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German Word Stress in Optimality Theory *

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Introduction

Stress has always been a recurrent theme in phonology, even more so since Liberman's dissertation (1975), in which the foundations of metrical theory were established. Liberman's view of stress as a phonetic means of grouping linguistic elements has found considerable agreement in the phonological community. However, the nature of both the groupings and the elements to be grouped is still a matter of debate. In this paper I make the very conventional assumption that syllables are grouped into feet.

Studies on stress systems fall into two classes. First, extensive typological studies, like those of Halle and Vergnaud (1987), Hayes (1980, 1995), and Idsardi (1992), for instance, compare the stress systems of a large number of languages and propose parameters of stress assignment and/or feet inventories. The second class of studies examine in detail the stress pattern of a single language or a language family from a theoretical point of view. The present paper falls into the second class. Close studies of individual language stress systems are important since they are a way of testing the validity of metrical theories. Though some languages have been extensively studied and can be claimed to be fairly well understood, this is far from being true of all languages.

This paper shows that Optimality Theory (OT) is able to elegantly capture the intricacies of German stress without too many special stipulations. OT is a theory of grammar recently developed by Prince and Smolensky (1993) and McCarthy and Prince (1993a, b, 1994, 1995), who have applied it to phonological facts from different languages. So far, the theory has been

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very successful in accounting for different aspects of phonology in several languages, particularly in the area of stress and related phenomena (see for instance the analyses proposed in Hammond 1995; Hung 1995; McCarthy and Prince 1993b; Pater 1995; Truckenbrodt, to appear; van de Vijver 1998; and Walker 1997, among others). OT offers simple means for representing stress. According to the theory, universal grammar provides a set of universal constraints, and the grammars of individual languages consist of at least one ranking of these constraints, which interact to select, for each input form, the optimal surface structure from a set of candidates. In the case of stress, fully metrified candidates are compared, and the one which best satisfies the constraints is grammatical. In particular, the technique of ranking constraints can be shown to solve some of the problems posed by an account of German lexical stress.

German stress is in need of a theoretical account since it has a number of intricacies which have led to conflicting analyses, some of which are compared at the end of this paper. The solution offered in the present paper is based on an extensive study of the data. In this, it differs from earlier proposals which typically take a small number of words into consideration. A second difference from earlier analyses comes from what are considered as light and heavy syllables. Here it is proposed that there is indeed a weight distinction in the German syllables, but of a different kind. Open syllables, which always have a tense vowel in their nucleus, as well as syllables with a lax vowel and a single closing consonant or glide, are light. Syllables with a tense vowel and a closing consonant and those with a lax vowel and two closing consonants are heavy. In short, the heavy syllables have an additional consonant as compared to the light ones. Furthermore, they are – nearly always – word-final. German also has a third type of syllable, the schwa syllable, with a schwa or a syllabic sonorant in its nucleus. The schwa syllables are never stressed and are metrically inert in a large part of the phonology. Thus the following hierarchy of syllable weight is assumed for German, where VV stands for long tense vowels and V for lax or short tense ones:[1] CVCC, CVVC > CVC, CVV, CV > Cə, where ə is a schwa or a syllabic sonorant.

The three kinds of syllables are illustrated in (1). Here and below, syllabification is indicated. Ambisyllabicity is expressed by a dot under the ambisyllabic consonant.

[1] The tense vowels are [i, y, e, ø, u, o] and the lax ones are [ɪ, ʏ, ɛ, œ, ʊ, ɔ]. [ɛ] is the only lax vowel that can be long. [a] has a different behavior: long [ɑ] is laxer than short [a].

(1) a. Open syllables with a tense vowel or closed syllables with a lax vowel, includingthose with an ambisyllabic closing consonant, are light.

Ökonomíe	[ø.ko.no.mi:]	‘economics’
Müll	[mʏl]	‘garbage’
Róbbe	[ʁɔb̥ə]	‘seal’
Ámeise	[ɑ:.maɪ̯̂.zə]	‘ant’

b. Syllables with a tense vowel and a closing consonant or with a lax vowel and two closing consonants are heavy.

Kamél	[ka.me:l]	‘camel’
Katafálk	[ka.ta.falk]	‘catafalque’

c. Syllables with a schwa or a syllabic sonorant in their nucleus are never stressed.

Róbbe	[ʁɔb̥ə]	‘seal’
Vógel	[fo:.gl̩]	‘bird’
báden	[bɑ:.dn̩]	‘rain’

The third novelty of the present paper lies in the analysis itself. Each word has a primary stress, which, in the regular case, comes from a word-final trochee. There is also an optional secondary stress at the beginning of the word, which is claimed to come from a word-initial trochee. Hence, a German word has at most two stresses, one final and one initial. Stress clashes are avoided, which means that the initial stress is realized only when the word is long enough to have an unstressed syllable between the initial and the final stress.[2] Nontrochaic stress patterns are analyzed either as a consequence of the weight of the final syllable (a heavy syllable is stressed) or as resulting from exceptional stress assignment. Three kinds of exceptional stresses are attested: final stress on a light syllable, penultimate stress on a word with a heavy final syllable and antepenultimate stress. Antepenultimate stress is in general possible only if the penult is an open syllable.

The paper is organized as follows. Section 1 examines the data. Section 2 presents an analysis of the regular stress patterns, and section 3 an analysis of the exceptional ones. Section 4 compares the present proposal with some past analyses of German lexical stress. Section 5 sums up the results.

[2] In words of more than four syllables, an additional rhythmic stress can be realized on every other syllable starting from the beginning or from the end of the word. Thus *Meteorologie* can be realized as *Mèteorologíe*, *Mèteòrologíe*, or *Mèteoròlogíe*, regardless of the melodic composition of the medial syllables (but see Alber 1997).

1. Data and generalizations

This section introduces the data and demonstrates the quantity sensitivity of German. The large lexical database CELEX, developed at the Max-Planck-Institute in Nijmegen, was used to examine the relation between syllable structure and stress in monomorphemes. The version of CELEX used for the present investigation consists of a list of about 52,000 words, both monomorphemic and complex. The information used was the orthographic list, the phonetic transcription and the accent pattern. The list was purged manually of monosyllabic words, proper names, derivations, compounds, occasional mistakes, and redundancies. The remaining list of monomorphemes contains about 6100 words: 3425 disyllabic, 1312 trisyllabic, 991 quadrisyllabic, and 384 longer words. In taking CELEX as the source of this investigation, large coverage of the data rather than exhaustivity was aimed at. Of course, all exact numbers given here are to be taken with a grain of salt, since CELEX does not include the entire German vocabulary. However, one can be confident that the proportions, expressed in percentages, are representative of the language as a whole.

The following generalizations emerge from a close examination of the data:

1) If a word has a heavy syllable, it is generally the final one.
2) Heavy syllables are stressed.
3) If a word has no heavy syllable, stress is on the penult or on the antepenult.
4) A superlight syllable is never stressed.

Recall the syllable weight contrasts introduced in the first section. Syllables are heavy if they have the composition CVVC and CVCC, where VV stands for long tense vowels and V for lax or short tense ones. All other syllables, CVC, CVV, CV, or Cə, are light – and Cə syllables are even superlight.

1.1. *Overview of the data*

Before the generalizations are illustrated in section 1.2 (see tables (10) to (14)), a discussion of the data is necessary. The disyllabic, trisyllabic, and longer words are introduced in turn.

First, take a look at the disyllabic words. Table (2) gives an overview of their stress patterns. After elimination of the complex words and some mistakes and redundancies, there remain about 3425 disyllabic monomorphemes in CELEX. Only those in the left column of (2) with a full vowel in each syllable are considered in further discussion below – all in all 1495 words – since the words with a final schwa (about 1930, as shown in the

right column of (2)) have predictable stress on the first syllable, due to the unstressability of schwa syllables. There are no monomorphemes with initial schwa syllables.[3]

(2) Disyllabic monomorphemes

	full vowel in 2nd syllable	schwa in 2nd syllable
stress on the 1st syllable	577	ca. 1930
stress on the 2nd syllable	918	0

Some examples of initially stressed disyllabic monomorphemes, organized by weight patterns, are listed in (3). It can be seen that most of these words (85%) have a final light syllable.

(3) Examples of disyllabic words with initial stress

a. Light-Light (472 words, 82%)

Gécko	[gɛk̩o]	‘gecko’
Vílla	[vɪl̩a]	‘villa’
Púdding	[pʊd̩ɪŋ]	‘blancmange’
Mámmut	[mam̩ut]	‘mammoth’
Dráma	[dʁɑ:.ma]	‘drama’
Júdo	[ju:.do]	‘judo’
Bíson	[bi:.zon]	‘bison’
Éfeu	[e:.fɔɣ̟]	‘ivy’
Áuto	[au̯.to]	‘car’
Fírma	[fʁ̟.ma]	‘company’
Kürbis	[kʏʁ̟.bɪs]	‘pumpkin’
Schárlach	[ʃaʁ̟.lax]	‘scarlet fever’

b. Light-Heavy (83 words, 14%)

Phárynx	[fɑ:.ʁʏŋks]	‘pharynx’
Gépard	[ge:.paʁ̟t]	‘cheetah’
Démut	[de:.mut]	‘humility’
Plátin	[plɑ:.tin]	‘platinum’
Índex	[ɪndɛks]	‘index’
Schícksal	[ʃɪk.zɑ:l]	‘destiny’

[3] Complex words can have an initial schwa syllable, like for instance those formed with the prefixes *ge-* or *be-* (*Geschréi* ‘shouting’ [gə.χʁaɪ̯], *Beámte* ‘civil servant’ [bə.am.tə]).

c. Heavy-Light (17 words, 3%)

éxtra	[ɛks.tχa]	‘extra’
Árktis	[aɐ̯k.tɪs]	‘Arctic’
Műesli	[my:s.li]	‘muesli’
Plánkton	[plaŋk.ton]	‘plankton’

d. Heavy-Heavy (5 words, 1%)

Léutnant	[lɔɤ̯t.nant]	‘lieutenant’
Sándwich	[sɛnt.vɪtʃ]	‘sandwich’

In (4), the finally stressed disyllabics are also organized in several weight patterns. The majority of finally stressed words (79%) have a final heavy syllable.

(4) Examples of disyllabic words with final stress

a. Light-Heavy (706 words, 77%)

Figúr	[fi.gu:ɐ̯]	‘figure’
Fasán	[fa.zɑ:n]	‘pheasant’
immún	[i.mu:n]	‘immune’
Kamél	[ka.me:l]	‘camel’
Studént	[ʃtu.dɛnt]	‘student’
Aláun	[a.laʊ̯n]	‘alum’
Menthól	[mɛn.to:l]	‘menthol’
Reptíl	[ʁɛp.ti:l]	‘reptile’
kompákt	[kɔm.pakt]	‘compact’
Diphtóng	[dɪf.tɔŋ]	‘diphthong’

b. Light-Light (125 words, 21%)

Kopíe	[ko.pi:]	‘copy’
Büró	[by.ʁo:]	‘office’
Spinétt	[ʃpi.nɛt]	‘spinet’
Hotél	[ho.tɛl]	‘hotel’
Schafótt	[ʃa.fɔt]	‘scaffold’
Apríl	[a.pχɪl]	‘April’

c. Heavy-Heavy (17 words, 2%)

Symptóm	[zʏmp.to:m]	'symptom'
Textíl	[tɛks.ti:l]	'textile'
extrém	[ɛks.tre:m]	'extreme'
Skulptúr	[skʊlp.tu:ɐ̯]	'sculpture'

The second set of data consists of the trisyllabic monomorphemic words, the classification of which is given in table (5). Unlike in the case of disyllabics, trisyllabic words containing schwas have to be taken into consideration since the presence of a schwa in a syllable does not necessarily imply stress on the preceding syllable. However, we will see that the following generalization holds for a large majority of words: Schwa is final and correlates with main stress on the penult. Table (5) illustrates the point. There are 528 trisyllabic words with final schwa and penultimate stress, but only 38 with final schwa and antepenultimate stress. Many of these 38 words have an alternative pronunciation as disyllabics – like *Prämie* or *Linie* (see below).

(5) Trisyllabic monomorphemes

	Words with final schwa	Words with final full vowel	Total
stress on the antepenult (σσσ)	38 (15%)	217 (85%)	255 (19%)
stress on the penult (σσσ)	528 (80%)	136 (20%)	664 (51%)
stress on the final syllable (σσσ)	0	393 (100%)	393 (30%)

(6), (7), and (8) list examples of trisyllabics with antepenultimate, penultimate, and ultimate stress.

The last syllable is light in 68% of the words with antepenultimate stress (6a, b). It is a schwa syllable in 15% of the these words, some of which are shown in (6c, d), and heavy in 17% of them (6e). The stressed syllable is nearly always light. Only the word *Rosmarin* 'rosemary', which has a strong flavor of compounding, has a heavy stressed syllable. The second syllable is a superlight schwa syllable in 6% of the words – as in *Kabeljau* 'cod' in (6b) – and light in all other cases. As already mentioned, some of the trisyllabic words with antepenultimate stress have an alternative pronunciation as disyllabics if there is a hiatus between the second and the third syllable. This happens only if the second syllable has a simple onset and a high vowel in its rhyme - as in *Prämie* 'bonus' and *Stadion* 'stadium' in (6c) – but not if the onset of the second syllable is complex. Thus *Februar* or *Pankreas* cannot be pronounced as disyllabics.

(6) Trisyllabic words with antepenultimate stress (255 words)

a. All three syllables are light

Éxodus	[ɛk.so.dʊs]	‘exodus’
Álbatros	[al.ba.tχɔs]	‘albatross’
Léxikon	[lɛk.si.kɔn]	‘encyclopedia’
Kólibri	[ko:.li.bʁi]	‘humming bird’
Gígolo	[ʒi:.go.lo]	‘gigolo’
Páprika	[papχi.ka]	‘pepper’

b. The initial and ultimate syllables are light, the penultima is a schwa syllable

Séllerie	[zɛl̥ə.ʁi]	‘celery’
Búmerang	[bu:.məʁaŋ]	‘boomerang’
Kábeljau	[kɑ:.bəl.jaʊ̯]	‘cod’

c. Words with a hiatus between the second and third syllable

Prắmie	[pχe:.mi.ə]	‘bonus’
Línie	[li:.ni.ə]	‘line’
Stádion	[ʃtɑ:.di.ɔn]	‘stadium’
Thýmian	[ty:.mi.an]	‘thyme’
Spézies	[ʃpe:.tsi.ɛs]	‘species’
Pínguin	[piŋ.gu.i:n]	‘penguin’
Ózean	[o:.tse.an]	‘ocean’
Fébruar	[fe:.bʁu.aɐ̯]	‘February’
Pánkreas	[paŋ.kχe.as]	‘pancreas’
Émbryo	[ɛm.bʁy.o]	‘embryo’

d. Words with a final schwa syllable

Hérberge	[hɛɐ̯.bɛɐ̯.gə]	‘inn’
Ámeise	[ɑ:.maɪ̯.zə]	‘ant’
Éidechse	[aɪ̯.dɛk.sə]	‘lizard’
Róboter	[ʁo:.bo.tɐ]	‘robot’
Áraber	[ɑ:.ʁa.bɐ]	‘Arab’
Mánager	[mɛnɪd̥ʒɐ]	‘manager’

e. The first two syllables are light and the last one is heavy

Índolenz	[ɪn.do.lɛnts]	‘indolence’
Kórridor	[ko:.ʁi.doɐ̯]	‘corridor’
Hárlekin	[haɐ̯.lə.kin]	‘harlequin’
Pélikan	[pe:.li.kan]	‘pelican’

In all 664 trisyllabic words with penultimate stress, the first and second syllables are light, except in the word *Apartment*, which is a non-assimilated loanword. It has already been mentioned that in most words with a final schwa syllable stress is on the penult. This is confirmed by the data. There are 566 trisyllabic words with a final schwa; 38 have an antepenultimate stress, and 528 have a penultimate stress. Thus, 93% of the words with final schwa have penultimate stress. Moreover, the last syllable is a schwa syllable in 80% of the words with penultimate stress, some of which are listed in (7a). The last syllable is light in the remaining 20%. It is an open syllable in 74 words, as in (7b), and a closed one in 62 words, as in (7c).[4] There is no trisyllabic word with penultimate stress and a heavy final syllable.

(7) Trisyllabic words with penultimate stress

a. Words with a final schwa syllable (664 words)

Anténne	[an.tɛn̩ə]	‘antenna’
Forélle	[fo.ʁɛl̩ə]	‘trout’
Schimpánse	[ʃɪm.pan.zə]	‘chimpanzee’
Október	[ɔk.to:.bɐ̯]	‘October’
Charákter	[ka.ʁak.tɐ̯]	‘character’
Lavéndel	[la.vɛn.dl̩]	‘lavender’

[4] The final syllables in this last class of words have been analyzed as suffixes by some people, like for instance by Kager (1989) for the equivalent Dutch words. They are analyzed here as monomorphemes because, if the last syllable is removed, the remaining stem is not a free morpheme. This criterion was used consistently to make the sometimes difficult decision as to whether a word is monomorphemic or complex. In (7c) there are exactly 36 words with final [ʊm], 25 words with [ʊs], 4 with [ɔɐ̯], 7 with [ɪs] and 1 with [ɪk].

b. Words with a final open light syllable

Inférno	[ɪn.fɛɐ̯.no]	‘inferno’
Konfétti	[kɔn.fɛt̩i]	‘confetti’
Gorílla	[go.rɪl̩a]	‘gorilla’
Moskíto	[mɔs.ki:.to]	‘mosquito’
Aréna	[a.ʁe:.na]	‘arena’

c. Words with a final closed light syllable

Inspéktor	[ɪn.spɛk.tɔɐ̯]	‘inspector’
Scholástik	[ʃo.las.tɪk]	‘scholasticism’
Hiátus	[hi.ɑ:.tʊs]	‘hiatus’
Muséum	[mu.ze:.ʊm]	‘museum’
Botánik	[bo.tɑ:.nɪk]	‘botany’
Arthrítis	[aɐ̯.tχi:.tɪs]	‘arthritis’

Now to the trisyllabic words with final stress in (8). The first two syllables are always light but never a schwa syllable. The final syllable is heavy in 74% of the words, as shown in (8a and b). The last syllables have the rhymal composition VVC in (8a) and VCC in (8b). The last syllable is light in the remaining 26%, some of which are listed in (8c).

In the trisyllabics, the finality of the heavy syllable as well as the correlation between stress and the weight of the final syllable is clearly apparent, as was the case in the disyllabics.

(8) Trisyllabic words with final stress (393 words)

a. Words with a stressed heavy syllable (CVVC)

Àppetít	[a.pe.ti:t]	‘appetite’
Àpparát	[a.pa.ʁɑ:t]	‘apparatus’
Hèroín	[he.ʁo.i:n]	‘heroin’
Kòrmorán	[kɔɐ̯.mo.ʁɑ:n]	‘cormorant’
Kàtalóg	[ka.ta.lo:k]	‘catalogue’
Mèteór	[me.te.o:ɐ̯]	‘meteor’
Pèrspektív	[pɛɐ̯.spɛk.ti:f]	‘telescope’
Pàradíes	[pa.ʁa.di:s]	‘paradise’
Vìtamín	[vi.ta.mi:n]	‘vitamin’

b. Words with a stressed heavy syllable (CVCC)

Àrtefákt	[aɐ̯.te.fakt]	‘artefact’
Àrchitékt	[aɐ̯.çi.tɛkt]	‘architect’
Dìamánt	[di.a.mant]	‘diamond’
Kàtafálk	[ka.ta.falk]	‘catafalque’
Mànuskrípt	[ma.nʊs.kχɪpt]	‘manuscript’
Fùndamént	[fʊn.da.mɛnt]	‘foundation’
Rèdundánz	[ʁe.dʊn.dants]	‘redundancy’
Tèstamént	[tɛs.ta.mɛnt]	‘will’
Vàgabúnd	[va.ga.bʊnt]	‘vagabond’

c. Words with a stressed light syllable

Jàlousíe	[ʒa.lu.zi:]	‘venetian blind’
Àvenúe	[a.və.ny:]	‘avenue’
Ètikétt	[e.ti.kɛt]	‘label’
Gàrantíe	[ga.ʁan.ti:]	‘guarantee’
Kàrusséll	[ka.ʁʊsɛl]	‘merry-go-round’
Kàbarétt	[ka.ba.ʁɛt]	‘cabaret’
Kòmpromíß	[kɔm.pχɔ.mɪs]	‘compromise’

To close this review of the data, consider the words in (9), which have more than 3 syllables. The position of the main stress is similar to that of the trisyllabics, except for the words in (9d), which illustrate that two classes of words have preantepenultimate stress: grammatical terms and a small number of quadrisyllabic words which sound like compounds because they have a schwa in their second syllable (see also Jessen 1998 for an extensive discussion of these words).

Longer words are interesting because they show that the secondary stress, if realized at all, is generally on the first syllable, at least if the main stress is not on the second syllable, since German avoids stress clash. Moreover, they also show that footing is not exhaustive, as will become clear from the analysis.

(9) Examples of longer words

a. Stress on the ultima, secondary stress on the initial syllable (60%)[5]

èxorbitánt	[ɛk.sɔ̝̆.bi.tant]	‘exorbitant’
Àdrenalín	[a.dʁe.na.li:n]	‘adrenalin’
Bìbliothék	[bi.bli.o.te:k]	‘library’
Àggressión	[a.gʁɛsi̯o:n]	‘aggression’
Àbonnemént	[a.bɔ.nə.mã]	‘subscription’
Ìnfanteríe	[ɪn.fan.tə.ʁi:]	‘infantry’
Òrthographíe	[ɔ̝̆.to.gʁa.fi:]	‘orthography’
spìrituéll	[spi.ʁi.tu.ɛl]	‘spiritual’

b. Stress on the penult, secondary stress on the initial syllable (28%)

Kàrawáne	[ka.ʁa.vɑ:.nə]	‘caravan’
Àntilópe	[an.ti.lo:.pə]	‘antelope’
Pròpagánda	[pχo.pa.gan.da]	‘propaganda’
àllegrétto	[a.le.gʁɛt̪o]	‘allegretto’
Àlligátor	[a.li.gɑ:.tŏ̝]	‘alligator’
Ìnitiále	[i.ni.tsi.ɑ:.lə]	‘initial (letter)’
Àpotheóse	[a.po.te.o:.zə]	‘apotheosis’
Lòkomotíve	[lo.ko.mo.ti:.və]	‘locomotive’
Àkkumulátor	[a.ku.mu.lɑ:.tŏ̝]	‘accumulator’
Stàphylokókkus	[ʃta.fi.lo.ko:.kʊs]	‘staphylococcus’
Àbrakadábra	[a.bʁa.ka.dɑ:.bʁa]	‘abracadabra’
Vìoloncéllo	[vi.o.lɔn.tʃɛl̪o]	‘violoncello’

[5] The great number of longer words with final stress is explained by their morphological status. Longer words are mainly Romance words which were complex and finally stressed in their original language.

c. Stress on the antepenult (10%)

Ìndivíduum	[ɪn.di.vi:.du.ʊm]	‘individual’
Anáphora	[a.nɑ:.fo.ʁa]	‘anaphora’
inkógnito	[ɪn.kɔ̣gnito]	‘incognito’
Currículum	[ku.ʁi:.ku.lʊm]	‘curriculum’
Análogon	[a.nɑ:.lo.gɔn]	‘analogy’
Analgétikum	[a.nal.ge:.ti.kʊm]	‘analgesic’
Komődie	[ko.mø:.di.ə]	‘comedy’
Aquárium	[a.kvɑ:.ʁi.ʊm]	‘aquarium’

d. Stress on the first syllable (2%)

Ímperativ	[ɪm.pe.ra.ti:f]	‘imperative’
Índikativ	[ɪn.di.ka.ti:f]	‘indicative’
Ákkusativ	[aku̯.za.ti:f]	‘accusative’
Ínfinitiv	[ɪn.fi.ni.ti:f]	‘infinitive’
Púmpernickel	[pʊm.pɐ.nɪkl̩]	‘pumpernickel’
Ábenteuer	[ɑ:.bn̩.tɔɣ̟ɐ]	‘adventure’
Kúddelmuddel	[kʊd̩l̩mʊd̩l̩]	‘muddle’
Pámpelmuse	[pam.pl̩.mu:.zə]	‘grapefruit’

1.2. *Generalizations*

We are now in a position to illustrate the generalizations from a more general perspective. The first observation mentioned at the beginning of this section was that heavy syllables usually appear in the final position. As (10) shows, the disyllabic, trisyllabic, and longer words all have a nonnegligible proportion of words with a final heavy syllable: 15% of the disyllabics, 26% of the trisyllabics, and 22% of the longer words. The disyllabic words have a small percentage of nonfinal heavy syllables (3%), which may be stressed or unstressed (see above). In trisyllabics and longer words, almost no nonfinal heavy syllables are found.[6]

[6] In CELEX, the only counterexamples to this generalization are *Rosmarin* and *Apartment.*

(10) Heavy syllables are in the word-final position

	Heavy syllable
Initial syllable in disyllabics	3%
Final syllable in disyllabics	15%
Nonfinal syllable in trisyllabics	0.2%
Final syllable in trisyllabics	26%
Nonfinal syllable in longer words	0%
Final syllable in longer words	22%

The second result is that heavy syllables are stressed. This is illustrated in (11) for disyllabics and in (12) for trisyllabics. If the final syllable of a word is heavy, stress is usually final, as is true in 79% of the cases for the disyllabics and in 87% for the trisyllabics.[7] In contrast, if the final syllable is light, it is not stressed in 85% of the cases for the disyllabics and 90% for the trisyllabics. This is especially true when the final syllable is a schwa syllable.

(11) Correlation between weight and stress of the final heavy syllable in disyllabics

Disyllabics	Final stress	Nonfinal stress
Heavy final syllable (918 words)	79% (723)	21% (195)
Light final syllable (577 words)	15% (88)	85% (489)

(12) Correlation between weight and stress of the final heavy syllable in trisyllabics

Trisyllabics	Final stress	Nonfinal stress
Heavy final syllable (343 words)	87% (299)	13% (44)
Light final syllable (969 words)	10% (94)	90% (875)

The third observation is that, if a word has no final heavy syllable, stress is penultimate. This is true for 95% of the disyllabics with a final light syllable (the words with a final schwa have been included in the calculation) and for 68% of the trisyllabics. These results are summed up in (13) and (14).

[7] The calculations are limited to the di- and trisyllabics since longer words do not bring new results.

(13) Correlation between weight and stress of the final light syllable in disyllabics

	Penult stress	Final stress
Disyllabics with a final light syllable	2419 words (95%)	125 words (5%)

(14) Correlation between weight and stress of the final light syllable in trisyllabics

	Penult stress	Initial stress	Final stress
Trisyllabics with a final light syllable	664 words (68%)	211 words (22%)	94 words (10%)

The fourth and last result is that a superlight syllable is never stressed. This is always true.

The correlation between syllable weight and stress position has been clearly established. It can thus be concluded that German is a quantity-sensitive language, since final heavy syllables are mostly stressed, and that it is a trochaic language, as demonstrated by the fact that if the final syllable is not heavy, stress is in most cases on the penult, especially if the last syllable is a schwa syllable.

However, a large number of words do not follow this pattern. Three main patterns of exceptionality exist. First, some final light syllables are stressed, as shown by the words listed in (4b) and (8c); second, some words with a final heavy syllable have penult stress, as in (3b and d); and third, in a certain number of trisyllabic and longer words, stress is on the antepenult, as in (6) and (9c). This happens when the penult is open, and not – or rarely – when the penult is closed. All these facts must be accounted for by an analysis.

2. An analysis of regular stress

This section presents a possible treatment of regular German stress in the Optimality Theory framework. Regular stress is on the penult if the final syllable is light and on the final syllable if it is heavy. The words *Kürbis* ‘pumpkin’, *Kamel* ‘camel’, *Museum*, *Sekúnde* ‘second’, with a final schwa, *Vitamín* ‘vitamin’, with a final heavy syllable, and *Apotheóse* ‘apotheosis’, a longer word with penultimate stress, are used to illustrate the proposal. An additional regular stress pattern is seen in the few trisyllabic words with a penultimate schwa syllable and a light ultima, like the word *Séllerie* [zɛl̩ə.ʁi] ‘celery’ in (6b). These words have regular antepenult stress, which is also accounted for without stress prespecification.

The OT constraints necessary for an account of regular stress in German monomorphemes are listed in (15) to (23).

WSP (Weight-to-Stress Principle, Prince 1990), given in (15), was first formulated by Prince and Smolensky (1993) in OT and requires heavy syllables to be stressed. In German, it accounts for stress on a final heavy syllable.

FOOT-BINARITY in (16) is formulated in terms of syllables. It posits that feet consist of either two syllables or just one heavy one. The spirit of the original constraint of Prince and Smolensky (1993), which requires that feet be binary at the level of syllables or moras, is preserved. However, since the moraic structure of German syllables is not considered here, reference to moras is avoided. One of the most important effects of this constraint is that feet are maximally two syllables long.

ALIGN-FOOT-RIGHT in (17) and ALIGN-FOOT-LEFT in (18), requiring feet to be aligned to the right and to the left edge of a Prosodic Word respectively, are responsible for the regular foot pattern, in which the final foot carries primary stress and the initial one secondary stress. These constraints are couched in McCarthy and Prince's (1993b) Generalized Alignment theory.

FOOT-FORM(TROCHAIC) in (19), from Prince and Smolensky (1993), says that feet are left-headed.[8] This constraint accounts for the trochaic form of the disyllabic feet.

NOCLASH in (20), going back to a proposal first made by Prince (1983) and Selkirk (1984), prohibits stress clashes. As will be shown below, this constraint is undominated in German monomorphemes.

FINAL-HEAD in (21) posits that main stress is right-bounded. According to the Continuous Column Constraint of Hayes (1995), a higher grid position can only be found in connection with a lower grid position, which means that only heads of feet can serve as heads of Prosodic Words.[9] As a result, when two feet are present on a word in German, the rightmost one is also the head of the Prosodic Word. Thus, stress can be penultimate or antepenultimate, but cannot appear further to the left in the regular stress pattern.

A schwa syllable is always unstressed. This unstressability can be accounted for by a constraint like NONHEAD(ə), as formulated by Cohn and McCarthy (1994) for Indonesian, which simply posits that schwa syllables cannot be heads of feet (22).

[8] An analysis in terms of feet is preferable to one in terms of peripherality and nonfinality, like the one proposed in Walker (1997) for instance, because feet are independently needed in the German morphology (see Féry 1997b).

[9] The Continuous Column Constraint is not formalized here. It is possibly a universally undominated constraint.

Finally PARSE-SYLLABLE in (23), from Prince and Smolensky (1993), requires that syllables be parsed into feet. As we will see below, this constraint is rather low ranking and does not have much effect in German.

(15) WSP (Weight-to-Stress Principle) (Prince and Smolensky 1993)
A heavy syllable is stressed.

(16) FOOT-BINARITY (Prince and Smolensky 1993)
Feet consist of either two syllables or of one heavy syllable.

(17) ALIGN-FOOT-RIGHT (McCarthy and Prince 1993b)
Align (Prosodic Word, Right; Foot, Right)
Every Prosodic Word ends with a foot.

(18) ALIGN-FOOT-LEFT (McCarthy and Prince 1993b)
Align (Prosodic Word, Left; Foot, Left)
Every Prosodic Word begins with a foot.

(19) FOOT-FORM(TROCHAIC) (Prince and Smolensky 1993)
Align (Foot, Left; Head of the foot, Left)
Feet are left-headed.

(20) NoClash
Adjacent heads of feet are prohibited.

(21) FINAL-HEAD
Align (Prosodic Word, Right; Head of the Prosodic Word, Right)
The head of a Prosodic Word is right-bounded.

(22) NonHead(ə)
Schwa syllables cannot be heads of feet.

(23) PARSE-SYLLABLE
Syllables are parsed into feet.

The effects of the constraints for regular stress are illustrated in the optimality-theoretic tableaux of this section. The next section examines the patterns of exceptionality. We begin with a tableau illustrating how regular trochaic stress on *Kürbis* ‘pumpkin’, a disyllabic word with two light syllables, is obtained. The optimal candidate a. fulfills FOOT-FORM(TROCHAIC) and FOOT-BINARITY in having a disyllabic trochaic foot. It also satisfies ALIGN-FOOT-RIGHT and ALIGN-FOOT-LEFT since the

Tableau 1.

/kʏgbɪs/	FOOT-FORM(TRO)	FT-BIN	ALIGN- FOOT - RIGHT	ALIGN-FOOT -LEFT	PARSE-SYLLABLE
a. (x .) ☞ Kürbis					
b. (x) Kür bis		*!	*		*
c. (x) Kür bis		*!		*	*
d. (. x) Kürbis	*!				

foot is aligned with both the left and the right edge of the word. And finally, it fulfills PARSE-SYLLABLE since both syllables are parsed. Since the optimal candidate a. fulfills all the relevant constraints while the other candidates violate at least one constraint each, Tableau 1 does not help to establish a ranking.

Though the final ranking cannot be motivated from the beginning on, it is nevertheless assumed in all tableaux, in order to avoid confusion. Ranking of the constraints will be motivated step by step whenever possible.

Turning now to *Kamel* 'camel', in Tableau 2, a disyllabic word with a final heavy syllable and regular final stress, we see that the optimal candidate a. violates two constraints, ALIGN-FOOT-LEFT and PARSE-SYLLABLE, since only the final syllable is parsed. All other candidates violate at least one other constraint. Candidate b., with two feet, violates NOCLASH, which prohibits adjacent stresses, as well as FOOT-BINARITY, since the first foot consists of a single light syllable. Candidate c. violates FOOT-FORM(TROCHAIC) in having an iambic foot. Candidate d. with a monosyllabic foot on the first, light syllable, violates FOOT-BINARITY, ALIGN-FOOT-RIGHT, PARSE-SYLLABLE, as well as WSP, which requires heavy syllables to be stressed. Candidate e. has a regular trochaic pattern, the optimal one in *Kürbis*, but it violates WSP, since the heavy syllable has no stress. Finally, candidate f., with no foot at all, violates WSP, both ALIGN-FOOT constraints and PARSE-SYLLABLE. This candidate would be eliminated under all possible rankings since the constraints violated by the optimal candidate are a subset of those it violates.

FOOT-FORM(TROCHAIC) and WSP, which are violated by at least one of the losing candidates in the tableau, must thus be ranked higher than

Tableau 2.

/kamel/	NO CLASH	FOOT-FORM (TRO)	FT-BIN	WSP	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT	PARSE-SYLLABLE
a. (x) ☞ Ka mel						*	*
b. (x)(x) Ka mel	*!		*				
c. (. x) Kamel		*!					
d. (x) Ka mel			*!	*	*		*
e. (x .) Kamel				*!			
f. Kamel				*!	*	*	**

ALIGN-FOOT-LEFT and PARSE-SYLLABLE, the constraints violated by the winning candidate. At this point, no ranking can be established for ALIGN-FOOT-RIGHT with respect to the other higher ranking constraints. The ranking of NOCLASH and FOOT-BINARITY cannot be established, either. Either ranking NOCLASH or FOOT-BINARITY above ALIGN-FOOT-LEFT and PARSE-SYLLABLE would eliminate candidate b.

Tableau 3 shows *Museum*, a trisyllabic word with three light syllables and regular penultimate stress. Since it is irrelevant, WSP is left out of the tableau. The optimal candidate has only one trochee at the right edge of the word. The first syllable is not parsed: its parsing violates NOCLASH and FOOT-BINARITY as illustrated in candidate b. Again, the optimal candidate violates ALIGN-FOOT-LEFT and PARSE-SYLLABLE. All other candidates, of which only the most interesting ones are shown in the tableau, violate at least one other constraint, either NOCLASH, FOOT-FORM(TROCHAIC), FOOT-BINARITY, and/or ALIGN-FOOT-RIGHT. This tableau motivates the ranking of ALIGN-FOOT-RIGHT above ALIGN-FOOT-LEFT since under the reverse ranking, candidate f. would be better than candidate a.

Tableau 4 shows *Sekunde*, a trisyllabic word with a final schwa syllable. The only difference with Tableau 3 is that here NONHEAD(ə) plays a role due to the presence of a schwa syllable. Candidate d., with a stress on the final schwa syllable, can be eliminated either by NONHEAD(ə) or by FOOT-BINARITY. In other words, the ranking of NONHEAD(ə) cannot be motivated

Tableau 3.

/muzeum/	NO CLASH	FOOT-FORM (TRO)	FT-BIN	ALIGN- FOOT -RIGHT	ALIGN-FOOT -LEFT	PARSE-SYLLABLE
a. (x .) ☞ Mu seum					*	*
b. (x) (x .) Mu seum	*!		*			
c. (. x) Muse um		*!		*		*
d. (x .)(x) Muse um			*!			
e. (x) Mu se um			*!	*	*	**
f. (x .) Muse um				*!		*

yet. It will be shown below, in Tableau 12, that NONHEAD(ə) is unviolated in German and that it is ranked higher than FOOT-BINARITY, which is violated in words with exceptional stress on a final light syllable.

Tableau 5 shows *Vitamin*, a trisyllabic word with final stress on a heavy syllable. The optimal candidate has a final foot on the last syllable, standing for main stress, and an initial foot, standing for secondary stress. This candidate fulfills all the constraints. Since the optimal candidate has two feet, FINAL-HEAD plays a role in deciding which one has main stress. However, the ranking of this constraint cannot be motivated, since the optimal candidate fulfills all constraints. As will become clear below, no ranking for this constraint can be motivated by the monomorphemic words examined in this paper. Candidate b. violates FINAL-HEAD in having main stress on the first foot and secondary stress on the final one. Candidate c., which has the foot structure of *Sekunde*, violates WSP, since the heavy syllable is not stressed, as well as ALIGN-FOOT-LEFT and PARSE-SYLLABLE, and is therefore eliminated.

Consider next *Sellerie* ‘celery’, a trisyllabic word with a penultimate schwa syllable and antepenultimate stress, illustrated in Tableau 6. The optimal candidate a. has a trochaic foot on its initial two syllables. The last syllable is left unparsed. This candidate violates ALIGN-FOOT-RIGHT and PARSE-SYLLABLE. However, since no candidate is doing better, this candidate is the winning one. Some relevant candidates are shown in Tableau

Tableau 4.

/zekundə/	NO CLASH	FOOT-FORM (TRO)	NON HEAD (ə)	FT-BIN	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT	PARSE-SYLLABLE
a. (x .) ☞ Se kunde						*	*
b. (x)(x .) Se kunde	*!			*			
c. (. x) Sekun de		*!			*		*
d. (x .) (x) Sekun de			*!	*			
e. (x) Se kun de				*!	*	*	**
f. (x .) Sekun de					*!		*

Tableau 5.

/vitamin/	FINAL-HEAD	NO CLASH	FOOT-FORM (TRO)	FT-BIN	WSP	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT	PARSE-SYLLABLE
a. x (x .)(x) ☞ Vita min								
b. x (x .)(x) Vita min	*!							
c. x (x .) Vi tamin					*!		*	*

6. Candidate b., with a final trochee, violates NONHEAD(ə), ALIGN-FOOT-LEFT, and PARSE-SYLLABLE; candidate c., with a parsed final syllable, violates FOOT-BINARITY; and candidate d., with a ternary foot, violates FOOT-BINARITY, too, for another reason.

This tableau demonstrates that NONHEAD(ə) and FOOT-BINARITY must be ranked above ALIGN-FOOT-RIGHT.

Tableau 6.

/zɛlərɪ/	NON HEAD (ə)	NO CLASH	FOOT-FORM (TRO)	FT-BIN	WSP	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT	PARSE-SYLLABLE
a. x (x .) ☞ Selle rie						*		*
b. x (x .) Sel lerie	*!						*	*
c. x (x .)(x) Selle rie				*!				
d. x (x . .) Sellerie				*!				

The last example for regular stress is the word *Apotheose*. Candidate a. of Tableau 7, the optimal output, satisfies all the constraints discussed so far, except for PARSE-SYLLABLE, which is violated once. As has already been shown in several tableaux, syllables do not have to be exhaustively parsed into feet. The optimal output has an initial and a final foot. The syllable in between is unfooted. Its footing causes a violation of NOCLASH and FOOT-BINARITY, as illustrated by candidate b. Candidate c., in which the left foot is not peripheral, violates ALIGN-FOOT-LEFT as well as PARSE-SYLLABLE. And finally, candidate d., with a ternary foot, violates FOOT-BINARITY.

This tableau shows once again that FOOT-BINARITY must be ranked above PARSE-SYLLABLE. Otherwise, it does not allow us to establish any additional rankings.

To sum up this section, a small number of attested constraints are sufficient to explain regular stress in German, to which the majority of words conform. So far we have motivated the following partial rankings:

NONHEAD(ə), FOOT-BINARITY » ALIGN-FOOT-RIGHT » ALIGN-FOOT-LEFT, PARSE-SYLLABLE.

FOOT-FORM(TROCHAIC), WSP » ALIGN-FOOT-LEFT, PARSE-SYLLABLE.

No ranking has been established for FINAL-HEAD and NOCLASH.

Tableau 7.

/apoteozə/	NON HEAD (ə)	NO CLASH	FOOT-FORM (TRO)	FT-BIN	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT	PARSE-SYLLABLE
a. x (x .) (x .) ☞ Apo the ose							*
b. x (x .) (x) (x .) Apo the ose		*!		*			
c. x (x .) (x .) A pothe ose						*!	*
d. x (x . .) (x .) Apothe ose				*!			

3. Exceptional stress

In this section, it is shown how the three patterns of exceptionality listed in section 1 – final stress on a light syllable, penult stress in words with a final heavy syllable, and most cases of antepenultimate stress in trisyllabic and longer words – can be accounted for with the help of just one additional constraint: HEAD-MATCH(FT). Before turning to the tableaux, a brief introduction to the ways in which phonologists have accounted for exceptional stress in the framework of Optimality Theory might be helpful.

A number of recent works, including Inkelas (1994), Hammond (1995) and McCarthy (1996), have provided OT accounts of exceptional stress in different languages. Inkelas (1994) accounts for exceptional stress in Turkish. In her approach, exceptional stress is the result of an underlying trochaic foot in the input. The high ranking constraint PARSE-FOOT guarantees that underlying feet are kept in the output. McCarthy (1996) convincingly shows that the constraint ranking of a language must not only require faithfulness of some prespecified prosodic structure, but must also ensure that only the possible forms will ever have a chance of emerging in the outputs. In other words, the constraints should not only account for what is possible in a language, be it regular or exceptional phonological behavior, but must also block what is impossible. If an undifferentiated PARSE-FOOT guarantees the emergence

of all prespecified foot structures, then any kind of exception is expected to appear. However, no language tolerates all sorts of exceptionality.

McCarthy (1996) illustrates his point with Rotuman, a language with regular penultimate stress. Rotuman has only short vowels, except in monosyllables or if the final syllable of a polysyllabic word is prespecified as a foot. In these two cases, a long stressed vowel may emerge. His treatment of Rotuman is couched in Correspondence Theory, according to which inputs and outputs must stand in a correspondence relation $\mathcal{R}$ (see McCarthy and Prince 1995 and McCarthy 1996 for Correspondence Theory). When α and β are correspondents of each other, the constraint HEAD-MATCH in (24), which is formulated in terms of this theory, expresses the fact that a prespecified head of a Prosodic Word in the input must also be the head of a Prosodic Word in the output.

(24) HEAD-MATCH (McCarthy 1996)
If α is the prosodic head of the word and $\alpha \mathcal{R} \beta$, then β is the prosodic head of the word.

Some Rotuman words with a final long vowel are shown in (25). The constraint ranking in (26) always blocks the emergence of a long vowel anywhere but finally because feet in Rotuman must be binary and final. In a monosyllabic word, or in a final prespecified foot, a vowel is automatically lengthened in order to satisfy moraic foot-binarity. As an input, a form *(to)kiri* with a foot on its initial syllable is possible, but it has no chance of emerging as an output because it violates the undominated right-alignment constraint.

(25) Long vowels are possible, but only word-finally *rí:* 'house', *hané:* 'honey', *siká:* 'cigar' but **tó:kiri* (*tokíri* 'to roll')

(26) FOOT-BINARITY, ALIGN-FOOT-RIGHT » Head-Match

Exceptional stress in German can be accounted for in a framework like the one proposed by McCarthy for Rotuman. Some patterns of exceptionality are possible, and some are impossible. Final stress on a light syllable, trochaic stress on a word with a final heavy syllable, and antepenultimate stress are attested, but – at least in monomorphemes – stress further to the left than antepenultimate and stress on a schwa syllable are practically excluded. The constraints responsible for stress must account for this. The following subsections examine the three types of exceptional stress in turn.

3.1. *Final stress on a light syllable*

Final stress on a light syllable, as illustrated by the words in (27), is readily accounted for. I assume that it is lexically prespecified and that the constraint HEAD-MATCH(FT) in (28), which posits that a prosodic head of a foot specified in the input (α) is also a prosodic head of a foot in the output (β), is active in German.

It must be mentioned that the light final syllables which bear stress seem to be a closed class. Words ending in [ɛl], [ɪl], [ɪs], [ɛt], [ɔt], [i:], [a͡i̯], rounded fronted vowels, and nasal vowels are usually stressed on this syllable (though there are some rare exceptions), regardless of whether the word is a disyllabic, a trisyllabic, or a longer word.

(27) Final stress on a light syllable

Karusséll	[ka.ʁʊ.sɛl]	‘merry-go-round’
Apríl	[a.pχɪl]	‘April’
Kompromíß	[kɔm.pχo.mɪs]	‘compromise’
Spinétt	[ʃpi.nɛt]	‘spinet’
Etikétt	[e.ti.kɛt]	‘label’
Schafótt	[ʃa.fɔt]	‘scaffold’
Kopíe	[ko.pi:]	‘copy’
Garantíe	[ga.ʁan.ti:]	‘guarantee’
Partéi	[paʁ.ta͡i̯]	‘party’
Avenúe	[a.və.ny:]	‘avenue’
Ballón	[ba.lɔ̃/ba.lɔŋ]	‘balloon’
Abonnemént	[a.bo.nə.mã]	‘subscription’

(28) HEAD-MATCH(FT)[10]

If α is the prosodic head of a foot and $\alpha \mathcal{R} \beta$, then β is the prosodic head of a foot.

Tableau 8 illustrates the working of the constraints for the word *Karussell* ‘merry-go-round’, which has a prespecified grid mark on the last syllable. The optimal candidate has two feet, one initial, standing for secondary stress, and one final, standing for main stress, thus fulfilling FOOT-FORM(TROCHAIC), FINAL-HEAD, HEAD-MATCH(FT), ALIGN-FOOT-RIGHT, and ALIGN-FOOT-LEFT. Other fulfilled constraints are NOCLASH, NONHEAD(ə), WSP,

[10] Notice that McCarthy formulates HEAD-MATCH in (25) in terms of the prosodic head of a word.

Tableau 8.

x /karʊsɛl/	FOOT-FORM (TRO)	FINAL-HEAD	HEAD-MATCH (FT)	FT-BIN	ALIGN-FOOT - RIGHT	ALIGN-FOOT - LEFT
a. x (x .) (x) ☞ Karus sell				*		
b. x (x .) Ka russell			*!			*
c. x (x .) (x) Karus sell		*!		*		
d. x (. x) Ka russell	*!					*

and PARSE-SYLLABLE, which are not shown in the tableau in order not to overload it. Since it consists of a light syllable, the final foot of the optimal candidate violates FOOT-BINARITY. A comparison between candidates a. and b. shows that the constraint HEAD-MATCH(FT) must dominate FOOT-BINARITY. If this ranking were reversed, candidate b. with a single binary foot would win. Candidate c. crucially violates FINAL-HEAD and candidate d. FOOT-FORM(TROCHAIC).

The ranking of HEAD-MATCH(FT) just below the undominated constraints will be motivated below. In a nutshell, the reason is that a prespecified stressed schwa syllable cannot emerge as optimal.

This tableau motivates the ranking of FOOT-FORM(TROCHAIC) and HEAD-MATCH(FT) above FOOT-BINARITY. Again, the ranking of FINAL-HEAD cannot be motivated since in all possible rankings, candidate a. would win over candidate c.

3.2. *Trochaic stress with a final heavy syllable*

A nonnegligible number of disyllabic words with a final heavy syllable nevertheless have a trochaic pattern (83 words in CELEX). This can be accounted for by a prespecified stress on the first syllable.

Candidate a. in Tableau 9 violates only WSP. In order to block the formation of a foot on the final syllable, like in candidate b., WSP must be ranked

Tableau 9.

x /au̯toɐ̯/	NO CLASH	FOOT-FORM (TRO)	HEAD-MATCH (FT)	FT-BIN	WSP	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT
a. x (x .) ☞ Autor					*		
b. x (x) Au tor			*!				*
c. x (x) (x) Au tor	*!			*			

below HEAD-MATCH(FT). If WSP were ranked higher than this constraint, candidate b. would win. Candidate c. is eliminated by NOCLASH and/or by FOOT-BINARITY. Notice that a final heavy syllable can function as the weak member of a foot only if the preceding syllable is prespecified for stress. Otherwise, WSP is active, as has been shown with *Vitamin.*

3.3. *Antepenultimate stress*

We now come to the third exceptional pattern, antepenultimate stress, which is in fact very common in German. Some of the tri- and quadrisyllabic examples are listed again in (29) and (30).

The words with exceptional stress on the antepenultimate come in different forms. First, some have a final schwa syllable (29a). A subset of these, like *Herberge* 'inn' or *Ameise* 'ant', though monomorphemic, resemble complex words (*Her-berge, A-meise*, since *bergen* 'to shelter' and *Meise* 'titmouse' exist as free morphemes) and can be said to have different stress properties than truly monomorphemic words. Others are loanwords from English, like *Teenager* or *Manager*. Still others, like *Roboter* and *Araber*, look like words derived with the suffix *-er*, even though *Robot-* and *Arab-* do not exist as free morphemes in German. This first class of words with antepenultimate stress are counterexamples to Vennemann's otherwise strong generalization, the Reduced Syllable Rule, which posits that words with a final schwa syllable have penultimate stress (see section 4.4 below).

The second class of words with antepenultimate stress in (29b) and (30) consists of words like *Páprika*, *Anáphora* or *inkógnito* which have nothing

special about them: just three – or four – plain light syllables, with a full vowel in each of the syllables.

The members of the third class (in (29c)) have a heavy final syllable. Some of them, like *Telefon* and *Pinguin,* have an alternative pronunciation with final stress. I suspect that these words have different possible analyses. If they are interpreted as monomorphemes, they are pronounced with final stress, but if they have a compoundlike interpretation, they are stressed on the initial syllable. A word like *Pínguin* is often pronounced with a glottal stop before the last syllable, which signals a foot boundary. Inside of a foot, no glottal stop can ever be inserted, as attested by words like *Théo, Muséum, Böe* [bø:.ə] 'gust of wind' and the like, in which no glottal stop is realized before the vowel-initial syllable. In *Pinguin*, then, the last syllable forms its own foot, but does not bear main stress. This speaks in favor of an interpretation of these words as stressed in analogy to complex words.

The last class of words with antepenultimate stress have a schwa syllable in their penult (29d). We saw in section 2 that these words have a regular antepenultimate stress.

In sum, many of the words with antepenultimate stress are stressed like compounds, or alternatively like derived words.[11] An analysis of these words as complex words immediately suggests itself for some of them, like the linguistic terms *Súbstantiv* and *Áblativ*, which have a final syllable that can be analyzed as a suffix (*-iv*). *Telefon* and *Elfenbein* 'ivory' could also be analyzed as compounds (*Tele-fon, Elfen-bein*). In other cases, such pseudo-word-building-processes are not evident. Words like *Pélikan, Báriton,* etc. cannot be said to have a derived or compounded structure. From a morphological point of view, they are plain monomorphemes.

(29) Trisyllabic words with antepenultimate stress

a.	Hérberge	[hɛɐ̯.bɛɐ̯.gə]	'inn'
	Ámeise	[ɑ:.maɪ̯.zə]	'ant'
	Téenager	[ti:.ne.dʒɐ]	'teenager'
	Mánager	[mɛn̩ɪḍʒɐ]	'manager'
	Róboter	[ʁo:.bo.tɐ]	'robot'
	Áraber	[ɑ:.ʁa.bɐ]	'Arab'
	Éidechse	[aɪ̯.dɛk.sə]	'lizard'
	Kálauer	[kɑ:.laʊ̯ɐ]	'pun'

[11] Karl-Heinz Ramers first suggested this analysis to me.

b.	Páprika	[papχi.ka]	‘pepper’
	Ánanas	[aːna.nas]	‘pineapple’
	Léxikon	[lɛk.si.kɔn]	‘encyclopedia’
	Brā́utigam	[bʁɔɣ.tɪgam]	‘bridegroom’
	Gígolo	[ʒi:.go.lo]	‘gigolo’
	Báriton	[bɑ:.ʁi.tɔn]	‘baritone’
	Pélikan	[pe:.li.kan]	‘pelican’
c.	Télefon	[te:.le.fo:n]	‘telephone’
	Pínguin	[pɪŋ.gu.i:n]	‘penguin’
	Elfenbein	[ɛl.fn̩.baɪ̯n]	‘ivory’
	Súbstantiv	[zʊp.stan.ti:f]	‘noun’
	Áblativ	[abla.ti:f]	‘ablative’
d.	Pfífferling	[pfɪfɐ.lɪŋ]	‘chanterelle’
	Kábeljau	[kɑ:.bəl.jaʊ̯]	‘cod’
	Schmétterling	[ʃmɛtɐ.lɪŋ]	‘butterfly’
	Séllerie	[zɛlə.ʁi]	‘celery’
	Búmerang	[bu:.mə.ʁaŋ]	‘boomerang’
	Chólera	[ko:.lə.ʁa]	‘cholera’

(30) Quadrisyllabic words with antepenultimate stress

Anáphora	[a.nɑ:.fo. ʁa]	‘anaphora’
inkógnito	[ɪn.kɔgni.to]	‘incognito’
Currículum	[ku.ʁi:.ku.lʊm]	‘curriculum’
Análogon	[a.nɑ:.lo.gɔn]	‘analogy’
Chamā́leon	[ka.me:.le.on]	‘chameleon’
Indivíduum	[ɪn.di.vi:.du.ʊm]	‘individual’

Since the group of words with antepenultimate stress is rather large, some phonologists – like Vennemann and Eisenberg – have claimed that antepenultimate stress is as regular as penultimate stress (see below). In a framework like OT it is not desirable to analyze two conflicting stress patterns as regular. The choice made here to declare penultimate stress as regular and antepenultimate stress as exceptional corresponds to the data – there are simply more words with penultimate than with antepenultimate stress.

I propose analyzing the words with antepenultimate stress in (29a) and (29b) as having a prespecified exceptional stress, hence again with the help

Tableau 10.

x /papχika /	FINAL-HEAD	NO CLASH	HEAD-MATCH (FT)	FOOT-BIN	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT
a. x (x .) ☞ Papri ka					*	
b. x (x)(x .) Pa prika		*!		*		
c. x (x .) Pa prika			*!			*
d. x (x .)(x) Papri ka				*!		

of HEAD-MATCH(FT). The words in (29c) are compoundlike and are not taken into consideration here, and those in (29d) have a regular stress.

Tableau 10 illustrates the word *Páprika*. The optimal candidate a. has a left-aligned foot. Once the first syllable is prespecified for stress, different factors block the formation of an additional foot on the last two syllables of this word, as for instance the constraint NOCLASH, which prohibits two adjacent stressed syllables in candidate b. Candidate c., with stress on the penult, violates HEAD-MATCH(FT) and ALIGN-FOOT-LEFT; and finally, candidate d., which fulfills both ALIGN-FOOT-RIGHT and ALIGN-FOOT-LEFT, is eliminated because it violates FOOT-BINARITY.

This tableau shows once more that ALIGN-FOOT-RIGHT is outranked by other constraints, here HEAD-MATCH and FOOT-BINARITY.

Antepenultimate stress is largely restricted to words with an open penult. There is thus an asymmetry between words like *Páprika* and *Pélikan* on the one hand, and *Veránda* and *Hibískus* on the other. The latter words cannot be stressed on the antepenult (as has been observed by Vennemann 1992; see section 4) though there are exceptions to this. I assume here that, although the segmental complexity of a German light syllable usually plays no role – both CVV and CVC are light – it does just in this context, that is, in the medial position of a trisyllabic word. For a detailed analysis of this case, I

refer the interested reader to Féry (1997a), where an analysis is proposed along the lines of Kager (1989) and Lahiri and Koreman (1988), who have observed the same asymmetry in Dutch. The analysis proposed there amounts to requiring each segment of the rhyme to count in this special case. In a word like *Hibiskus* the medial syllable has two segments and is thus segmentally more complex than a word like *Paprika*, which has only one segment in its rhyme. Penultimate stress on words like *Veranda* and *Hibiskus* is regular and requires no further explanation.

Two stress patterns must still be eliminated. First, preantepenultimate stress, which, as we have seen, is represented by two classes of words, illustrated in (9d). One – the grammatical terms – can be analyzed as a case of derivation with the suffix *-iv*, or alternatively as a paradigmatic class of words with contrastive stress on the first syllable (Vennemann 1992); the other one – with a penultimate and a final schwa syllable – can be interpreted as a case of pseudo-compounding (Jessen 1998). For compounding and derivation, additional constraints (not examined here) are needed which partly override the effect of ALIGN-FOOT-RIGHT. As a consequence, stress can be further to the left than in monomorphemes, as exemplified by words like *Árbeitslosigkeit* 'unemployment', a derived word, *frőhlichere* 'more joyful', an inflected word, and *Fúßballmannschaft* 'soccer team', a compound.

If the marginal cases and the complex words mentioned above are left out of consideration, preantepenultimate stress can be excluded from the possible patterns. Traditionally, German is assumed to obey the Three Syllable Window from the right edge, an *ad hoc* condition without any explanatory power. In the present framework, preantepenultimate stress can be blocked straightforwardly by the constraint ranking that has been proposed so far. If a word has four or more syllables with a prespecified stress on one of the syllables preceding the antepenultimate one, there still remain enough syllables to build another foot to the right.[12] This is illustrated schematically in (31).

(31) No preantepenultimate stress

		x				
a. Input:	σ	σ	σ	σ	σ	
					x	
		x			x	
b. Ouput:	(σ	σ)		σ	(σ	σ)

[12] A reviewer has pointed out to me the analysis of Polish in Idsardi (1992), which includes a similar observation. In this language, too, if enough material follows a prespecified stress, a metrical constituent can be built, the result being that stress cannot be further to the left than antepenultimate.

Tableau 11.

x /ɑpoteozə/	NO CLASH	FINAL-HEAD	FOOT-FORM (TRO)	HEAD-MATCH (FT)	FOOT-BIN	ALIGN-FOOT-RIGHT	ALIGN-FOOT-LEFT
a. x (x .) (x .) ☞ Apo the ose							
b. x (x .) Apo theose						*!	
c. x (x .) (x .) Apo the ose		*!					

The hypothetical tableau 11 shows a word consisting of five syllables with a prespecified stress on the first syllable. FINAL-HEAD guarantees that candidate a. with the pattern (31b), is optimal. Candidate b., with only one, left-aligned foot, violates ALIGN-FOOT-RIGHT and candidate c., with main stress on the left foot, violates FINAL-HEAD. The constraint HEAD-MATCH(FT), though high-ranking, is not high enough to allow any kind of exceptional stress pattern to emerge. The constraint hierarchy as it stands only admits final and antepenultimate stress in addition to the regular penultimate stress.

The second pattern which has to be eliminated is one in which a schwa syllable prespecified as stressed emerges as optimal. Here a violation of HEAD-MATCH(FT) must be forced by NONHEAD(ə), unviolated in German, so that NONHEAD(ə) must be crucially ranked above HEAD-MATCH(FT). This is illustrated in the hypothetical tableau 12 with the word *Forélle* ‘trout’, in which a prespecified stress on the schwa syllable has been added, giving thus **Forellé*.

The last tableau shows the effect of NOCLASH with the help of *Symptóm* ‘symptom’, a disyllabic word with two heavy syllables and final stress. This word has a prespecified stress on the ultima which garantees that the optimal candidate also has a final stress. The optimal candidate a., with a single foot on the ultima, violates WSP, ALIGN-FOOT-LEFT, and PARSE-SYLLABLE. Without the effect of HEAD-MATCH(FT) candidate b. would be better, since it fulfills ALIGN-FOOT-LEFT and PARSE-SYLLABLE in addition to the other constraints satisfied by both candidates. Candidate b.

Tableau 12.

x /foʁɛlə/	NON HEAD (ə)	FINAL-HEAD	FOOT-FORM (TRO)	HEAD-MATCH (FT)	FOOT-BIN	ALIGN-FOOT - RIGHT	ALIGN-FOOT - LEFT
a. x (x .) ☞ Fo relle				*			*
b. x (x .) (x) Forel le	*!				*		

Tableau 13.

x / zymptom/	NO CLASH	FOOT-FORM (TRO)	HEAD-MATCH (FT)	WSP	FOOT-BIN	ALIGN-FOOT - RIGHT	ALIGN-FOOT - LEFT	PARSE-SYLL
a. x (x) ☞ Symp tóm				*			*	*
b. x (x .) Symptóm			*!	*				
c. x (x)(x) Symp tóm	*!							

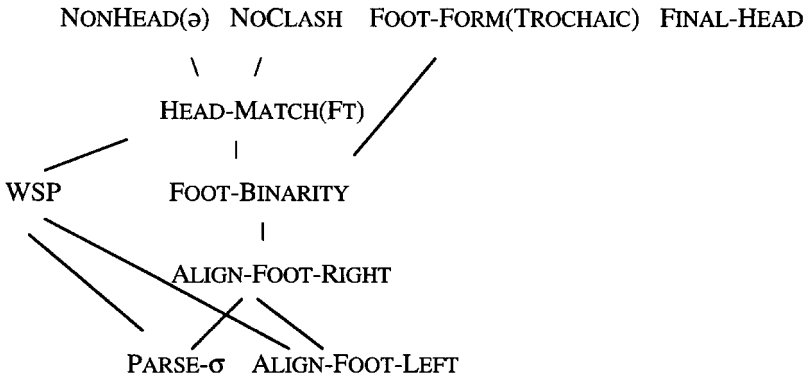
is eliminated only because it violates HEAD-MATCH(FT). Consider now candidate c. This candidate does also better than candidate a. with respect to ALIGN-FOOT-LEFT and PARSE-SYLLABLE. It is also superior to both candidate a. and b. as far as WSP is concerned. However, it crucially violates NOCLASH, demonstrating that this latter constraint must dominate at least WSP, ALIGN-FOOT-LEFT, and PARSE-SYLLABLE. It still could be ranked below the top-ranking constraints, but, since it is never violated in the optimal monomorphemes, it is assumed to be undominated.

3.4. *Summary*

Optimality Theory, in the form of the constraint hierarchy in (32), has been used in the analysis of lexical stress in German. The constraints which are never violated by the monomorphemes are FINAL-HEAD, NOCLASH, FOOT-FORM(TROCHAIC), and NONHEAD(ə). These are the undominated constraints. The other constraints have been shown to be violated by one or more optimal candidates of the tableaux. HEAD-MATCH(FT) is violated in the hypothetical input *Forellé*, FOOT-BINARITY is violated in *Karusséll*, WSP in *Áutor* and *Symptóm*, ALIGN-FOOT-RIGHT in *Séllerie* and *Páprika*, ALIGN-FOOT-LEFT in *Kamél*, *Muséum*, *Sekúnde*, and *Symptóm*, and PARSE-SYLLABLE in *Kamél*, *Muséum*, *Sekúnde*, *Séllerie*, *Apotheóse*, and *Symptóm*. No ranking could be established between FOOT-BINARITY and WSP or between ALIGN-FOOT-LEFT and PARSE-SYLLABLE.

The final ranking is shown in (32).

(32) Final constraint ranking



4. Comparison with past proposals

This last section compares the present analysis with some past proposals. The discussion is centered around four central questions. First, whether a partitioning of the German words into native and nonnative vocabulary is necessary for an account of lexical stress. Second, whether German is a quantity-sensitive or insensitive language. Third, how heavy and light syllables are defined. And finally, which are the principles regulating the location of main stress. Only those proposals which analyze monomorphemes are taken into consideration here since complex words were not included in the study.

4.1. *Native and nonnative words*

The analysis offered in the present paper does not distinguish between native and nonnative words though this distinction has sometimes been made in the literature (see, for instance, Wurzel 1980 and Benware 1987). Wurzel (1980) formulates a separate set of rules for each class of words (see below).

As observed by Giegerich (1985), rules and generalizations can only be formulated for words with two or more stressable syllables. These words are generally nonnative since the native monomorphemic vocabulary consists mainly of words too short to be in need of stress rules. Also that part of the native vocabulary consisting of words of more than one syllable behaves largely like the nonnative vocabulary. For instance, words with a final schwa syllable have penultimate stress, regardless of their origin. As a consequence, a distinction between the native and nonnative vocabulary is not necessary for an account of lexical stress.[13]

4.2. *Quantity-sensitivity or quantity-insensitivity*

The problem of whether German is quantity-sensitive or quantity-insensitive has been much debated in the literature. The position taken here is that German is quantity-sensitive. The problem that emerges when one analyzes German as a quantity-sensitive language is that the kind of quantity-sensitivity needed is not the traditional one. Typologically, two types of quantity-sensitivity have been described in the literature (see Hayes 1995). First, open syllables with long vowels are heavier than open syllables with short vowels. Second, besides the distinction just mentioned, closed syllables are heavier than open ones. This is not what we find for German. In this language, long vowels are heavier than short ones, but since short vowels are generally only found in closed syllables, at least when they are stressed, open syllables and closed ones do not automatically differ in weight. Only word-final ‘superheavy’ syllables are heavier than all other syllables.

Some phonologists, like Wurzel (1980) and Giegerich (1985), have assumed the more traditional kind of quantity-sensitivity. However, this leads to problems. Wurzel analyzes only the nonnative words as quantity-sensitive

[13] This does not mean that the German lexicon behaves homogeneously in all parts of the phonology. On the contrary, the stratification of the lexicon is probably much more complex than has so far been assumed. At least the following strata have partially different phonologies. First, the core lexicon, consisting of words of Germanic origin, is phonologically the most restricted. Second, assimilated loanwords from other Germanic languages, like Yiddish, Dutch, English, Northern German, and the like, include words presenting a slightly different phonology from the core lexicon. Third, there are also the assimilated words of Romanic origin – the nonnative words – and finally nonassimilated words, like the many English words entering the German lexicon nowadays. See Ito and Mester (1995, 1998) for a similar stratification of the Japanese lexicon and Féry (1999) for German.

since, according to him, in this part of the vocabulary stress falls on the last heavy syllable if there is one and on the first syllable otherwise. In contrast, in his analysis, all native words uniformly bear stress on the first syllable. But, as already mentioned, the native vocabulary consists mainly of monosyllabic stems plus some unstressable suffixes, like the inflectional (*-em, -en, -er* etc.) and the derivational affixes (*-ig, -isch, -ung, -heit, -los* etc.), which means that even if these words were quantity-sensitive, the effect of syllable weight would be invisible. Giegerich (1985) also analyzes stress as quantity-sensitive (see below for his stress assignment rule).

Other phonologists consider German a quantity-insensitive language, like for instance Hall (1992), Kaltenbacher (1994), and Wiese (1996). Wiese is puzzled by the fact that both open and closed syllables, irrespective of the status of the closing consonant as ambisyllabic or not, can be stressed (as in *Angína, Lamétta* and *Veránda* respectively) and comes to the conclusion that German must be quantity-insensitive (see also Claßen et al. 1998 for an account along Wiese's lines).

In the account presented in this paper, heavy syllables attract stress and schwa syllables repel it; all other syllables have the same weight and have been analyzed as light. As demonstrated in the preceding sections, in words with only light syllables, regular stress is trochaic.

4.3. *Syllable weight*

Among the authors assuming that German is a quantity-sensitive language there is no consensus as to which kind of syllables are heavy and which are light. It has been shown above that, in the present analysis, only syllables with a tense vowel and a closing consonant as well as syllables with a lax vowel and two closing consonants are considered heavy. The following syllable weight hierarchy has been assumed throughout the paper: CVCC, CVVC > CVC, CVV, CV > Cə.

Wurzel considers closed syllables, as well as those with a diphthong or a long vowel, to be heavy and open syllables with a short vowel to be light. Wurzel's syllable weight hierarchy is CVVC, CVCC, CVV, CVC > CV. Giegerich has the same hierarchy word-internally, but since he assumes consonant extrametricality,[14] his word-final hierarchy is CVV, CVVC, CVCC > CVC, CV.

Vennemann (1992), on the other hand, considers all and only closed syllables heavy and all open syllables light. His hierarchy is thus CVCC, CVVC, CVC > CVV, CV. The reason for this analysis is that, as was shown above, in trisyllabic and longer words, antepenultimate stress is gener-

[14] Extrametricality results in the metrical invisibility of the extrametrical constituent.

ally only possible if the penult is open (the penult in words like *Lamétta, Konfétti, Madónna*, and *Dilémma* is considered closed because it consists of a lax vowel followed by an ambisyllabic consonant). My impression is that this generalization is too strong. First, there is a certain number of words with antepenultimate stress and a closed penult (*Hérberge, Ámeise, Kálauer, Náchtigall, Brắutigam*, etc.). Second, there are many words like *Aréna* with a stressed open penult. And finally, there are too many words with a final closed syllable which do not have final stress, like *Mámmut, Kűrbis, Éfeu, Plánkton, Muséum, Botánik, Éxodus, Léxikon, Fébruar*, etc.

Vennemann defends the position that German has only one set of vowels, unmarked for length and tenseness. Vowels become long and tense or short and lax depending on the kind of syllables they are in. If they are in an open syllable ('smoothly cut syllable'), they are tense and long, but in a closed syllable ('abruptly cut syllable') they are lax and short (see also Becker 1996 for a similar view). Two problems arising from Vennemann's approach should be mentioned. First, the dependence of the vowels, quality on the kind of syllables they are in is far from being regular. Both lax and tense vowels appear in closed syllables, especially in monosyllables and in final syllables of polysyllabics. Pairs like *Beet* [be:t] 'plot'/*Bett* [bɛt] 'bed', *Fuß* [fu:s] 'foot'/*Nuß* [nʊs] 'nut', *Idiot* [idio:t] 'idiot'/*Fagott* [fagɔt] 'bassoon', and the like, are very frequent. Second, in many cases, ambisyllabicity of a consonant is a consequence of the quality of the preceding vowel and not the cause. In words like *Kippe* or *Robbe* the medial consonant closes the first syllable, which would otherwise be open. Syllable structure, in German as in other languages, is not underlying but results from the quality of its constituting segments. For Ramers (1992), as for me and most other authors, however, German has two underlying sets of vowels: tense vowels, which are long when stressed, and lax ones, which are always short, whether stressed or unstressed. Phonologists disagree as to which property is underlying. It may be the quality (tense or lax) or the quantity (long or short). But there is general agreement that tense and long vowels are heavier than lax and short ones. In this paper I have not attempted to give an explicit solution to the vowel problem (however see Féry 1997a for a moraic theory of the German vowels) but have just assumed that tense vowels are heavier than lax ones. The problems mentioned for Vennemann's approach do not arise.

4.4. *Stress assignment rules*

No stress assignment rules have been posited here since Optimality Theory compares and evaluates output candidates with ranked constraints. However, since all other proposals on German stress have used stress assignment rules or templates, it is useful to take a look at them.

According to Giegerich (1985), which is probably the most extensive study of German stress so far, and the first one couched in an explicit theoretical framework, the following generalization accounts for lexical stress: "[. . .] the main stress in German words falls on the final syllable if it is heavy; it falls on the penultimate syllable if the final one is light and the penultimate heavy; it falls on the antepenultimate syllable if both syllables that follow are light" (p. 23). Though Giegerich's work is very useful for a large number of words – both monomorphemes and complex words – his approach presents two major problems. First, he characterizes words like those in (33) as having a heavy final syllable. But, since he assumes that word-final consonants are extrametrical, a final syllable with a short vowel needs two consonants in order to be heavy. Giegerich posits that the words in (33) are closed by geminates, leading to heaviness. However, the assumed gemination is based on orthography, not phonetics, since the final consonant is pronounced as a simple one and not as a geminate. Thus, phonetically, there is no gemination, and as a consequence of extrametricality, the last syllable must be light (see Hayes 1986 for the same objection).

(33)	Metáll	[me.tal]	'metal'
	Rebéll	[ʁe.bɛl]	'rebel'
	Karusséll	[ka.ʁu.sɛl]	'merry-go-round'
	Tyránn	[ty.ʁan]	'tyrant'
	Prozéß	[pχo.tsɛs]	'process'
	Kongréß	[ka.ʁu.sɛl]	'congress'
	Fagótt	[fa.gɔt]	'bassoon'
	Katárrh	[ka.taɐ̯̂]	'catarrh'

The second problem comes from the analysis of the words in (34), which, according to Giegerich, have an open heavy penult. However, nothing distinguishes the penult of these words from those of the words in (35) and (36), which are said to have two light final syllables, except for the position of the stress: All have a tense vowel in an open syllable. The fact that the [e] of *Aréna* is long is a *consequence* of stress, and the [e] of *Kámera* is short *because* it is unstressed. In other words, Giegerich analyzes the stressed vowels as heavy and the unstressed vowels as light, which is circular. (See Wiese 1996 for the same criticism and Kaltenbacher 1994 for a critical overview of Giegerich.)

(34)	Angína	[aŋ.gi:.na]	'angina'
	Aréna	[a.ʁe:.na]	'arena'
	Koróna	[ko.ʁo:.na]	'corona'

(35)	Drosóphila	[dʁo.zo:.fi.la]	‘drosophila’
	Harmónika	[haɐ̯.mo:.ni.ka]	‘harmonica’
	Kompósitum	[kɔm.po:.zi.tʊm]	‘compound’
	Úterus	[ʊt̩ə.ʁus]	‘uterus’
(36)	Última	[ʊl.ti.ma]	‘final syllable/ultima’
	Kámera	[kam̩ə.ʁa]	‘camera’

Other phonologists have proposed accounting for stress with the help of templates or feet assignment, like Eisenberg (1991), Grewendorf, Hamm and Sternefeld (1987), and Wiese, for example, who all give a fragmentary description of lexical stress. Eisenberg (1991) claims that the canonical accentual structures of German are the trochee and the dactyl, in that order of preference. According to him, the penult and the antepenult are the usually stressed syllables but never the ultima or a syllable before the antepenult.

Grewendorf, Hamm, and Sternefeld (1987) also claim that a trochee is canonically built in German. In their account, nontrochaic patterns are explained by heaviness of the last syllable, extrametricality, and exceptionality.

Wiese (1996) assumes that a trochee is erected as a default foot on the final two syllables of a word. Thus, *Árbeit* ‘work’ and *Lámpe* ‘lamp’ have the same status: Both have a regular trochaic stress. If a final trochee is not possible, a nonbranching foot appears on the last syllable. However, since according to Wiese German is quantity-insensitive, a branching foot should always be possible. All cases of final stress, as well as all cases of antepenultimate stress, are analyzed as irregular.

The last approach which should be mentioned here is Vennemann (1992), who formulates a few very accurate descriptive generalizations, reproduced here in (37).

(37) a. Full syllable rule: Only full syllables can be accented.
b. Reduced syllable rule: A covered reduced ultima arrests the accent on the last full syllable.
c. Three syllable rule: Only the last three full syllables can be accented.
d. Penult rule: The accent does not retract beyond a heavy penult.

These generalizations reflect, first, the unstressability of schwa syllables (37a), which has been confirmed by the CELEX survey presented above; second, the fact that a word with a final schwa syllable is generally stressed on the penult (37b), which has been confirmed, too; third, the so-called ‘Three

Syllable Window', which restricts the possible location of main stress to the final three syllables of a nonderived word (37c) and which also conforms to the data; and, finally, the generalization that a closed penult generally blocks the emergence of stress on a syllable to its left (37d). This last generalization, though not as strong as the first ones, has largely been confirmed by the data as well and corresponds to the intuitions of the native speakers. However, all these generalizations are purely descriptive. A problem is that they do not attempt to provide a full account of the facts. Final stress, for instance, is not mentioned. A critical survey of the literature focusing on Vennemann's rules can be found in Jessen (1998).

5. Conclusion

This paper has shown that an analysis based on a careful empirical study of lexical stress in German can explain some intricate phenomena which have been given various accounts in the literature. The proposed analysis of stress has been couched in the framework of Optimality Theory, making use of a small number of independently motivated constraints.

The following properties of lexical stress in German monomorphemes have been demonstrated:

- German is a quantity-sensitive language.
- In monomorphemes, regular main stress is on the penult if the final syllable is light, and on the final syllable if it is heavy. In trisyllabic words with a penultimate schwa syllable, main stress is antepenultimate.
- Footing is not exhaustive. An optional secondary stress may be on the first syllable, except if secondary stress would provoke a stress clash.
- Exceptional stress is restricted to final stress on some light syllables, penultimate stress in some words with a final heavy syllable, and antepenultimate stress in some words with an open penult or a penult closed by an ambisyllabic consonant. Some trisyllabic and quadrisyllabic words show a compound-like stress pattern.

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