [Frauen]$_1$ kenne ich viele $[_{NP}$ blonde t_1].
women know I many blonde
'As for women, I know a lot of blonde ones.'

If A–N–N compounds were phrases, we might expect extraction to be possible. (23) provides evidence that A–N–N compounds behave like compounds and not like phrases since extraction is not possible.

(23) a. Ich kenne viele [Blonde-Frau(en)-Tricks].
I know many blonde-women-tricks
'I know many blonde women tricks.'

b. *[Tricks]$_1$ kenne ich viele [Blonde-Frau(en)-t_1].
tricks know I many blonde-women
'intended: Tricks, used by blonde women, I know many.'

A further property that A–N–N compounds share with regular compounds is that they can be modified by further syntactic material, e.g., adjectives.

(24) a. ein schöner [Frauenschuh]
a beautiful women.shoe
'a beautiful lady's shoe'
b. ein erfolgreicher [Blonde-Frau-Trick]
a successful blonde-woman-trick
'a successful blonde woman trick'

However, A–N–N compounds have a different stress pattern than regular compounds. The left-hand members of phrasal compounds display their normal stress pattern (Wiese 1996). For a detailed discussion of the stress pattern of A–N–N compounds see Sect. 2.3.1.

Since it has been argued that there is a continuum between compound and phrase, phrasal compounds might fit in that continuum in the sense that they unify properties of both. Concluding, A–N–N compounds, as well as other phrasal compounds, exhibit typical properties of compounds (right-headedness, the status of anaphoric islands, opacity for movement operations and the possibility of being modified), while maintaining the properties of their phrasal left hand part (like stress). The left hand part allows for quite diverse structures (see, e.g., Meibauer 2007; Neef 2009), e.g., for PPs (*die [[$_{PP}$Vor-Premieren]-Fahrt]* 'the before-première trip)', VPs (*die [[$_{VP}$Länger-leben]-Diät]* 'the longer-live diet') or whole sentences (*der [[$_{CP}$Muss-das-denn-sein]-Blick] 'the must-that-be gaze'*).

2.3 Internal structure of A–N–N compounds

If an A, an N and another N are to be merged, there are several potential possibilities for doing so. The question is, which two of the three elements are combined first. Does A combine with N_1 first and in a second step with N_2, as illustrated in (25a)? Or do the two Ns combine into a complex noun first which is modified by an adjective in a second step (see (25b))? The third possibility equals the possibility in (25a) with the difference that the first constituent A+N_1 does not result in an NP, but in a complex A+N head (see (25c)).

(25) a. $[_N\ [_{NP} \text{A}\ \text{N}_1]\ \text{N}_2]$
b. $[_{NP}\ [_{NP}\ \text{A}\ [_N \text{N}_1\ \text{N}_2]]]$
c. $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$

In the following subsections we will briefly discuss all potential structures and present evidence why we assume the structure given in (25a) to be the correct one.

2.3.1 Evidence against [$_N$ [$_N$A N_1] N_2]

The structure $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$ is a purely morphological one in the sense that merger of two categories does not result in a phrase, but in a complex word. The result of merging A and N_1 is a complex head N.[5] This kind of A–N-compounding is a productive word formation process in German (*Blau-meise* 'lit: blue tit, nun', *Schwarz-arbeit* 'lit: black work, illegal employment', *Schnell-straße* 'lit: fast street, highway'). In the second step, this complex N combines with N_2, as is the case for regular N+N-compounding. As is usual for German compounds, there is no internal inflection. In German, $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$-compounding is also a productive process. Examples are given in (26).

(26) a. $[_N\ [_N\ [_A$ Blau] $[_N$ meise-n]] $[_N$ nest]]
blue *tit*-LINK *nest*
'nun nest'
b. $[_N\ [_N\ [_A$ Schwarz] $[_N$ arbeit-s]] $[_N$ skandal]]
black *work*-LINK *scandal*
'illegal employment scandal'
c. $[_N\ [_N\ [_A$ Schnell] $[_N$ straße-n]] $[_N$ bau]]
fast *street*-LINK *building*
'highway building'

Strategies 1 and 2, where the adjective shows overt inflection, obviously cannot be cases of regular $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$-compounding where the adjective never inflects. Strategy 3, however, seems to show exactly this pattern. Examples are repeated in (27).

[5] We follow Ackema and Neeleman (2004) assuming morphology to be an independent generative module. For a more detailed introduction of the underlying architecture see Sect. 4.2.

(27) a. [$_N$ [$_N$ [$_A$ Rot] [$_N$ kreuz]] [$_N$ schwester]]
red cross nurse
'Red Cross Nurse'
b. [$_N$ [$_N$ [$_A$ Schön] [$_N$ wetter]] [$_N$ wolke]]
nice weather cloud
'nice weather cloud'

Although A–N–N compounds which show Strategy 3 overtly seem to pattern like the compounds presented in (26), their stress pattern provides evidence that they are in fact different. In German N+N compounds, stress is always on the left hand part (see (28)).

(28) *Compound Stress Rule* (see Chomsky and Halle 1968 and, e.g., Sternefeld 2006: 10 for German, our translation)
Within a pair of sister nodes [$_N$ A B] B bears stress if B is a branching node (means that A bears stress, if B is not branching).

In (29) the stress pattern of N+N compounds is illustrated. In the following examples, stress is indicated by capital letters. The same stress pattern holds for German A+N-compounds where A never inflects, as shown in (30).

(29) a. [$_N$ HAUS] [$_N$ tür]
house door
'front door'
b. [$_N$ AUTO] [$_N$ reifen]
car tire
'car tire'
c. [$_N$ FUß] [$_N$ ball]
foot ball
'football'

(30) a. [$_A$ BLAU] [$_N$ meise]
blue tit
'nun'
b. [$_A$ SCHWARZ] [$_N$ arbeit]
black work
'illegal employment'
c. [$_A$ SCHNELL] [$_N$ straße]
fast street
'highway'

If the [A–N]-compounds in (30) are combined with an additional noun, they keep their stress on the first syllable.

(31) a. [$_N$ [$_N$ [$_A$ BLAU] [$_N$ meise-n]] [$_N$ nest]]
blue tit-LINK *nest*
'nun nest'
b. [$_N$ [$_N$ [$_A$ SCHWARZ] [$_N$ arbeit-s]] [$_N$ skandal]]
black work-LINK *scandal*
'illegal employment scandal'

c. [$_N$ [$_N$ [$_A$ SCHNELL] [$_N$ straße-n]] [$_N$ bau]]
fast *street*-LINK *building*
'highway building'

This is different from the non-inflecting A–N–N-compounds presented in (27). In their case, the stress of the [A–N]-component is always on the first noun (see (32)) and not on the adjective as in (31).

(32) a. [$_N$ [[$_A$ Rot] [$_N$ KREUZ]] [$_N$ schwester]]
red *cross* *nurse*
'Red Cross Nurse'
b. [$_N$ [[$_A$ Schön] [$_N$ WETTER]] [$_N$ wolke]]
nice *weather* *cloud*
'nice weather cloud'
c. [$_N$ [[$_A$ Alt] [$_N$ HERREN]] [$_N$ verein]]
old *gentlemen* *club*
'old gentlemen's club'

The *Compound Stress Rule* applies recursively to complex compounds. In the cases shown in (32), it predicts stress on the first syllable: since *nurse* is not branching, stress is predicted at the left hand part [*red cross*]. Since *cross* is not branching either, stress is predicted on *red*. However, the rule makes the wrong prediction. The stress on the compounds in (32) is always on the first noun. The fact that the Compound Stress Rule does not hold for the cases in (32) is evidence that A–N–N compounds are not regularly built [[A–N]–N]-compounds where the [A–N]-constituent is a noun itself. The [A–N]-constituent in A–N–N compounds rather shows the stress pattern of phrases (see (33)). This generalization holds independently from the concord pattern (see (34)).

(33) a. [$_{NP}$ [$_A$ Rot-es] [$_N$ KREUZ]]
red-STRG.N.SG.NOM *cross*
'Red Cross '
b. [$_{NP}$ [$_A$ schön-es] [$_N$ WETTER]]
nice-STRG.N.SG.NOM *weather*
'nice weather'
c. [$_{NP}$ [$_A$ alt-e] [$_N$ HERREN]]
old-STRG.M.PL.NOM *gentlemen*
'old gentlemen'

(34) a. wegen d-er Rot-es KREUZ
because the-F.SG.GEN *red*-STRG.N.SG.NOM *cross*.N.SG.NOM
Schwester
nurse.F.SG.GEN
'because of the Red Cross nurse' (agreement of A and N_1)

b. wegen d-er Rot-en KREUZ Schwester
because the-F.SG.GEN *red*-WK.F.SG.GEN *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross nurse' (agreement of A and N_2)

c. wegen d-er Rot-Ø KREUZ Schwester
because.of the-F.SG.GEN *red* *cross.*N.SG.NOM *nurse.*F.SG.GEN
'because of the Red Cross nurse' (no agreement, Ø-marking)

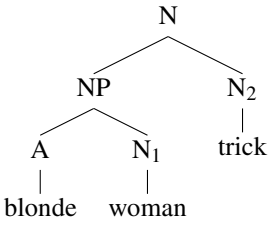
d. wegen d-er Rot-e KREUZ Schwester
because.of the-F.SG.GEN *red*-DEFAULT *cross.*N.SG.NOM *nurse.*F.SG.GEN
'because of the Red Cross nurse' (no agreement, *e*-marker)

Concluding, we have shown that regular $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$ compounds differ from phrasal A–N–N compounds with respect to their stress pattern. The stress pattern of the [A–N]-constituent in A–N–N compounds behaves like that of phrases in contrast to the typical compound stress pattern of regular $[_N\ [_N \text{A}\ \text{N}_1]\ \text{N}_2]$ compounds.

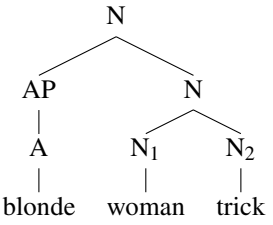
2.3.2 Evidence against $[_{NP}\ [_{NP}\ A\ [_N N_1\ N_2]]]$

The main problem with the structure $[_{NP}\ \text{A}\ [_N \text{N}_1 \text{N}_2]]$ is that it does not reflect the correct semantic interpretation of an A–N–N compound. Independent of the concord pattern, semantically the adjective always modifies N_1. Syntactically however, Strategy 2 suggests that the adjective modifies N_2. (35) and (36) illustrate the apparent bracketing paradox.

(35) Apparent semantic structure



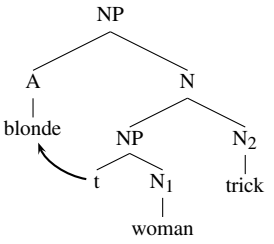
(36) Apparent syntactic structure



If we do not want to ignore the incorrect semantic interpretation that inevitably follows from (36), the structure given in (35) has to be the underlying one.[6]

[6] Under the assumption that the structure in (35) is the underlying one, one could try to derive structure (36) from this underlying structure. Consequently, one would have to assume movement of A above N_2 (see (i)).

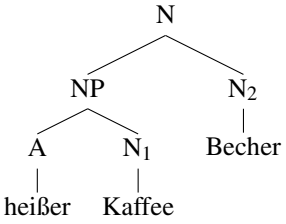
(i)



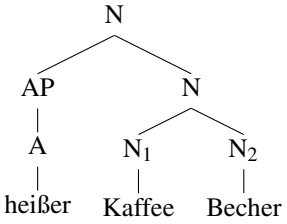
The problem with this analysis of bracketing paradoxes is that there is no independent evidence why A should move into a higher position.

Further support for this view comes from ambiguous A–N–N compounds, where the two different structures lead to two completely different interpretations: in (37) *Heißer-Kaffee-Becher* 'a cup for hot coffee' it is the coffee which is hot (intended meaning). In (38) *heißer Kaffeebecher* 'a hot cup of coffee' it is the cup which is hot. This example illustrates that the alternative structure in (38) exists, but that this structure belongs to a different linguistic expression which has a completely different meaning.

(37)



(38)



Further evidence against the structure $[_{NP}$ A $[_{N}$N$_1$ N$_2$]] comes from tests on semantic selectional restrictions.

Considering the bracketing paradox *beautiful dancer*, both meanings are semantically well-formed: it is plausible to have a 'beautiful person who dances' ([A [N er]]) or a 'person who dances beautifully' [[A N] er]. The same holds for the example we gave in (37) and (38), *Heißer Kaffee Becher*, 'a cup for hot coffee' or 'a cup of coffee which is hot'. But compare the examples *blonde dancer* and *Blonde Frau Trick* 'blonde woman trick'. Nobody would consider *blonde dancer* to be a bracketing paradox, since [[blonde dance] -er] is not well formed. Obviously, this is due to semantic restrictions: *dance* simply cannot select for *blonde*. The same holds for *Blonde Frau Trick* 'blonde woman trick'. In terms of semantic restrictions *trick* cannot select for *blonde*.

From a syntactic point of view, it turns out that syntactic tests like ellipsis do not shed light satisfactorily on the question of what the correct internal structure of A–N–N compounds is. We briefly discuss why we nonetheless want to argue for the structure $[_{N}$ $[_{NP}$A N$_1$] N$_2$].

In principle, we see three potential possibilities for dealing with the problem. The first solution would be to assume that there are A–N–N compounds which have $[_{N}$ $[_{NP}$A N$_1$] N$_2$] and others which have $[_{NP}$ A $[_{N}$N$_1$ N$_2$]] as underlying structure (which was proposed by Lawrenz 1995). Given that our experimental results show that one and the same A–N–N compound can go along with four different concord patterns (see Sect. 3.2), we find it rather unattractive to assume four different possible structures for one single compound which always has the same semantic interpretation, independently from the concord pattern.

The second path which could be pursued would be to say: the underlying structure is always $[_{NP}$ A $[_{N}$N$_1$ N$_2$]]. We want to point out some consequences of such an analysis. From the experiment described in the next section, we will clearly see that the adjective can either interact with the first noun or with the second noun. The question is: if N+N

formed a compound first, how can it be possible that the adjective can target N_1 in terms of agreement? Normally, the non-head of an N+N compound is not accessible for syntactic operations (*Lexical Integrity Hypothesis*). However, agreement with N_1 was the most frequent strategy used in the experiment. Even if we came up with a proposal that allowed agreement in that configuration, we would have to restrict that mechanism to specific compounds. In other words, we would have to explain why this kind of agreement is not possible with regular N+N compounds (compare: *die schön-e Haustür*) 'the beautiful front door', where *beautiful* refers to *door* but not **die schön-es Haustür* where *beautiful* refers to the house). Additionally, one would have to come up with an explanation for how the correct semantic meaning is computed from this structure.

The third possibility is to assume that all A–N–N compounds have $[_N\ [_{NP}$A $N_1]$ $N_2]$ as underlying structure. As already discussed, under this assumption the correct semantic interpretation comes for free. But we have a similar problem: there is an unexpected concord pattern (agreement of A with N_2).[7] However, we found it much more plausible to come up with a solution for this problem, namely that it is due to the timing and the order in which competing syntactic operations and constraints apply (see Sect. 4). Put simply, the appearance of the unexpected agreement pattern can be attributed to a violation of the Minimal Link Condition, which has been proposed in optimality theoretic terms for various other phenomena (see Broekhuis and Woolford 2013; Legendre et al. 1998; Hale and Legendre 2004; Vogel 2004).

Summarizing, we have argued from a semantic point of view and from a conceptual one why we think it is plausible to assume that all A–N–N compounds have the internal structure $[_N\ [_{NP}$A $N_1]$ $N_2]$. Our claim is that the semantic relation in all A–N–N compounds is always represented correctly. What "goes somehow wrong" in the case of Strategy 2, is syntactic agreement.

3 Experiment

The main aim of our experiment was to answer the following questions: (i) Do all four strategies really exist? An informal survey showed that native speakers' judgments vary greatly. Especially in the case of Strategy 2 there were doubts as to whether this pattern is really used. (ii) Which factor(s) have an influence on case concord patterns in German A–N–N compounds?

In the following section, we will present the design and the results of the experiment. The study confirms that all four strategies are used and we found that grammar internal factors do not play a decisive role in determining the choice of strategy, but that the variation is to a large part due to speakers' individual preferences. All results will be discussed in detail.

[7] In this case, strictly speaking, the Lexical Integrity Hypothesis is also violated. However, one element that is accessible for syntactic operations (N_2) is at least the head of the complex noun (in contrast to the target N_1 within the alternative structure $[_{NP}$ A $[_N N_1$ $N_2]]$). Note that the very existence of phrasal compounds has been taken as a challenge to the Lexical Integrity Hypothesis.

3.1 Methods

3.1.1 Design

The experiment was designed as a fill-in-the-blank task. Participants had to fill in a questionnaire by hand. The task was to form a new word from given words. Each item consisted of a given adjective and two given nouns, which were presented one after another in a row.

All given words were completely uninflected. Below the word row, there was a given sentence with a gap where participants had to fill in their newly built word. Participants were told explicitly that they must not change the order of the given words. After having filled in the gap, they had to write down what they believed the new word could mean (there were empty lines below for their definition). For an example see Fig. 1.

In the instruction, participants were told that the study is about the meaning of new complex words in German. Participants were neither told that the study is about inflection/case marking nor that they can, should or should not change the form of the words. The definition task was only included to make participants believe that the study is about the meaning of the words they formed.

The questionnaire was constructed of 12 target items and 12 fillers. Every target item consisted of one adjective and two nouns. Only non-idiomatic compounds were included. The following independent variables were varied: (i) gender of N_1 and N_2 (masculine, feminine, neuter). (ii) case assigning preposition (dative vs. genitive), and (iii) position of the gap (sentence initial vs. sentence medial).

Three genders and two nouns lead to nine potential gender combinations. We excluded the combinations $N1_{masc}$-$N2_{masc}$, $N1_{neut}$-$N2_{neut}$, $N1_{fem}$-$N2_{fem}$, because if gender does not differ, it cannot be detected which noun the adjective agrees with. So the following six conditions were included: $N1_{masc}$-$N2_{fem}$, $N1_{masc}$-$N2_{neut}$, $N1_{fem}$-$N2_{masc}$, $N1_{fem}$-$N2_{neut}$, $N1_{neut}$-$N2_{masc}$, $N1_{neut}$-$N2_{fem}$. There were two items per

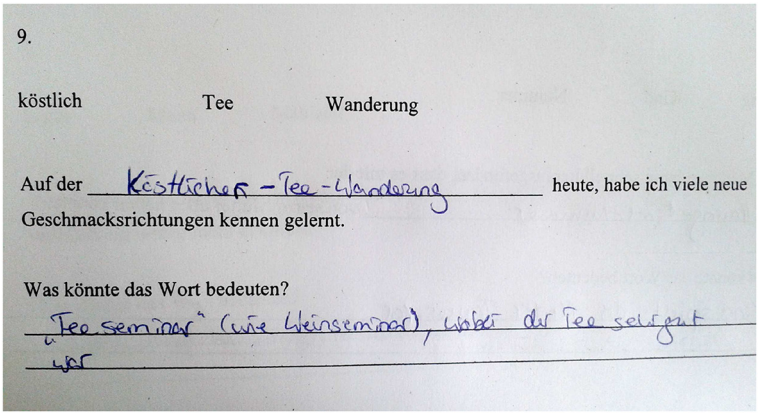


Fig. 1 Example item

condition, so in total there were 12 target items. For one item of each condition, a preposition that assigns genitive case was used in the gap sentence and for the other item it was a preposition that assigns dative case. In one item of each condition the gap was sentence initial, in the other item it was sentence medial.[8]

3.1.2 Nature of the stimuli

One challenge was trying to prevent participants from forming an N+N compound immediately out of the two given nouns. In this case, only agreement of the adjective with N_2 is expected because N_2 is the head of the whole compound. To prevent participants from building this structure, several things were considered: (i) N_1 and N_2 never formed a well-known German compound, e.g., there were no combinations where N_1 was *Haus* 'house' and N_2 *Tür* 'door', since *Haustür* 'front door' is a very frequent German compound.[9] (ii) Care was taken that it made only sense semantically to relate the adjective to N_1 and not to N_2. This was done, e.g., by making N_1 an animate noun and combining it with an adjective that can only modify animate nouns like in *Blonde-Frau-Trick* 'blonde woman trick'. Therefore, people were forced to build the intended structure where A modifies N_1 and not N_2.

The 12 fillers were all phrasal compounds of the type [Phrase]-N, but they never contained adjectives followed by nouns (e.g., *[Bitte-nicht-stören]-Schild* 'Please-do-not-disturb-sign' or *[Vielleicht-morgen]-Einstellung* 'Maybe-tomorrow-attitude').

Six out of the 12 fillers had to be inflected either for genitive or for plural (3 for genitive and 3 for plural). The given context was designed in such a way, that without putting the appropriate markers for genitive or plural, the sentence was ungrammatical. Thus it was controlled whether participants read the given sentence carefully and it could be noticed when participants just copied the uninflected given words into the gap without paying attention to the context sentence (see Sect. 3.1.4 *Excluded participants*).

3.1.3 Participants

Thirty-one participants have been tested, 21 females and 10 males. Their age was between 16 and 62. Seventeen were younger than 20 years and 14 older than 20 years. The average age was 29.5 and the median was 18. Nine of them stated that they speak no dialect, 22 said that their dialect was Swabian, which is spoken in the south of Germany. The questionnaire was only distributed among people who had no professional linguistic background.

3.1.4 Excluded participants

Originally, 43 participants took part in the study. Two participants were excluded because they did not fill in the gaps (they only did the definition task). Out of the

[8] Since we neither expected an effect of the gap position nor of the case assigning preposition, these factors were not crossed with each other.

[9] Of course there is no guarantee that speakers nevertheless had the N+N interpretation in mind since N+N compounding is a very productive process in German. The important point is that there were no stimuli that were obviously N+N compounds.

Table 3 Distribution of speakers' inflection score

Number of inflections (score)	1	2	3	4	5	6	7	8	9	10
Number of participants	2	4	1	3	2	2	4	7	8	8

remaining 41 participants, only 31 were considered for further analysis because 10 did not pass a further 'filter' we used. The experimental design bore the risk that participants might just copy the three given words from the row into the gap, since they were not told explicitly that they should *change* the words. We refrained from including this information in the instructions, because we wanted to avoid any priming concerning inflection. To differentiate between those participants who did not put any inflection on the adjective because they liked this form best and those who just copied the words because they thought they were expected to do so, we included inflection tasks on the fillers. Six out of the 12 fillers had to be obligatorily inflected either for genitive or for plural (three for genitive and three for plural). Without inserting the appropriate markers for genitive or plural, the sentence was ungrammatical. Additionally, there were six target items which were assigned genitive case by a preposition. In four cases, participants had to mark the second noun with a genitive marker overtly. In total, participants were supposed to use overt plural or genitive markers on the second noun in 10 sentences: three times for plural within the fillers, three times for genitive within the fillers and four times for genitive within the target items (the remaining two genitive target items had no overt genitive marker).

Participants who added all appropriate markers correctly were assigned an *inflection score* of 10. Participants with an *inflection score* $\leqq 4$ were excluded from the study. As can be seen in Table 3, 10 participants were excluded because they used the appropriate inflection markers only 4 times or less than 4 times.[10]

By counting whether participants used inflection markers at the second noun, we got a broader picture of their inflection behaviour in general. This way we excluded the results of participants who thought they were expected to just copy the given words into the gap. Interestingly, there were participants with a score $\leqq 4$ who never inflected the adjective (Strategy 3), but there were also participants with a score ≥ 8 who had this strategy.

Summarizing, given the broader general picture of the inflection behaviour of every participant, we conclude that for participants who used a lot of zero inflection, it was not the case that they did so because they do not use inflection in general or because they got the task wrong.

[10] We decided to keep participants who at least inflected half of the given items. This was the best compromise between excluding the ones who probably just copied and not losing too many participants who probably got the task right but missed some inflection due, e.g., to decrease of concentration.

3.2 Results

Four different strategies to deal with case concord in German A–N–N compounds were attested. 40.2% of the responses show agreement of the adjective with N_1. 17.3% of the responses show agreement with N_2. 38.8% of the responses show no case marking at all. In 1.9% of the responses, the adjective neither agrees with N_1 nor with N_2, but shows the marker *-e*. Figure 2 illustrates the total distribution of all four types of agreement. 'Ø' stands for the zero-marking strategy, 'e' for the *-e*-marking one.

Speakers' consistency varied. There were 11 participants who had a consistent strategy: 6 of them always used the zero-strategy (hence: Ø), 4 always used the N_1-strategy and 1 always used the N_2-strategy. Seven participants used three strategies ($N_1/N_2/Ø$) and 9 used two different strategies (N_1/-e: 1 participant, $N_1/Ø$: 4 participants, N_1/N_2: 2 participants, $N_2/Ø$: 2 participants). There were 4 speakers who used all of the four attested strategies.

Since the gender of the nouns was our most important independent variable, Fig. 3 shows the proportion of agreement strategies across the six gender combinations. Figure 3 suggests that in the combinations which start with a feminine noun, there was much less N_2-agreement compared to the cases where N_1 was masculine or neuter. Statistical tests (see following section) confirm that the gender of the first noun is a significant factor that influences the choice of the agreement strategy, but it is not the most important one. It looks as if Strategy 4 (*-e*) does not appear if the gender of the first noun is feminine. In fact, this cannot be determined, since agreement with N_1

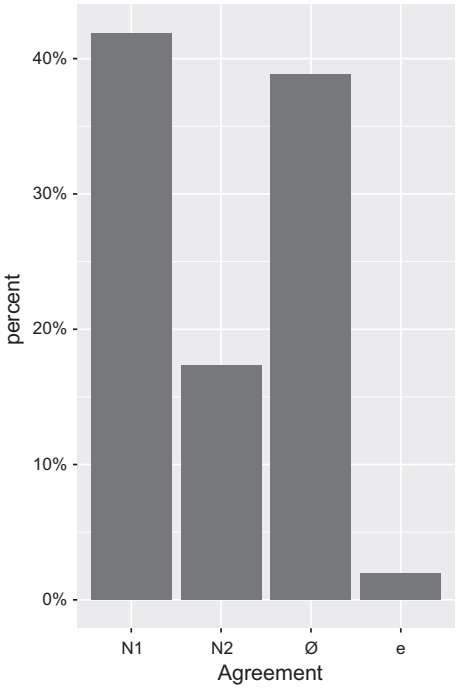


Fig. 2 Total proportion of Agreement Strategies

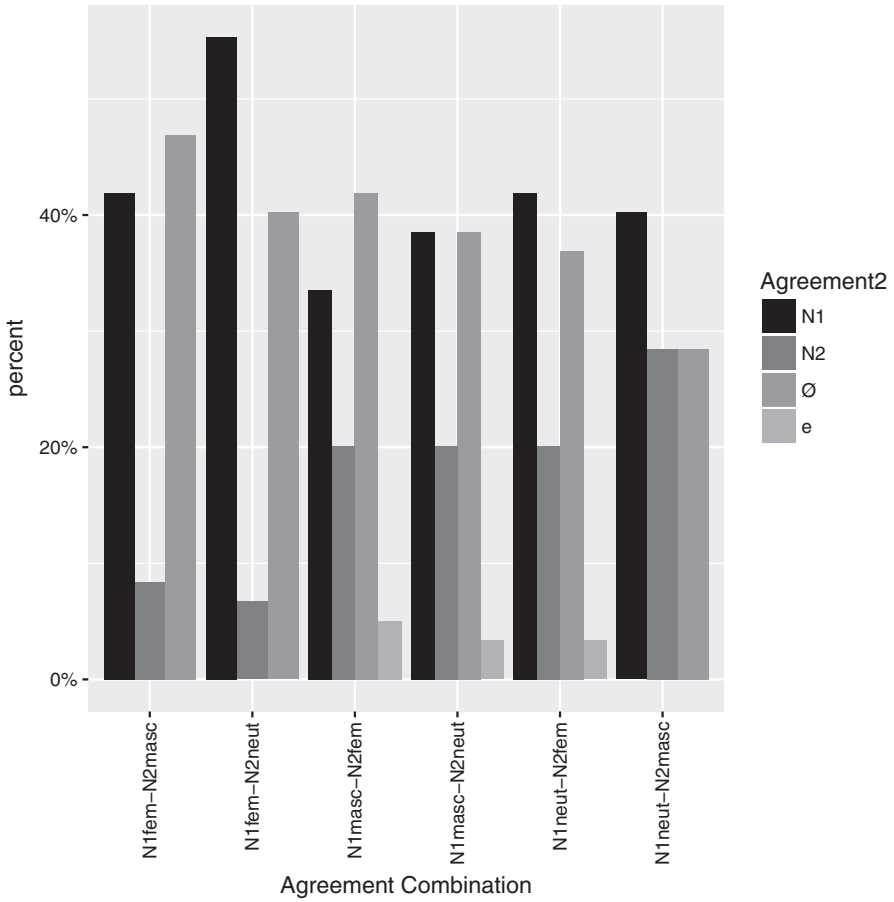


Fig. 3 Proportion of agreement strategies across the six gender combinations

also surfaces as *-e*. If there was an *-e-marker* on the adjective followed by a feminine noun, this was coded as N_1-agreement. The main issue of the study was to show that N_2-agreement exists, whereas it is quite uncontroversial that N_1-agreement exists. Therefore this syncretism is ignored for the moment. The important observation is that there was no gender combination which lacks N_2-agreement completely. Nevertheless, it should be kept in mind that in the combinations that start with a feminine noun, what appears to be N_1-agreement might also be no agreement + *-e*-marker.

3.3 Statistical analysis

In this section, we turn to the statistical analysis of the data collected in our experiment. Our main goal is to determine which factors play a role in the choice of a strategy and to what degree. Since we have four different possible responses (agreement of the adjective with N_1, with N_2, no agreement/no marker and no agreement/*-e*-marker),

a simple logistic regression model does not work in this case. There are in principle two alternatives. One is to use a multinomial model, and the other one is to do multiple pairwise comparisons with logistic regression models for all possible pairwise combinations in the data.[11] The main advantage of the second option is that model evaluation and model cross-validation are considerably simpler for logistic regression than for multinomial models; for this reason we chose this alternative. Additionally, we fitted a Random Forest model to assess variable importance and cross-check the results from the logistic models.

We had to exclude all observations with no agreement+-*e*-marker from the analysis because there were only 7, which makes building a regression model highly inaccurate. We are thus left with three possible pairs we want to compare: the decision between agreement with the first noun and agreement with the second noun (hence N_1 vs. N_2), between agreement with the first noun and no agreement (hence N_1 vs. Ø), and between agreement with the second noun and no agreement (hence N_2 vs. Ø).

3.3.1 N_1 vs. N_2 model

First, we look at the pair N_1N_2. We fit the model with the formula: `Agreement ~ Gender.N1 + Gender.N2 + Sex + (1|Adjective) + (1|Speaker)`.[12] This formula means that we are predicting the chosen agreement (N_1 or N_2 in this case) from the factor GENDER N1, the factor GENDER N2, and the SEX of the speaker. We are also allowing the model to freely move the intercept for the ADJECTIVE modifying the compound and for the SPEAKER. This is because it is reasonable to believe that different adjectives might have different effects as to which of the nouns they tend to agree with, and different speakers might show different preferences in this regard. Initially the factors AGE (of the speaker), CASE ASSIGNING PREPOSITION, and POSITION OF THE GAP were also considered but they were not significant in any of the models. We will thus not report them. Since logistic regression finds the log odds for success or failure (1 or 0) of a given outcome, we set one of the responses to be 'success' and the other to be 'failure' for each model, but this is just a technical issue, there are no implications as to which level is set to which value.

For the model N_1N_2, agreement with the first noun (N_1) was set as failure (0), and agreement with the second noun (N_2) was set to success (1). The results can be seen in Table 4.

Table 4 shows first the variance and standard deviations for the random effects (SPEAKER and ADJECTIVE). Here we see that there was a little variation between adjectives, but very large variation between participants, which suggests that the use of different strategies might be due to personal preferences (we will confirm this observation in the following models). The second section presents the estimated coefficients

[11] Alternatively one could compare X vs. Not X. We think, however, that this option is not ideal for our data, because not all speakers considered all strategies, and there is no a priori reason to think there is a meaningful 'Not X' opposition to each strategy. Nevertheless, the results of this analysis in an X vs. Not X fashion agree with our approach and conclusion. They are available with the code and raw data here: Results.

[12] Although there are some small variations in the significance of these effects in the other two models, we will use this same formula for all three comparisons for consistency.

Table 4 Coefficients for Model N_1N_2

	Random effects:				
Groups	Name	Variance	Std.Dev.		
Speaker	(Intercept)	14.6467	3.8271		
Adjective	(Intercept)	0.4149	0.6442		
Number of obs: 211,	groups: Speaker, 24	Adjective, 12			
	Fixed effects:				
	Estimate	Std. error	*z* score	*p* value	
(Intercept)	−7.3167	2.0698	−3.535	.000408	***
Gender.N1 masc	4.3570	1.2748	3.418	.000631	***
Gender.N1 neut	3.8303	1.2264	3.123	.001789	**
Gender.N2 masc	1.6670	0.9690	1.720	.085349	.
Gender.N2 neut	0.8813	0.9739	0.905	.365492	
Sex male	3.5697	2.1107	1.691	.090783	.

(the log transformed odds) for each factor level with respect to the base line (the intercept). It also shows the standard error, *z* score and *p* value. The first thing we can observe is that the gender of the first noun in the A–N–N compound has the largest significant effect regarding the choice of agreement with N_1 or agreement with N_2. Negative estimated coefficients mean that there is a reduction in the log odds of success, while positive coefficients indicate an increase in the log odds of success. The coefficient of the intercept represents a base line (in this case Gender.N1=fem, Gender.N2=fem, Sex=female). What we can see is that log odds of agreement with N_1 in the A–N–N compound are highest when the gender of N_1 is feminine and the sex of the speaker female. A masculine or neuter N_1 increases the log odds of agreement with the second noun in the A–N–N compound. The gender of N_2 does not seem to have an effect.

Since our predictors (genders of N_1 and N_2) have more than two levels, we also conducted post-hoc tests to assess the significance of the difference between all different levels. The results are given in Tables 5 and 6. What we see is that there is a significant difference between feminine and not feminine for the gender of the first noun, but we find no significant differences (and considerably lower estimates) for the gender of the second noun. This suggests that only the gender of the first noun has an effect, and within this factor, only the opposition feminine vs. not feminine.

To assess the model's accuracy we used repeated random sub-sampling validation. In this method we randomly split the data set into a training set (in this case 80%) and a testing set (20% of the data). We then fit the model using the training set and use the model to predict the data in the testing set. The process is then repeated *k* times (100 in our case) and the results are averaged over all models. The reason for using this method is that our data set is relatively small, but we do not want to evaluate the model on the same data we used to train it. By doing multiple splits we can test our model against new data, and by doing repeated testing we can prevent splits of the data that

Table 5 Multiple comparison for variable `Gender N1`, for Model N_1N_2

Comparison	Estimate	Std. error	*z* score	*p* value	
masc - fem == 0	4.3570	1.2748	3.418	.00177	**
neut - fem == 0	3.8303	1.2264	3.123	.00497	**
neut - masc == 0	−0.5267	0.9608	−0.548	.84591	

Table 6 Multiple comparison for variable `Gender N2`, for Model N_1N_2

Comparison	Estimate	Std. error	*z* score	*p* value
masc - fem == 0	1.6670	0.9690	1.720	.197
neut - fem == 0	0.8813	0.9739	0.905	.637
neut - masc == 0	−0.7857	1.0401	−0.755	.730

Table 7 Confusion Matrix N_1N_2

	Reference	
Prediction	0	1
0	24.13	3.04
1	2.40	8.43
Accuracy = 0.86		
C score = 0.84		

might skew the model one way or another. The results of the validation process for Model N_1N_2 can be seen in Table 7.

Table 7 presents an averaged confusion matrix for the model, the accuracy and the area under the ROC curve (C score). The C score is an accuracy measure that can range from 0 (perfectly bad model) to 1 (perfectly accurate model), but it differs from the normal accuracy score in that it takes into account that the predicted classes may not be balanced. A C score of more than 0.8 means a very good predictive model. Overall, we can see that the model has relatively high accuracy and a high C score. We can also observe that the predictions were mostly accurate, with relatively few misses in the many iterations. We can thus conclude that the model fits the data well, even when tested against new observations.

3.3.2 N_1 vs. Ø model

Next we analyzed first noun agreement vs. no agreement: $N_1Ø$ (N_1 set to 0, and Ø set to 1). We used the same formula for the model as before. The results of Model $N_1Ø$ can be seen in Table 8.

In this case we see that most of the factors that were significant for Model N_1N_2 have relatively low coefficients, and did not reach significance in this model. The only factor that reached significance in this case was the sex of the speaker. The effect

Table 8 Coefficients for Model $N_1Ø$

	Random effects:				
Groups	Name	Variance	Std.Dev.		
Speaker	(Intercept)	19.70	4.438		
Adjective	(Intercept)	1.74	1.319		
Number of obs: 289,	groups: Speaker, 30;	Adjective, 12			
	Fixed effects:				
	Estimate	Std. error	*z* score	*p* value	
(Intercept)	−0.5879	1.7646	−0.333	.7390	
Gender.N1 masc	0.2443	1.2631	0.193	.8466	
Gender.N1 neut	−1.4185	1.3139	−1.080	.2803	
Gender.N2 masc	−0.6119	1.2985	−0.471	.6375	
Gender.N2 neut	−1.4191	1.2886	−1.101	.2708	
Sex male	4.4897	2.1700	2.069	.0386	*

Table 9 Multiple comparison for variable `Gender N1`, for Model $N_1Ø$

Comparison	Estimate	Std. error	*z* score	*p* value
masc - fem == 0	0.2443	1.2631	0.193	.980
neut - fem == 0	−1.4185	1.3139	−1.080	.527
neut - masc == 0	−1.6628	1.3053	−1.274	.410

Table 10 Multiple comparison for variable `Gender N2`, for Model $N_1Ø$

Comparison	Estimate	Std. error	*z* score	*p* value
masc - fem == 0	−0.6119	1.2985	−0.471	.885
neut - fem == 0	−1.4191	1.2886	−1.101	.513
neut - masc == 0	−0.8073	1.2540	−0.644	.796

of sex in this model replicated the same direction we saw earlier in Model N_1N_2, namely that male speakers were more likely to prefer second noun agreement than female speakers. Since the intercept is non-significant, however, we cannot conclude that a feminine second noun in non-initial position will increase the log odds of no agreement.

The corresponding post-hoc comparisons for the levels of GENDER.N1 and GENDER.N2 are given in Tables 9 and 10.

Once more, we performed a repeated random sub-sampling validation on the model. The result can be seen in Table 11. We can observe that Model $N_1Ø$ also has a high accuracy and C score, and a good classification accuracy over all with very few averaged misses. This is slightly surprising since we found that only SEX was significant as a predictor, but it could indicate that most of the variation is being explained by

Table 11 Confusion Matrix $N_1Ø$

	Reference	
Prediction	0	1
0	22.35	3.11
1	3.21	21.33
Accuracy = 0.87		
C = 0.87		

Table 12 Coefficients for Model $N_2Ø$

	Random effects:				
Groups	Name	Variance	Std.Dev.		
Speaker	(Intercept)	11.4912	3.3899		
Adjective	(Intercept)	0.4547	0.6743		
Number of obs: 289,	groups: Speaker, 30;	Adjective, 12			
	Fixed effects:				
	Estimate	Std. error	*z* score	*p* value	
(Intercept)	4.1562	1.6131	2.577	.00998	**
Gender.N1 masc	−2.0774	1.0472	−1.984	.04729	*
Gender.N1 neut	−3.1562	1.0561	−2.989	.00280	**
Gender.N2 masc	−0.8912	0.9427	−0.945	.34450	
Gender.N2 neut	−0.4998	0.9350	−0.534	.59300	
Sex male	0.2419	1.6161	0.150	.88103	

the random effects, that is speakers' individual preferences and to a lesser degree preferences of the adjectives. We will come back to this later.

3.3.3 N_2 vs. Ø model

Finally, we come to the pair of second noun agreement vs. no agreement (Model $N_2Ø$). We fit the model with the same formula we used before. The results can be seen in Table 12.

In this model, N_2 is set to failure and Ø is set to success. For the factor Gender N_1 we see that once again masculine and neuter gender increase the log odds of seeing agreement with the second noun, while feminine gender increases the odds of no agreement. In this case, we observe no effect for the sex of the speaker. The post-hoc multilevel comparisons are shown in Tables 13 and 14. This time the post-hoc comparison does not detect the effect of masculine vs. feminine that the model indicates.

Validation of the model shows results similar to the two previous models. The results of the validation process for Model $N_2Ø$ can be seen in Table 15.

Table 13 Multiple comparison for variable `Gender N1`, for Model $N_2Ø$

Comparison	Estimate	Std. error	*z* score	*p* value	
masc - fem == 0	−2.077	1.047	−1.984	.11596	
neut - fem == 0	−3.156	1.056	−2.989	.00794	**
neut - masc == 0	−1.079	0.963	−1.120	.50102	

Table 14 Multiple comparison for variable `Gender N2`, for Model $N_2Ø$

Comparison	Estimate	Std. error	*z* score	*p* value
masc - fem == 0	−0.8912	0.9427	−0.945	.611
neut - fem == 0	−0.4998	0.9350	−0.534	.854
neut - masc == 0	0.3914	1.0103	0.387	.920

Table 15 Confusion Matrix $N_2Ø$

	Reference	
Prediction	0	1
0	7.56	1.78
1	2.34	21.32
Accuracy = 0.88 C = 0.86		

3.3.4 Predictor assessment and variable importance

Although the gender of the first noun turned out to be statistically significant in two cases, its effect seems fairly small compared with the degree of variation over the different participants. It is possible (and likely from the results of the $N_1Ø$ model) that this is only a minor effect in comparison with speaker variation. To evaluate this possibility we used Random Forest (see Breiman 2001; Segal 2004; Hothorn et al. 2006; Zeileis et al. 2008). Random Forest (RF) works by fitting many different partition trees on random subsamples of a data set and with random subsets of the predictors. In the final model, all individual trees 'vote' for a given outcome based on the values of the predictors. Here we used the RF algorithm implemented in the package `party`. This time we fit the following model: `Agreement ~ Gender.N1 + Gender.N2 + Sex + Speaker + Adjective`. The reason for this choice of model is that RF does not handle random effects differently from fixed effects. An advantage of RF is that it can handle response variables with multiple levels directly, so we are fitting the model to the whole data set.

What we see in Table 16 is that the RF model is about as accurate as the mixed effect models in predicting the three strategies from the factors. The main difference can be seen when looking at the importance of the individual predictors. We can see the

Table 16 Confusion Matrix and model statistics for the Random Forest

	Reference		
Reference Prediction	N1	N2	Ø
N1	138	10	15
N2	3	44	3
Ø	9	5	117
Statistics by Class:			
	Class: N1	Class: N2	Class: Ø
Balanced Accuracy	0.8956	0.8624	0.8998
Model statistics			
Accuracy = 0.87			

Table 17 Mean decrease in accuracy by predictor removal

Speaker	Adjective	Sex	Gender.N1	Gender.N2
0.3217	0.0133	0.0120	0.0104	−0.0003

mean decrease in accuracy of removing each factor in Table 17.[13] This table shows that most of the variance is explained by speaker variability/individual differences between speakers and to a second, lesser degree by the adjective. This means that most of the variation is due to sociolinguistic factors and not linguistic ones. The gender of the first noun and the adjective are only weak predictors compared to SPEAKER, and the gender of the second noun is, as seen before, completely irrelevant in our current model.

We can visualize an approximation of the RF model with a partition tree that considers all predictors in Fig. 4. In this tree, we can clearly see the results we have already discussed. A large number of speakers prefer a single strategy. Within speakers who used two or more strategies, some prefer N_1-agreement with feminine nouns, while others (mostly women) prefer N_2-agreement when the first noun is neuter or masculine.

3.3.5 Conclusion of the experimental results

The main objective of this experiment was to determine all possible concord strategies that speakers use when they inflect A–N–N compounds for case. Our main result is that there are three different strategies: agreement of the adjective with the first noun, agreement with the second noun, or no agreement at all. A potential fourth strategy was also attested which consisted of using a default *-e* suffix (we will attribute this to a variation of the no agreement strategy, see Sect. 4.5.4).

The second important result is that most of the variation is due to speakers' preferences. An effect of the sex of the speaker was detected (although not always significant): males preferred no agreement over agreement with the first noun (Model N_1Ø), whereas females favoured N_2-agreement in some cases.

[13] We used the option `conditional = True` for the variable importance measurements because both SPEAKER and SEX are correlated variables.

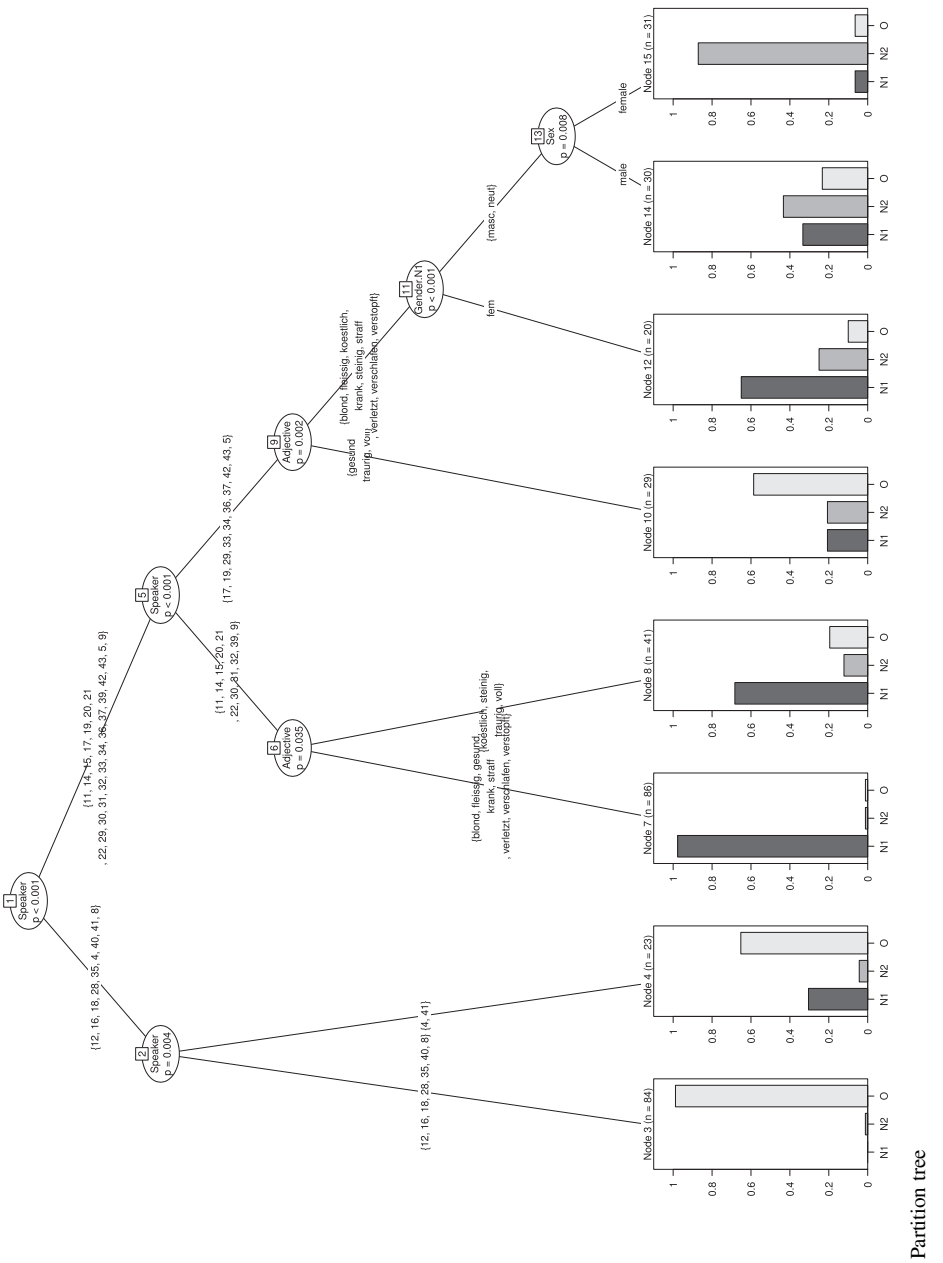


Fig. 4 Partition tree

As far as the grammatical factors are concerned, only the gender of the first noun in the A–N–N compounds played a role in the decision between first noun agreement and second noun agreement, and second noun agreement or no agreement. If the first noun of an A–N–N compound is masculine or neuter, speakers preferred agreement with the second noun over agreement with the first noun or no agreement. In contrast, if the first noun is feminine, speakers preferred agreement with the first noun over agreement with the second noun. However, there was no significant effect for first noun agreement vs. no agreement. This is surprising because the gender of the first noun was a significant predictor, but the only relevant distinction seems to be N_2 vs. not N_2. We will see, however, that this might follow from how the different strategies are derived theoretically (see Sect. 5.4).

3.4 Discussion

Our study confirmed that agreement of the adjective with the second noun in an A–N–N compound is an existing pattern that speakers use. 17.3% of all items showed this agreement pattern, even though study participants were neither told that there are different possibilities for the adjective to agree with nor that the study is about agreement/inflection. This is an important result for two reasons: (i) in informal judgment tasks, the existence of this pattern was strongly questioned and, (ii) from a theoretical point of view, agreement of the adjective with N_2 is unexpected because it seems to violate standard locality conditons like the Minimal Link Condition (see Sect. 4.5.2 for derivations).

In 40.2% of the items, the adjective agrees with N_1, and 38.8% of the items do not show any compound internal agreement at all. In 1.9% of the items the adjective neither agrees with N_1 nor with N_2, but it shows the marker *-e*. In the following part of the paper, we will derive all four existing patterns theoretically (see Sect. 4). The existence of four different strategies confirms our intuition that speakers feel some trouble or conflict concerning adjectival agreement in A–N–N compounds, which will be a crucial point in our analysis. This becomes most evident in face of the fact that most speakers used more than one strategy. It is worth noting that it was quite obvious that several participants were unsure what they should do with the adjective. Sometimes they changed or corrected their answers by overwriting them or by striking them through (see the example in Fig. 1 where the marker was changed from *-en* (Strategy 2) to *-er* (Strategy 1)). Some participants even gave several options (inflection markers in brackets). This could be easily detected since all participants filled in the questionnaire by hand.

The analysis we will present accounts for the empirical distribution of all four strategies. Although we found that the variation is primarily due to speakers' individual preferences, our analysis derives why agreement with N_1 and no agreement at all occur more often than agreement with N_2 (see Sect. 5.4). We also found that grammar internal factors do not play a decisive role in determining the choice of strategy. Whether a preposition assigns dative or genitive case to the A–N–N compound is irrelevant. Furthermore, neither the age of the speaker nor the position of the gap in the given sentence had any effect on the choice of strategy. This is what we expected. The only

factor that seems to play a weak role is the gender of the first noun. Speakers show the tendency to agree with N_1 if N_1 is feminine. We have no explanation for this effect, yet. What we observe is that agreement with feminine N_1s always surfaces as *-e*. This is a morphologically and phonologically less complex marker than the marker for masculine N_1s (*-er*) and neuter N_1s (*-es*). However, whether factors like the complexity of the markers or other phonological reasons are on the right track to account for this observation remains an open question at this moment.

4 Analysis

We claim that in the case of German A–N–N compounds adjectival inflection depends on (i) the order of the operations Agree and Insertion and (ii) on the interaction of these operations with the Strict Cycle Condition and the Minimal Link Condition.

We follow De Belder and van Koppen (2014) in their view that different strategies of A–N–N compound inflection are a consequence of the order of operations that apply, but we will also show that their analysis for Dutch A–N–N compounds does not make the correct empirical predictions for German A–N–N compounds. Secondly, since our proposal to resolve the puzzle in German is based on the framework of Ackema and Neeleman (2004), we will briefly introduce their main idea of how syntax and morphology interact with each other. Finally, we will make explicit our underlying assumptions and putting everything together we will show how all four strategies in German can be derived.

4.1 Discussion of previous analysis: Dutch A–N–N compounds (De Belder and van Koppen 2014)

A–N–N compounds are a productive pattern in other Germanic languages as well. De Belder and van Koppen (2014) analyzed Dutch A–N–N compounds which also show compound internal adjectival inflection.[14] An example is given in (39) where inflection is marked with AGR.

(39) a. kaal-e-kat-adoptie
hairless-AGR-*cat-adoption*
'adoption of hairless cats'
b. oud-e-heren-club
old-AGR-*gentlemen-club*
'old gentlemen's club' (De Belder and van Koppen 2014: 1)

In Dutch, there are two adjectival markers: a default *-e*-affix and a Ø-affix. The latter one only occurs with neuter, singular, indefinite nouns. Two of the main results of an online survey (judgment task) were that the *-e* affix is always an option to appear on the adjective and that the Ø-marker was most frequently chosen when N_1 was neuter and

[14] For an overview and for syntactic derivations of all possible different types of A–N(–N) compounds in Dutch see also De Belder and van Koppen (2016).

singular and when the whole DP was indefinite. So, the puzzle is to explain why the adjective in A-N_{neut}-N configurations can have either the *-e* marker or the Ø-marker.

Following Harley (2009) and Borer (2009, 2013), De Belder and van Koppen (2014) assume that compounds are formed in syntax. The [A–N]-component is built in a separate workspace (see Johnson 2002; Uriagereka 2002, 2012) and merged with the head noun of the compound. Furthermore, they show that the [A–N]-constituent lacks its own D-layer.

(40) *een de-kaal-e-kat-adoptie
*a the-hairless-*AGR-*cat-adoption*
(De Belder and van Koppen 2014: 2)

According to De Belder and van Koppen (2014), definiteness is encoded on D. Adjectives bear an unvalued definiteness feature which needs to get valued in the course of the derivation. But if the [A–N_1]-constituent lacks its own D-layer which contains the definiteness information, how can the unvalued definiteness feature [udef] on the adjective get valued? De Belder and van Koppen (2014) propose two possible strategies:

(41) a. Strategy 1: Spell-out ≫ Merge
The [udef]-feature on the adjective does not get valued in its own workspace. A default spell-out obtains before [A–N_1] is merged with N_2. The result is the elsewhere affix *-e* on the adjective, which realizes a defective feature set (Preminger 2011).

b. Strategy 2: Merge ≫ Spell-out
There is no default spell-out of the separate workspace where [A–N] is built. After N_2 is merged, the adjectival probe is still active. In this case, adjectival inflection inside the [A–N_1]-constituent is sensitive to functional material outside its own workspace. The [udef]-feature on the adjective gets valued by the [idef]-feature of the D-head of the entire compound via feature-sharing (Frampton and Gutman 2006; Pesetsky and Torrego 2007). In the context of the feature specification [neuter, singular, indefinite] this leads to the marker Ø.

In the following, we will briefly explain why the analysis proposed by De Belder and van Koppen (2014) cannot account for the German data. This is due to the two facts that in contrast to Dutch, (i) German A–N–N compounds show case concord and (ii) German has four different options of adjectival inflection.

De Belder and van Koppen's (2014) Strategy 1 (spell-out of the separate workspace ≫ Merge) would correctly predict our Strategy 4 (agreement with none of the nouns, (default) *e*-marker). After Merge of A and N_1, both would be sent to spell-out immediately. So the case probe on A would not get valued and a default valuation would obtain. Nevertheless, De Belder and van Koppen's (2014) Strategy 2 (Merge ≫ Spell-out) predicts a pattern that does not exist in German: In German the adjective is also marked for case, which means that there is an unvalued case probe on the adjective that wants to get valued in the course of the derivation. De Belder

and van Koppen's (2014) Strategy 2 predicts that the case probe on A is still active when N_2 is merged. Let us assume that after the [A–N]-component is merged with N_2, the adjective agrees with N_1, analogously to Dutch (our Strategy 1). The crucial difference is that after Agree, the German adjective shares an unvalued case feature with N_1, which the Dutch adjective does not. This, in turn, means that A and N_1 both get valued by a case assigning element later in the derivation. If the assigned case was genitive case, we would expect to see a genitive marker on N_1, but this never happens. In German A–N–N compounds a genitive marker on N_1 is never grammatical, as was already shown in (11), (12) and (13).[15]

Furthermore, De Belder and van Koppen's (2014) analysis nicely explains the existence of two different markers in Dutch, but since German shows four different options of adjectival inflection, more work needs to be done.

4.2 Syntax-morphology interactions in Ackema and Neeleman (2004)

We adopt the view that morphology is a generative system that defines grammatical word structures. Following Ackema and Neeleman (2004), we assume "that the modules of syntax, semantics and phonology each contain a submodule that generates phrasal representations and a submodule that generates word-level representations." (Ackema and Neeleman 2004: 3).

What is *usually* referred to as 'syntax' is, according to this model, a submodule of a bigger syntax module. Ackema and Neeleman (2004) call this submodule phrasal syntax. The big syntax module also contains a distinct submodule that generates hierarchical structures for words, which they call word syntax.[16]

Under the assumption that syntax and morphology are two independent generative systems, labeling of categories depends on the locus of merger. If a head α and a dependent β are to be combined, they can undergo morphological merger within the morphology submodule or syntactic merger within the syntax submodule. In the morphology submodule morphological merger will apply resulting in a morphological category $[_{\alpha}\ \beta\ \alpha]$. In the syntax submodule syntactic merger results in a syntactic phrase $[_{\alpha P}\ \alpha\ \beta P]$ (Ackema and Neeleman 2004: 48 and see chapter 3 for arguments that the two systems are in competition).

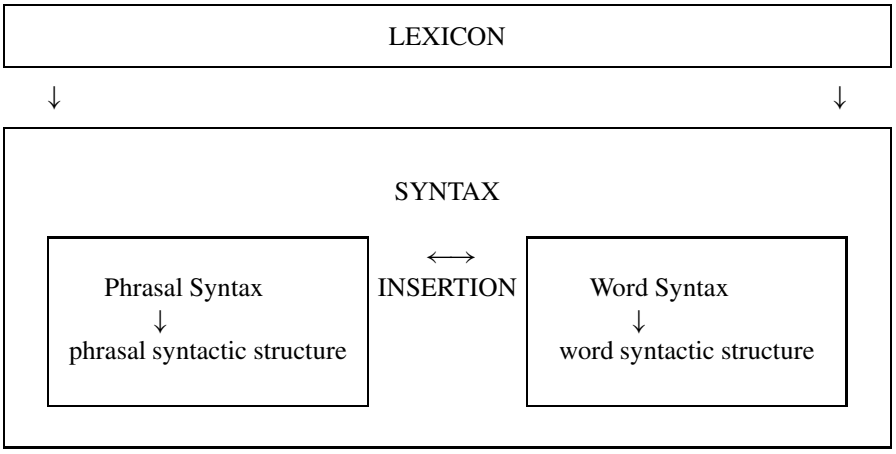
One of the central claims of Ackema and Neeleman (2004) is that there is no asymmetry between syntax and morphology. They are parallel systems that interact. As Ackema and Neeleman (2004) point out, syntactic and morphological representations are generated independently from each other, but they can be inserted into each other.

[15] Instead of feature-sharing one could assume that case is assigned via *Multiple Agree* (Hiraiwa 2001; Vainikka and Brattico 2014). That means that the case of a functional head can be assigned to more than one element (e.g., to D and N heads or other DP internal elements that inflect for case, see, e.g., Assmann et al. 2014). However, under this alternative the mentioned problem would remain the same: since those elements that have an unvalued case feature receive a value, A and N_1 would get the same case from a v- or a P-head.

[16] A note of clarification: 'Word syntax' is what we usually call 'morphology' and 'phrasal syntax' equals what normally is called only 'syntax'. Henceforth, if the terms 'morphology' and 'syntax' are used, they correspond to Ackema and Neeleman's (2004) word syntax and phrasal syntax.

Under this view, it is necessary to assume an operation of insertion.[17] The abstract model is illustrated in (42).[18]

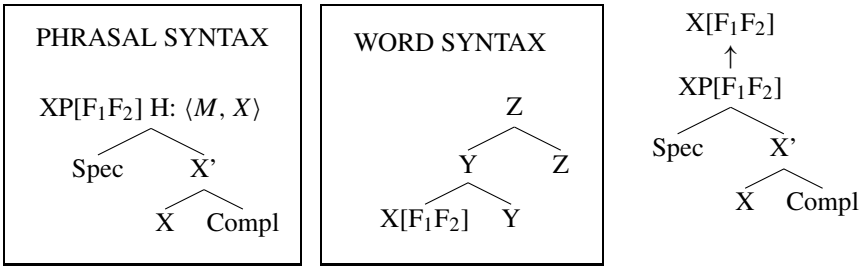
(42)



We briefly illustrate the insertion of a syntactic representation into a morphological representation, as is the case for phrasal compounds according to Ackema and Neeleman (2004).

In (43) on the left, we see a syntactic representation (with the features $[F_1F_2]$). *H:* $\langle M, X \rangle$ indicates that the host where the syntactic representation is to be inserted, is a node X in morphology (= word syntax), which we see in the middle. On the right, the insertion process is illustrated: Insertion of the syntactic representation into the morphological node X is represented by an upward arrow.

(43)

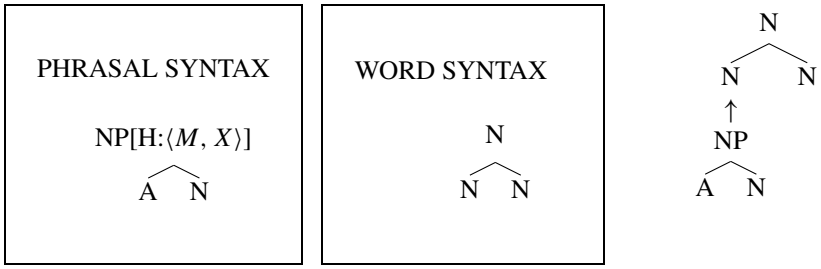


[17] According to Ackema and Neeleman (2004), insertion is a relation of feature matching between two nodes in different representations. As discussed in Meibauer (2007), Ackema and Neeleman (2004) are not explicit which are the features that may play a role in the process of feature matching. We adopt Meibauer's (2007) view that it is more plausible to assume that the respective building block is inserted without any feature checking mechanism.

[18] Note that in Ackema and Neeleman's (2004) model, syntactic processes do not take place in the lexicon (in contrast to Hale and Keyser's (1993) proposal of L-syntax and S-syntax). The lexicon is a list of syntactic, morphological, and phonological irregularities (Ackema and Neeleman 2004: 50).

In (44) the building and insertion process is illustrated for A–N–N compounds. The [A–N]-component is built in the phrasal submodule (left). This [A N]-constituent is inserted (right) into an N node of a compound that is built in the morphological submodule (middle).

(44)



4.3 Assumptions

In addition to the model of Ackema and Neeleman (2004) about syntax-morphology-interactions, we will make the following assumptions: Morphological realization is postsyntactic (Distributed Morphology, see Halle and Marantz 1993). All syntactic operations are feature-driven. The two basic operations are *Merge* for structure building and *Agree* for argument encoding by case assignment/agreement. These are triggered by the following features (for notation see Sternefeld 2006; Heck and Müller 2007).

(45) *Two types of features that drive operations*

a. Structure building features (e.g., subcategorization features) [•F•] trigger Merge with an element that bears a corresponding feature [F].
b. Probe features [∗F∗] trigger Agree.

We adopt the following definition of Agree (based on Chomsky 2000, 2001b).

(46) Agree between a probe P and a goal G obtains if the following conditions are met:

a. P and G are in a c-command relation
b. G is the closest goal to P.
c. G is active (G has an unvalued case feature [C:□]).
d. P bears at least one unvalued probe feature (e.g., [∗ϕ:□∗]) and thereby seeks the value of a matching feature of G
... with the result that ...
e. G values P (results in [∗ϕ:F∗]) and P values G (results in [C:F]).

Thus, case assignment is a reflex of agreement in ϕ-features (see (46e)). The direction of Agree in (46a) is unspecified since we follow Baker (2008) in assuming that both options exist: the probe can c-command the goal (downward-Agree) or the goal can c-command the probe (upward-Agree) (see also Carstens 2016; Georgi 2014).

We take Agree to be feature-sharing (Frampton and Gutman 2006; Pesetsky and Torrego 2007). This means that after Agree between a probe and a goal, the two share their valued features. If G does not provide a value for P, P and G share the unvalued feature. This feature is valued on P and G later in the derivation by a probe P' which is specified for a value (for DP internal feature-sharing see also Georgi and Salzmann 2010).

There are two important principles that will be relevant for local Agree relations in our analysis: The Strict Cycle Condition and the Minimal Link Condition.

(47) *Strict Cycle Condition* (Chomsky 1973, 1993)
No rule can apply to a domain dominated by a cyclic node A in such a way as to effect solely a proper subdomain of A dominated by a node B which is also a cyclic node.

We follow McCawley (1988) in the view that every node is a cyclic domain.

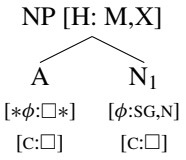
(48) *Minimal Link Condition* (Chomsky 1995, 2000)
An Agree operation involving α and β can only take place if there is no δ such that (i) and (ii) hold:
(i)δ is closer to α than β
(ii)δ bears a feature that has not yet participated in Agree.

As was argued for in Sect. 2.3, we assume that the basic structure of A–N–N compounds is $[_N\ [_{NP}\text{A}\ \text{N}_1]\ \text{N}_2]$.

4.4 Conflicting principles

The core of the analysis is the claim that the different strategies observed in the experiment are a consequence of the order of operations that apply. Adjectival inflection depends on (i) the order of the operations *Agree* and *Insertion* of the [A–N]-component into a morphological node and (ii) the interaction of these operations with the *Strict Cycle Condition* and the *Minimal Link Condition*. As we have seen in the previous section, A and N_1 are merged in the phrasal syntax submodule. This Merge results in an NP.

(49) Merge of A and N_1 (phrasal)



At this point of the derivation, there is more than one feature that needs to be discharged. On the one hand, there is the ϕ-probe that could be discharged via the operation Agree. On the other hand, the phrase is marked by a host-feature (see Ackema and Neeleman 2004). If this optional feature is present, it demands that this phrase has to be

inserted somewhere, in this case into a node X in the morphology submodule.[19] This feature can be discharged via the operation Insertion.[20] From an intuitive perspective, it makes sense to agree as soon as possible to receive a value, but it is also desirable to complete a word first before any syntactic operations apply to it, as it is normally the case when complex words are inserted into phrasal nodes. Formally speaking, we deal with the *Earliness Requirement* (Pesetsky 1989) which demands that operations must apply as soon as their structural conditions are met. Under the assumption that operations apply sequentially (see Chomsky 1965; Chomsky and Halle 1968; Kisseberth 1972; Koutsoudas 1972; Williams 1974; Epstein and Seely 2002; Georgi 2014 among others), there is obviously a dilemma: At the point of the derivation shown in (49), conditions for both Agree and Insertion are met. The conflict arises because Earliness holds for both operations. Müller (2004, 2009) discusses the same conflict between the operations Merge and Agree. He points out that conflicts between operations "must be resolved in a language by giving one Earliness requirement priority over the other in the case of conflict - in other words, by ranking the two requirements", (Müller 2004: 4).

A framework in which it can easily be modeled that requirements are ranked and that lower ranked requirements can be violated is Optimality Theory (OT, Prince and Smolensky 1993; McCarthy and Prince 2004). In the spirit of OT, we take the Agree-condition, the Minimal Link Condition and the Insertion operation to be violable constraints. The Strict Cycle Condition (SCC), however, is part of GEN, which means that it is not violable. This assumption follows from the observation that there is no evidence at all that the SSC could actually be violated. The only case in which a violation of the strict cycle has ever been argued for in the literature, is counter-cyclic adjunct insertion (Lebeaux 1988). Given that there is both strong empirical and conceptual evidence against late counter-cyclic adjunct insertion (see Chomsky 2001a; Fischer 2004 and references cited in the latter for alternative theories that account for the core data), we assume that the SSC is part of GEN.

In contrast, there is considerable evidence that the Agree condition is violable. It has been proposed that Agree is fallible in general (Preminger 2011) or specifically that Merge can take priority over Agree and vice versa (Assmann et al. 2015). As for the MLC, it has also been proposed to be a violable OT-constraint (Broekhuis and Woolford 2013) and see also Legendre et al. (1998); Hale and Legendre (2004); Vogel (2004) for the constraint 'BAR: A chain link may not cross a barrier', an optimality theoretical implementation for economy of movement.

Note that in contrast to standard global optimization processes, which assume that optimization applies to complete structures (see Grimshaw 1997; Pesetsky 1998; Legendre et al. 1998 among others), the optimazition that is assumed here is extremely local in the sense that it applies iteratively to small portions of structures. The com-

[19] In order to avoid a violation of the Inclusiveness Condition by adding a feature later to the derivation, we assume that the host-feature was present on the noun from the beginning. After Merge it was projected to NP.

[20] Ackema and Neeleman (2004) do not say anything about dischargement. As far as I understand them, the feature is just present like categorial features. We assume that in case this feature is present, it triggers the operation Insertion explicitly.

peting candidates are derivational steps (see Chomsky 2000; Epstein and Seely 2002; Heck and Müller 2007).[21]

In order to account for optionality in optimality theoretic terms, the concept of global ties has been proposed (Sells et al. 1996; Ackema and Neeleman 1998; Müller 2000b; Schmid 2001; Prince and Smolensky 2004; Müller 2012). Global ties can be understood as abbreviations for the simultaneous presence of different constraint rankings, in other words different grammars, in a language. A tie of two constraints A and B is rendered as A∘B. (see Müller 2012). Ordered global ties essentially work like this: "A constraint ranking that exhibits an ordered global tie of two constraints B∘C is underspecified; it is an abbreviation that encodes the simultaneous presence of two hierarchies that exhibit the rankings B≫C and C≫B, respectively. A candidate is grammatical if it qualifies as optimal under one of the possible resolutions of the tie" (Müller 2012: 25).

We claim that the Agree condition, the Insertion operation and the MLC are tied and that different resolutions of the tie lead to the four different concord strategies. This will be shown in Sect. 4.5. In Sect. 5.4, we discuss the six possible rankings (grammars) that result from the three tied constraints. We show that the theoretical distribution of the concord strategies reflects the frequency of used strategies in the experiment.

4.5 Derivations

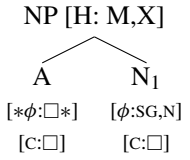
In the upcoming sections, we will give the detailed derivations and optimization processes for all four strategies step by step.

4.5.1 Strategy 1: agreement of A with N_1

When A and N_1 are merged, there are two operations that could apply next: Agree or Insertion, since the Earliness Requirement demands the dischargement of the ϕ-probe on A as well as the dischargement of the host feature. We will illustrate that agreement of A with N_1 is the consequence of the ranking Agree ≫ Insertion.

At the point of the derivation in (49), repeated in (50), there are two possible scenarios: agreement of A with N_1 or no agreement at all.

(50)



[21] Optimization has been suggested to apply to clauses (Ackema and Neeleman 1998), phases (Fanselow and Ćavar 2001; Müller 2000a), phrases (Müller 2000c; Heck and Müller 2000; Fischer 2004; Heck 2004), or after each step (Chomsky 2000; Epstein and Seely 2002; Heck and Müller 2007). The last, most radical view, which we assume here, is called *extremely local optimization* by Heck and Müller (2007).

One of the possible resolutions of the tie Agree ∘ Insertion ∘ MLC is the ranking Agree ≫ Insertion ≫ MLC. In (51), the optimization process under the ranking SSC ≫ Agree ≫ Insertion ≫ MLC is illustrated. This ranking leads to agreement of A with N_1.[22]

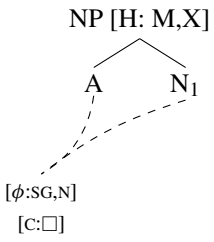
(51) SSC ≫ Agree ≫ Insertion ≫ MLC

Input	SSC	AGREE	INSERT	MLC
☞ 1. A targets N_1			*	
2. A does not probe		*!		

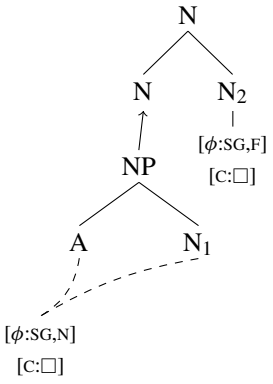
Since at this point of the derivation there is only one cycle present and since there is no intervening element between A and N_1, Candidate 1 neither violates the SCC nor the MLC. In the case of Candidate 2 where simply no Agree operation happens, there is also no violation of the two conditions. But if A targets no element at all (Candidate 2) and no agreement happens, the higher ranked requirement AGREE is violated. If the adjective targets N_1 (Candidate 1), the requirement of early INSERTION of the phrase is violated. But since this requirement is lower ranked, Candidate 1 wins the competition. The result is agreement of A and N_1.

After Agree has applied, A shares ϕ-features with N_1 and both share an unvalued case feature (see (52), feature-sharing is illustrated by the dotted lines). In the next step, NP is inserted into the node N in the word syntax submodule (see (53)).

(52) Agree of A and N_1



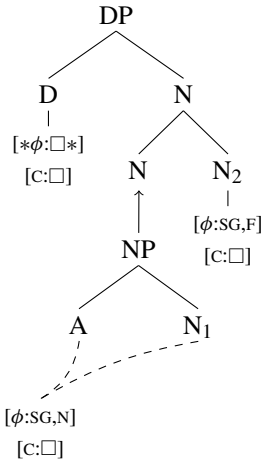
(53) Insertion of NP into N (after Agree)



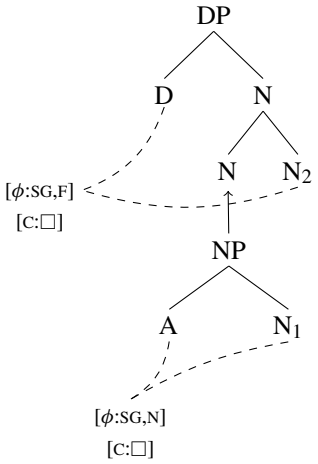
[22] The tableaux are read as follows: '*' indicates a violation of the constraint. '!' indicates the fatal constraint violation of each candidate. '☞' marks the winner of the competition.

The new complex noun is now combined with a determiner which results in a DP (see (54)). D agrees with the closest noun, which is N_2. Closeness is defined in terms of asymmetric c-command: α (N_2) is closer to β (D) than γ (N_1) if β (D) asymmetrically c-commands both α (N_2) and γ (N_1), and if α (N_2) asymmetrically c-commands γ (N_1).[23] After Agree, D and N_2 share N_2's ϕ-features and an unvalued case feature (see (55)).

(54) Merge of D



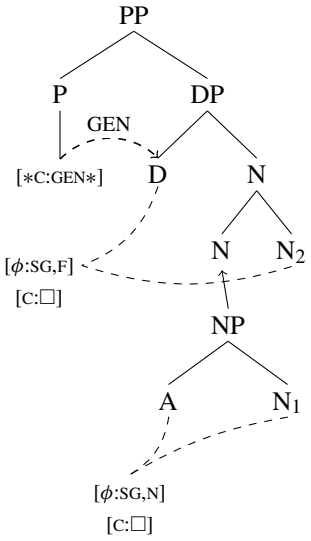
(55) Agree of D and N_2



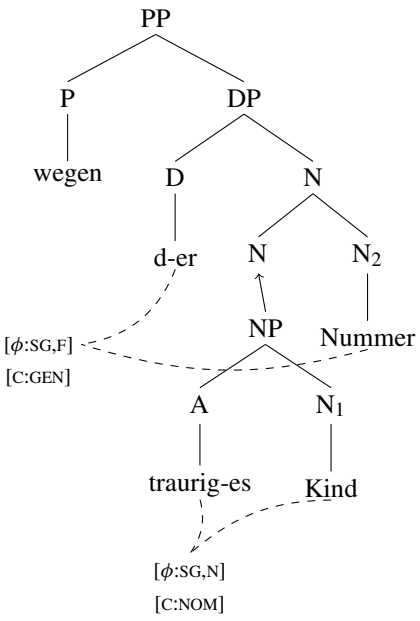
The next step is Merge of P. P has a case probe and assigns genitive case to D, as illustrated in (56). Since D shares an unvalued case feature with N_2, both receive genitive case.

[23] Note that the [A–N_1]-component itself is not a complex head or a terminal, but an NP. Insertion does not change the category of the inserted representation. The [A–N_1]-part is still a phrase. In Ackema and Neeleman's (2004) original proposal the inserted material is not actually present in the host structure. It is only a relation of feature matching. In this point, we differ from Ackema and Neeleman (2004) and rather follow Meibauer (2007), assuming that inserted representations are *really* inserted. So, we understand insertion more as an overwriting of the original N node. Since the discussed data suggest that the host structure can see material contained in the inserted structure (see Sect. 5.3 for further discussion), in this case it is N_1 that matters for closeness.

(56) Case assignment of P to D



(57) Structure after Spell-out



The PP-phase is now sent to spell-out. As can be seen in (56), the shared unvalued case feature of A and N_1 did not receive a value during the derivation.

Following De Belder and van Koppen (2014), who assume default valuation of unvalued definiteness features in Dutch, we assume default valuation of the unvalued case feature in German (see Preminger 2011). The shared unvalued case feature of A and N_1 receives nominative case, since nominative case is the unmarked case in German (see Bhatt 1990). Since there was no interaction of the adjective with the determiner, the adjective is marked with the marker that belongs to the strong inflection paradigm.[24] The adjective also shares ϕ-features with N_1. This is why the strong marker *-es* for the feature specification [SG,N] is chosen in the given example.

(58) Vocabulary item
A[[ϕ:SG,N],[C:NOM]] _ $\emptyset_{Det}$ ↔ *-es*

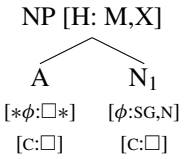
There is no overt nominative marker for the noun. (57) illustrates the final structure.

4.5.2 Strategy 2: agreement of A with N_2

The starting point for this derivation is again when A and N_1 are merged. A's ϕ-features and the host feature both need to get discharged.

[24] For a detailed explanation see Sect. 5.1.

(59) Merge of A and N_1 (phrasal)

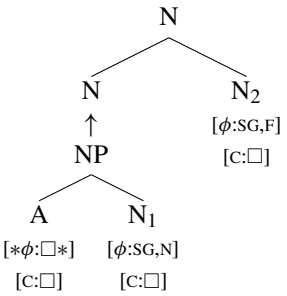


The crucial difference is that, this time, Insertion applies before Agree. The ranking is SSC ≫ Insertion ≫ Agree ≫ MLC. This leads to the opposite result from the one we saw in (51): since Insertion is higher ranked than Agree, the phrase is inserted into the morphological node immediately.

(60) Step 1: SSC ≫ Insertion ≫ Agree ≫ MLC

Input	SSC	INSERT	AGREE	MLC
1. A targets N_1		*!		
☞ 2. A does not probe			*	

(61) Insertion of NP into N (before Agree)



After insertion has applied, the probe on A is still unvalued and needs to search for a goal. N_1 is still the closest goal but since the structure is now inserted into the N node, N_2 is also present. Due to the high ranked Strict Cycle Condition (see (47)), A can only target N_2 now. Under the assumption that every node is a cyclic domain (see McCawley 1988), Agree of A with N_1 violates the Strict Cycle Condition. NP, which dominates A, is already dominated by another cyclic node (the root node N). The SSC would be violated, because Agree of A and N_1 would solely affect a subdomain of the highest cyclic domain (the root node N). In contrast, N_2 is only dominated by the root node N, which is not dominated at this point of the derivation. Therefore, the only possible goal for A to agree with is N_2. The second optimization step with all three possible candidates is shown in (62). INSERTION is not a requirement anymore, since it was already fulfilled in the first cycle.

(62) Step 2: SSC ≫ Insertion ≫ Agree ≫ MLC

Input	SSC	INSERT	AGREE	MLC
1. A targets N_1	*!			
☞ 2. A targets N_2				*
3. A does not probe			*!	

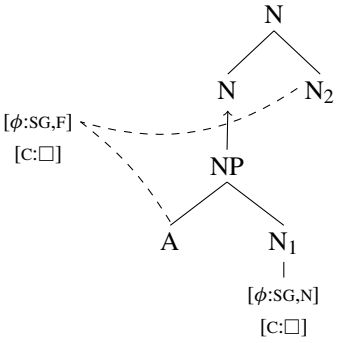
Candidate 1 is out, because it violates the highly ranked SSC. Candidate 3 is out, because no probing at all violates the Agree condition. The winning Candidate 2 also violates one requirement, namely the MLC.

(63) *Minimal Link Condition*
An Agree operation involving α and β can only take place if there is no δ such that (i) and (ii) hold:
(i)δ is closer to α than β
(ii)δ bears a feature that has not yet participated in Agree.

Agreement of A and N_2 violates the MLC because (i) N_1 is closer to A and (ii) N_1 has not yet participated in Agree. However, since the MLC is ranked the lowest, the violation of this requirement is not a fatal one. Candidate 2 is the most optimal candidate and wins the competition in this case.

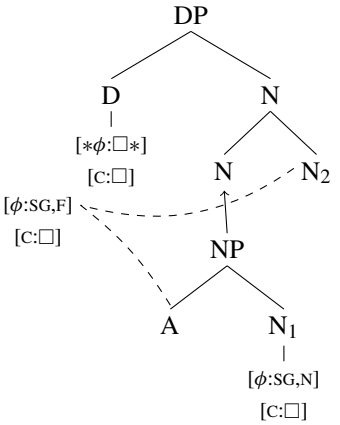
After Agree, A and N_2 share an unvalued case feature and N_2's ϕ-features, as shown in (64).

(64) Agree of A with N_2 (after Insertion)

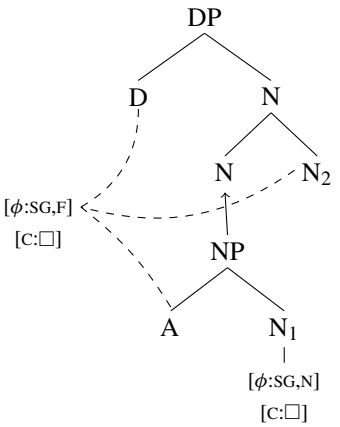


The next step is Merge of D (see (65)). D agrees with the closest noun, which is N_2. As shown in (66), after Agree, D and N_2 share N_2's ϕ-features and an unvalued case feature, which are also shared with A.

(65) Merge of D

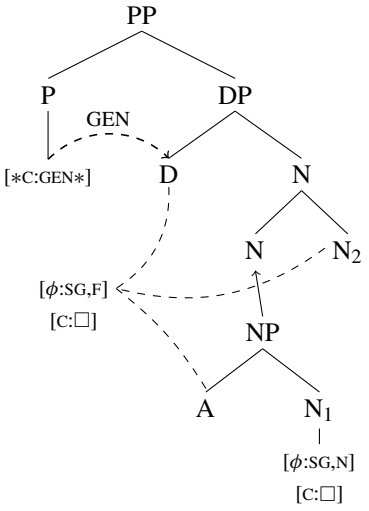


(66) Agree of D and N_2

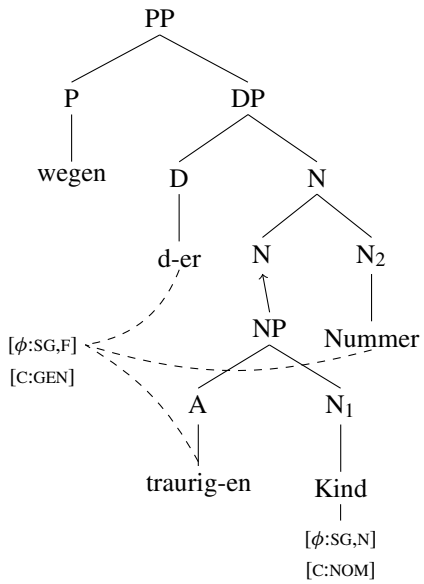


When P is merged, its case probe assigns genitive case to D. Since D shares a case feature with A and N_2, D, A and N_2 receive genitive case (see (67)). N_1, in contrast, never took part in any Agree relation. Its unvalued case feature gets valued by default (nominative case). The final structure after Spell-out is shown in (68). The vocabulary item for an adjective with the feature specification *singular, feminine, genitive* in the context of a determiner is *-en*.

(67) Case assignment of P to D



(68) Structure after Spell-out



(69) Vocabulary item
A[[ϕ:SG,F],[C:GEN]] _D ↔ *-en*

4.5.3 Strategy 3: no agreement, no marker

Strategy 3 is the one where no compound internal inflection is present.

(70) a. [$_N$ [$_{NP}$ [$_A$ Rot] [$_N$ kreuz]] schwester]
red *cross.*N *nurse.*F
'Red Cross Nurse'
b. [$_N$ [$_{NP}$ [$_A$ Schön] [$_N$ wetter]] wolke]
nice *weather.*N *cloud.*F
'Nice weather cloud'

38.8% of the items in the experiment were treated this way. As we have seen in Sect. 2.3.1 , the [A–N]-component has the stress pattern of a phrase and not the one of a regular [A–N]-compound. Based on this evidence from stress, we treat the [A–N]-part as an uninflected phrase instead of a word.

Why does Strategy 3 arise? As already mentioned, we argue that the requirements AGREE, INSERTION and MLC are not strictly ordered with respect to each other. Compound internal concord results in Strategy 3 when the MLC is higher ranked than the Agree condition. After Merge of A and N_1, the first optimization process is equal to the one for Strategy 2. Candidate 2 (no probing) wins over agreement with N_1. The evaluation where Agree is higher ranked than the MLC is shown in (71).

(71) Step 1: SSC ≫ Insertion ≫ MLC ≫ Agree

Input	SSC	INSERT	MLC	AGREE
1. A targets N_1		*!		
☞ 2. A does not probe				*

The difference between Strategies 2 and 3 is due to the second optimization when the [A–N]-constituent is inserted. As before, there are three potential candidates now: A could target N_1, N_2 or no element at all. Targeting N_1 is not an option because of the highly ranked SSC. Targeting N_2 is out, because it violates the MLC. This time, the violation of the MLC is fatal, because it is higher ranked than Agree. Under this ordering, no agreement at all is the most optimal candidate, as can be seen in (72).

(72) Step 2: SSC ≫ (Insertion) ≫ MLC ≫ Agree

Input	SSC	INSERT	MLC	AGREE
1. A targets N_1	*!			
2. A targets N_2			*!	
☞ 3. A does not probe				*

The consequence is that the [A–N]-component is sent to spell-out without having agreed with anything. This is why we do not see any marker on the adjective.

(73) Vocabulary Item
A[[ϕ:□],[C:□]] ↔ Ø

4.5.4 Strategy 4: no agreement, -e-marker

1.9% of the tested items neither showed agreement with N_1 nor with N_2, but the adjective was marked with an *-e*. Examples are given in (74).

(74) a. mit d-er Traurig-e Kind Nummer
with the-F.SG.DAT *sad*-INFL *child*.N.SG.NOM *number*.F.SG.DAT
'with the attitude of a sad child'

b. wegen d-er Rot-e Kreuz Schwester
because.of the-F.SG.GEN *red*-INFL *cross*.N.SG.NOM *nurse*.F.SG.GEN
'because of the Red Cross Nurse'

c. mit d-em Fleißig-e Autor Gesicht
with the-N.SG.DAT *hard.working*-INFL *author*.M.SG.NOM *face*.N.SG.DAT
'with the face of a hard-working author'

If there was agreement with N_1, we would see the marker *-es* (for a neuter N_1 as in (74a) and (74b)) or *-er* (for a masculine N_1 as in (74c)). If there was agreement with N_2, we should get the marker *-en* in all cases.

Since there is definitely no agreement with any of the nouns, we assume that this strategy syntactically equals Strategy 3. This means that in the course of the derivation the adjective is not in an Agree relation with any of the nouns. In that case, for the majority of speakers this leads to a bare adjective (38.8% of responses) as presented in the previous section. Obviously, some speakers (less than 2% of responses) do not allow for completely uninflected attributive adjectives (they are rarely used in German, basically in idiomatic expressions only like *auf gut Glück* 'on the off chance', lit: 'on good luck' or *ruhig Blut* 'keep cool', lit: 'calm blood'). We assume that the *-e* (*schwa*) is inserted at PF as a last resort strategy to avoid bare attributive adjectives.

It is not surprising that phonology chooses a marker that is on the one hand a very common one, in other words, an underspecified one (compare the adjectival inflection paradigms in Tables 1 and 2), and on the other hand it is phonologically the least complex one (in comparison with other common markers like, e.g., *-en*). Maybe the appearence of the *schwa* (also) depends on phonological requirements triggered by the adjective itself (syllabic structure, moraic structure etc.). To test this, further empirical work is required.

5 Discussion of remaining questions

In this section, we want to discuss the following remaining questions:

(75) a. Why does Strategy 1 always lead to strong adjectival inflection and Strategy 2 always to weak adjectival inflection?

b. What does the analysis predict for regular/general agreement of an attributive adjective with a noun?
c. Why is it that not all phrasal compounds interact with their host structure?
d. How does the analysis account for the distribution of N_1-, N_2- and Ø-agreement revealed in the experiment?

5.1 Weak versus strong inflection

In the German DP, we get *monoinflection* (see Helbig and Buscha 2001: 274). This means that gender, number and case are only expressed once, either on the determiner or on the adjective. If the adjective is preceded by a determiner that does not indicate these categories, e.g., the indefinite article *ein* 'a' or the possessor *sein* 'his', the so-called strong paradigm is used. The same holds if there is no determiner present. If the adjective is preceded by a determiner which *does* indicate the categories number, gender and case, e.g., the definite article *d-er/d-ie/d-as* 'the' or the demonstratives *dies-e/dies-er/dies-es* 'this', the weak paradigm is used.

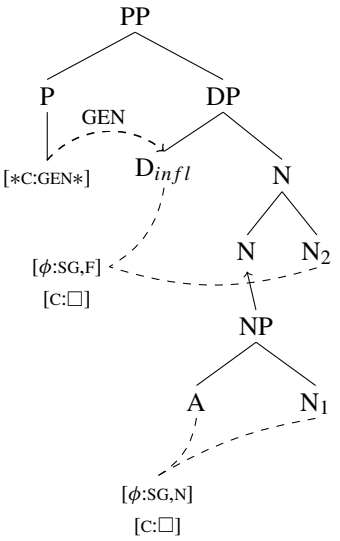
For German A–N–N compounds, the following generalization holds: Strategy 1 always goes hand in hand with strong adjectival inflection. Strategy 2 always implies weak adjectival inflection. In this subsection, we will show that the presented analysis captures this generalization.

Whether a determiner is able to indicate gender, number and case has to be encoded somehow in the grammar. We assume that this is done by a diacritic.[25] Determiners that indicate gender, number and case are marked with the diacritic *Infl*. Under this assumption, adjectival inflection can be explained as follows: If an adjective shares ϕ-/case-features with a determiner which has the inflection-diacritic, post-syntactic morphology chooses the weak paradigm. If it shares its features with a determiner that has no diacritic or if there is no determiner present, the strong paradigm is chosen. Turning back to A–N–N compounds, recall that in the case of Strategy 1, the adjective shares its features only with N_1 (see (76)). It does not share them with the determiner. This is why morphology chooses the strong paradigm, although the definite article has the diacritic which says that it is able to indicate gender, number and case features. In other words, in this case we get 'double inflection' instead of monoinflection, because there is no connection between the determiner and the adjective.

In the case of Strategy 2 (see (77)), the determiner also has the diacritic. But in this case, the adjective shares its features with the determiner. Since this connection is established in syntax (via Agree), morphology chooses the weak adjectival inflection paradigm.

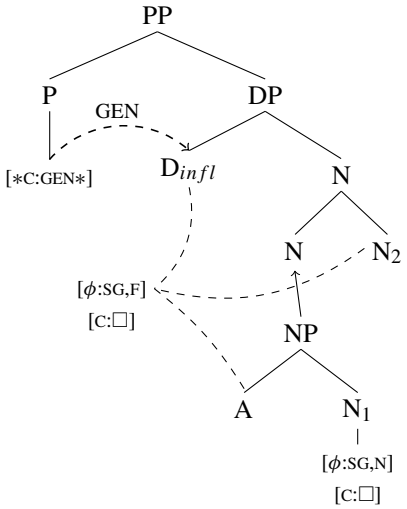
[25] This is just one possibility. There might be other solutions like an additional feature, etc.

(76) Strategy 1



Vocabulary item:
A[[ϕ:A,B],[C:X]] ↔ strong inflection

(77) Strategy 2



Vocabulary item:
A[[ϕ:A,B],[C:X]] _D_{infl} ↔ weak inflection

5.2 Predictions for regular agreement of attributive adjectives

Since Agree can be ranked low and therefore has to 'wait' sometimes or does not apply at all, wouldn't this analysis predict that we should see uninflected attributive adjectives more often? The answer is no, because in the case of simple Merge of an attributive adjective with a noun, the two operations Agree and Insertion do not co-occur. When an adjective and a noun are merged without being inserted into an N in the word syntax submodule, there is no reason to assume a feature that indicates that the phrase wants to be inserted. In other words, if there is no insertion to be done, there is no host-feature present which could be in conflict with a probe-feature.

In (78), the constraint INSERT is irrelevant because Insertion is not required. The optimal candidate is always the one where A agrees with N_1, regardless of the ranking of Agree and the MLC. It does not violate any of the remaining constraints, whereas the alternative candidate violates the Agree condition.

(78) SSC ≫ Insert ≫ Agree ≫ MLC

Input	SSC	INSERT	AGREE	MLC
☞ 1. A targets N_1				
2. A does not probe			*!	

5.3 Interaction of inserted structure with host structure

We briefly want to discuss the interaction of the inserted structure with its host structure. Ackema and Neeleman (2004) explicitly state that there should be no interaction: "Given our reasoning in the previous sections, we predict that phrases embedded in words are invisible to processes in the morphological representation". The German data show, as supported by the presented experiment, that this prediction is sometimes correct (when A agrees with N_1) and sometimes not (if A agrees with N_2). In sum, we have seen evidence from Dutch (see De Belder and van Koppen 2014) and from German for the fact that the adjective of an inserted [A–N]-component *has* the possibility to interact with its host structure. But why is it only the $[_{NP}$ A N]-constituent that can interact with its host structure? Other phrasal compounds do not seem to interact with their hosts. The explanation is again that other phrasal compounds do not get to the point where the Agree-Insertion conflict could arise. If a CP is inserted (e.g., $[[_{CP}$ Ich-mag-dich]-Blick] 'I-like-you-view'), all Agree operations (verbal agreement with the subject) have already applied within the vP. The projection where the host-feature becomes relevant, the CP in the upper example, is not yet present in the structure when Agree applies. Therefore, there is no potential conflict as is the case for A–N–N compounds.

5.4 Empirical distribution of the strategies

A further point which speaks in favour of the analysis is that it predicts the correct empirical distribution of N_1-, N_2- and Ø-agreement as revealed in the experiment.

From our experiment we can conclude that the rankings are mostly a product of individual speakers' preferences, and only very weakly sensitive to linguistic variables. In this case, we might expect that all three mainly attested strategies, N_1-, N_2- and Ø-agreement, are equally distributed (around 33.3% each). But this is not the case. Recall the results of the experiment presented in Sect. 3.2: N_1-agreement was the most frequent one, Ø-agreement was the next most frequent and N_2-agreement was the least frequent. This needs to be explained. The explanation can be derived if we have a look at the possible rankings and their respective resulting agreement strategies. Since we propose three unordered (tied) constraints (Agree, Insertion, MLC), we expect six possible rankings. These rankings are listed in (79).

Furthermore, (79) shows that three out of these six possible rankings lead to agreement with N_1.[26] These are rankings a), b) and e). Agreement with N_1 and no agreement at all are the only possible candidates in the first optimization step. But since in these three rankings Agree is higher ranked than Insertion, it is always N_1 that is targeted by Agree (cf. the tableau in (51) for the full optimization under ranking a)).

[26] Elements which end up agreeing with the adjective are circled.

Two out of the six rankings lead to Ø-agreement. These are ranking d) and ranking f). After the first optimization, Agree did not apply because under this ranking Insertion was more important (cf. the tableau in (71) for this step under ranking d)). So the probe on the adjective is still active and it has a second chance to get valued after Insertion has applied. The two possible candidates are agreement with N_2 or no agreement at all.[27] Since the MLC is higher ranked than Agree, the resulting strategy is no agreement at all (cf. the tableau in (72)).

The only possible ranking which leads to N_2-agreement is the one in c). Insertion is ranked the highest and leads to no agreement in the first optimization step (cf. the tableau in (60) for Optimization 1 under ranking c)). Since Agree is higher ranked than the MLC, this ranking leads to agreement with N_2 (cf. the tableau in (62) for Optimization 2).[28]

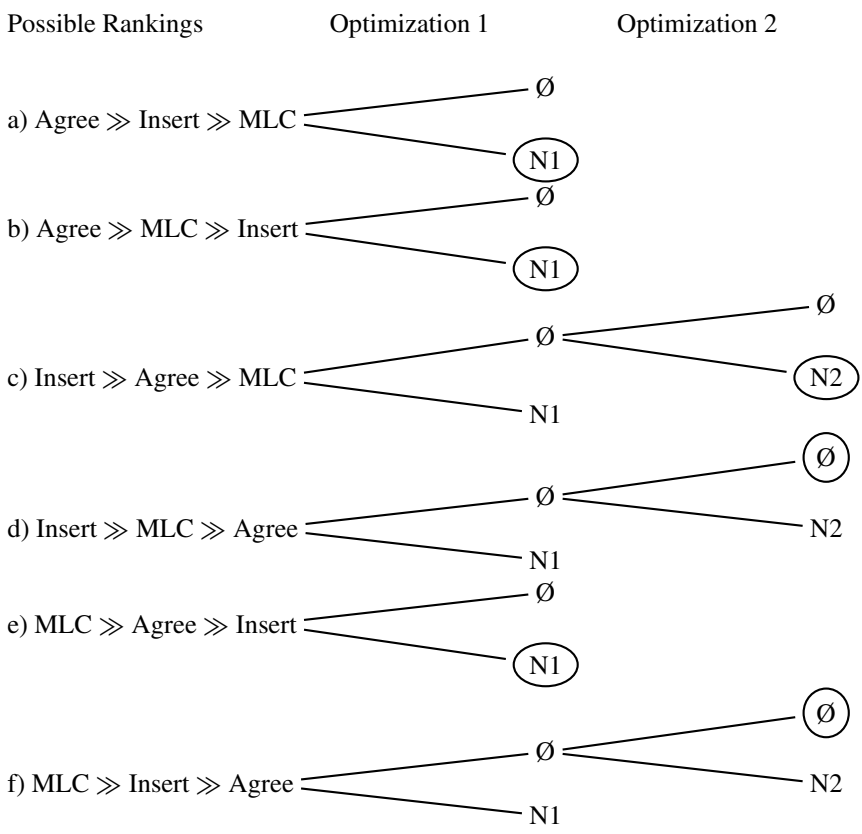
Summarizing, we predict the following: N_1-agreement should be the most frequently occuring strategy. Given the six rankings, N_1-agreement is the resulting strategy under three rankings out of six. In contrast, Ø-agreement should occur less frequently, since it is the resulting strategy under two rankings out of six. Finally, we predict N_2-agreement to be the least frequently occuring strategy, since there is only one ranking out of six under which N_2-agreement is the resulting strategy. This is exactly the distribution we found in the experiment.

[27] Agreement with N_1 is a candidate as well, but it has not been included in the overview since it can never win due to the high ranked Strict Cycle Condition.

[28] As we reported in Sect. 3.2, one speaker can use multiple rankings/grammars. Eleven speakers always used the same concord strategy, so they obviously have only one single ranking/grammar available. Nine speakers had 2 different strategies, 7 speakers had 3 different strategies and 4 speakers used all four attested strategies. From our experiment, we can conclude that the choice of rankings is mostly a product of individual speakers' preferences, and only very weakly sensitive to linguistic variables. The fact that speakers have different preferences or rather use some options more frequently than others, is not a unique one. Such cases have been addressed under the label *Stochastic OT*, a version of the concept of ordered global ties (see Anttila 1997; Boersma and Hayes 2001; Hayes 2001 for phonological phenomena and for syntactic applications see Aissen 2003a, b (on optionality with differential object marking and with DP-internal possessor placement), Bresnan et al. 2001 (on optionality in passive formation) and Bresnan et al. 2007 (on types of inflection of the verb *be*, including negation, in varieties of English)).

An alternative OT-model that could account for the alternate constraint rankings within individual speakers is one introducing floating constraints as proposed by Reynolds (1994). Within this model, hierarchical rankings of floating constraints may change in a principled manner in relation to a certain subset of other constraints whose ranking is fixed, allowing different forms to be optimal under different rankings (see Nagy and Reynolds 1997 for variable word-final deletion in Faetar).

(79)



6 Conclusion

The adjective in German A–N–N compounds shows a variety of possibilities to inflect for case: it can either agree with the first noun, with the second noun or with neither of them. This is interesting, because German normally lacks compound internal inflection. This paper had two goals: the first goal was to prove that all three concord strategies are attested. This was successfully done by a production-task experiment. One of the attested strategies, agreement of the adjective with N_2, is unexpected from a theoretical point of view, because it seems to violate the Earliness requirement and the MLC. The second goal of the paper was to derive all patterns theoretically and especially to explain why the unexpected pattern exists.

First, it was shown that A–N–N compounds are real compounds and not phrases. Evidence for the word status comes from their headedness and from tests that show that they are anaphoric islands as well as islands for extraction. They clearly differ from phrases, but it was also shown that they are neither regular N+N compounds that are modified by an adjective, nor that the [A–N]-component is an A+N compound

itself (stress pattern). Based on all this evidence, it can be concluded that they are real phrasal compounds.

Our claim is that the semantic relation in A–N–N compounds is always represented correctly and that the [A–N]-component is always a phrase. As a consequence, the different observed inflection strategies are not due to different structures (contra Lawrenz 1995). We rather argue that the observed diversity is a consequence of the order of syntactic operations that apply: In German A–N–N compounds, adjectival inflection depends on (i) the order of the operations Agree and Insertion and (ii) on the interaction of these operations with the Strict Cycle Condition and the Minimal Link Condition.

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