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Swedish word stress in optimality theory

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1 Introduction

The purpose of this paper is to give an introduction to how lexical word stress in Swedish can be analysed with modern phonological theories as metrical phonology (Liberman 1975) and optimality theory (Prince & Smolensky 1993). Central concepts and structures within the phonological theories are introduced and discussed, and examples of how the word stress pattern of Swedish can be treated within optimality theory (OT) are given. We will deal both with monomorphemic words, as well as compound words and affixes.

2 Metrical phonology

Within OT, word stress has mainly been analysed using concepts borrowed from metrical phonology, e.g. feet and syllable weight. We will, therefore, first give a short introduction to this theory.

  Metrical phonology is a theory about rhythm and stress in languages, and part of its roots comes from the metrical descriptions of poetry in the Antiques. However, the origin of modern metrical phonology came with Liberman 1975 and it was further developed by e.g. Liberman & Prince 1977. One of the distinguishing characteristics of metrical phonology is that it not only shows the relationship between different prominence levels, but also the grouping pattern, i.e. the forming of prosodic groups triggered by stress.

2.1 Prosodic hierarchies

In order to describe lexical word stress, a prosodic hierarchy is used. The basic form of this has three levels: syllable, foot and word. The syllables are the smallest units and carry stress. On the foot level syllables are grouped together, and one syllable within every group is identified as the head of the foot. On the word level one foot is identified as the head foot, also becoming the head of the whole word. Nespor & Vogel 1986 and Hayes 1995 put

another level above the word (but below the phrase): the clitic group. We will use this level to treat the word stress pattern of compound words (see Tableau 5). Often another level *below* the syllable is used: the mora level. A mora is an abstract length unit, and is used to show the weight of a syllable. Following common procedure, we will use Greek letters to symbolise levels, e.g. small *sigma* (σ) for syllable, and small *mu* (μ) for mora.

2.2 Metrical grids

The rhythmical structure of linguistic units is usually illustrated in metrical grids. This is done by symbolising each unit on a given level. A strong unit receives the symbol 'x' and a weak unit the symbol '.'. In order to show the grouping structure, parentheses are put around the units that are grouped together, see (1). Putting each level in the prosodic hierarchy on a line of its own shows the hierarchical structure.

(1)   *Level*
        Word   (x   )
        Foot   (x   .)   (x   .)
        Syllable   σ   σ   σ   σ
                       re   dπ   se… ra   *reducera* 'reduce'

In (1) it can be seen that the word's main stress is on the penultimate syllable, while there is a strong, rhythmically induced, unstressed syllable in initial position. The grouping relations are seen as well. An important principle within metrical phonology is that a strong unit on one level *must* be supported by a strong unit in the same column on the level below. This is what Hayes 1995 calls *The Continuous Column Constraint*.

2.3 Parameters

It is common to formalise the description of the metrical structure of a language by using the following five parameters (based on Hayes 1995 and Kager 1995):

1. Boundedness: whether the language has feet with more than two syllables or not.
2. Quantity sensitivity: whether the language distinguishes between different syllable weights or not.
3. Foot headedness: where the head of the foot is.
4. Word headedness: where the head of the word is.
5. Directionality: the direction of foot-formation (forward or backward).

2.3.1 Parametric analysis of Swedish. The description of stress in Swedish non-compound words in Bruce 1998 yields the following parameter values: Swedish has bounded feet (the fundamental pattern is disyllabic), is quantity sensitive (interacts with the weight of the rhyme of a syllable), the foot head is left-bounded (trochaic), the word-head is right-bounded, and the foot-formation starts at the right edge of the word. In compound words each morpheme is analysed first, then the position of the main stress is determined.

2.4 Universal foot inventory

A later stage in the development of metrical theory abandons the parametrical description since they can combine to create stress systems that are either rare or unattested (Hayes 1987). Instead, a set of foot structures is suggested, which function as theoretical primitives. These are given in (2).

(2)   Syllabic trochee: $(x \quad .)$
$$\sigma \quad \sigma$$

Moraic trochee: $(x \quad .)$ or (x)
$$\sigma_\mu \quad \sigma_\mu \qquad\qquad \sigma_{\mu\mu}$$

Iamb: $(. \quad x)$ or (x)
$$\sigma_\mu \quad \sigma_{\mu\mu} \qquad\qquad \sigma_{\mu\mu}$$

2.4.1 Feet used by Swedish. According to Riad 1992 the dominating foot in Swedish is the moraic trochee, which is realised either with a long vowel consisting of two moras or a short vowel + consonant, which realise one mora each. However, see 4.5!

2.5 Extrametrical syllables

Some syllables cannot be grouped together with any other syllable and can also not form a group of its own since it only has a weak unit (less than two moras).

When a syllable is weak (less than two moras), but is unable to form a foot with another syllable, the weak syllable is called *extrametric*, and is left unparsed by the foot-forming procedure. This occurs e.g. in words with two syllables and final stress, like *banan* 'banana'. Extrametric syllables are shown within angled brackets, as in (3).

(3) $<\sigma> \quad (x)$
     ba   nA…n

3. Optimality theory

Here we give a brief presentation of the structure and analysis method of OT. Central concepts as tableaux, constraints and rankings are introduced.

3.1 Introduction

OT (Prince & Smolensky 1993) is a development of generative grammar and shares its attentions towards formal descriptions and search for universal features among the world's languages. The central idea within OT is that surface forms in languages are the result of a tug-of-war between competing grammatical principles, called *constraints*. In this way OT differs from traditional grammar, which uses rewriting or transformational rules. In traditional grammar, one form is derived from another with rules. In OT, representations are eliminated when they violate a constraint until one candidate remains, the winning or *optimal* candidate. OT thus concentrates on the interaction between grammatical principles.

OT should be seen as a general theory of grammar. It has mostly been used for phonology, but the number of studies within syntax and morphology is increasing. OT, like generative grammar, claims to be a theory about the human language capacity.

3.2 Structures, concepts and analysis method

An optimality theoretic description of a linguistic phenomenon consists of an input form, a grammar (sometimes called GEN) that generates all possible output candidates from the input, and a set of constraints that decide the outcome of the grammar. The constraints are ranked, i.e., they are applied in a specified sequential order. The constraints are also universal, i.e.; they are valid for all human languages. Structural differences between languages depend on different rankings from one language to another.

Since the constraints eliminate candidates as they are applied, the final remaining candidate is the winning or optimal candidate. In order to 'win', to become the optimal candidate, a candidate does thus not need to satisfy all constraints in order to be grammatical, it suffices that it is better than all the competing candidates (for the same underlying input form). This is perhaps the greatest difference between OT and traditional grammar. The mechanism that evaluates the grammar is sometimes called EVAL, or H-EVAL, where the H stands for 'harmonic', which in this case means that the candidate that is most harmonic in relation to the constraints is preferred.

3.3 Tableaux

Optimality theoretic analyses are often represented in tableaux. These show the input form, the constraint ranking, selected candidates and their violations, and the winning candidate.

Violations are marked with an asterisk: '*' (many violations of the same constraint cause more '*'). When a constraint violation means that a candidate becomes non-optimal, i.e., that there are other remaining candidates not violating (or violating less) this constraint, this is marked with '!', and the candidate's fields for the lower ranked constraints are shaded. A winning candidate is shown with a pointing hand. See Tableau 1.

Tableau 1. Illustration of OT tableaux.

Each candidate is presented on a separate line, and the constraints are shown at the top of each column, with the highest ranked constraint to the left. Violations are indicated with an asterisk, fatal violations with exclamation mark, and the winning candidate with a pointing hand.

/ form /	CONSTRAINT 1	CONSTRAINT 2
candidate 1	*!	
☞ candidate 2		*

4 Swedish word stress in OT

Before moving into how stress is treated in OT, we shall give a brief summary of the rule system for lexical stress in Swedish. We will not deal with phrasal stress here, but we will include aspects of compound words and derivatives (word + affix).

4.1 The placement of stress in Swedish words

Stress is a fundamental rhythmical feature in Swedish, and it is perceptually important that stress comes at the correct position in words. Stress is a feature of the syllable, while accentuation and focussing are features of the foot and word respectively. The position of stress in Swedish words is not fixed, it can occur in different positions. This means that stress is distinctive, i.e., two words can differ only in their stress pattern. This often also causes a change in vowel quality. There is also a connection between stress and syllable weight: a stressed syllable is always heavy. Bruce 1993 summarises the most important rules for Swedish stress placement. A fundamental difference is made between monomorphemic and compound words (true compounds and derivatives).

4.1.1 Monomorphemic words. Monomorphemic words consist of one root morpheme. The following rules apply:

- if the final syllable is closed (or otherwise heavy), stress is placed on this syllable. Exception: if the final syllable is *-el*, *-en* or *-er*. These syllables often contain a /E/ (schwa) vowel, which is never stressed.
- if the final syllable is open, and the penult is closed, stress is placed on this syllable.
- if both the final and the penult are open, stress is placed on the ante-penult.

As noted by Bruce, there are several exceptions to this rule and it is easy to find counterexamples. We will follow this analysis with a change regarding trisyllabic words; a closed final syllable does not always receive stress in this case. The following principles will be used:

- polysyllabic words have penultimate stress.
- superheavy final syllables have final stress.
- trisyllabic words with an open penult and closed final syllable get antepenultimate stress.
- exceptions have prespecified foot patterns in their input forms.

Polysyllabic words have penultimate stress:

(4)   a.'mø:.ba   *amöba*   'amoeba'
       g".'stal.ta   *gestalta*   'to shape'
       'A:.nIs   *anis*   'aniseed'

Superheavy final syllables give the word final stress:

(5)   ba.'nA:n   *banan*   'banana'
       ka.ta.'stro:f   *katastrof*   'disaster'

Trisyllabic words with open penult and closed final get antepenultimate stress. However, closed penult results in penultimate stress:

(6)   'mA:.ra.tOn   *maraton*   'marathon'
       re.'ak.tOr   *reaktor*   'reactor'

4.1.2 Derivatives. Derivatives consist of a root morpheme plus affixes (prefixes and suffixes). Affixation can affect the stress pattern in different ways. The following situations occur (affixes not translated):

- affix does not affect stress pattern: *be-, ent-, för-, -ande, -else.*
- affix attracts stress and deprives the root of stress: *-ant, -graf, -ör.*

- affix attracts stress but does not deprive the root of stress; word behaves like compound (see 4.1.3): *hyper-, o-, -artad, -bar, -het.*

4.1.3 Compounds. Compound words usually have two stresses, one on the first stressable element, and one on the second stressable element. The first one of these gets main stress, while the second gets secondary stress. Stressable elements are the root, and the affixes that carry stress. The peculiar thing about compounds is that they consist of (at least) two morphemes, each with stress. The reason that the pattern is different is that this 'surplus' of stresses must be solved.

4.2 Candidate generation

For every input form fully metrified candidates are constructed. This includes grouping syllables into feet (foot forming), assigning the head of each foot, and assigning a head foot of the word.

The number of formal possibilities becomes rather large, since every combination of grouping, foot headedness and word headedness must be generated. Therefore, it is common practice not to show all the candidates in tableaux, only those that best illustrate the features of the grammar or the forms attested elsewhere in the language.

4.2.1 What is the correct input form? For Swedish, there is a problem in using the quantity distinction in the input forms, since the analysis becomes circular (quantity is used to predict stress, which causes quantity differences). The input form should therefore not contain any quantity information, and hence no vowel quality information since this usually is derived from the quantity.

4.3 Mora counting

A fundamental unit in the following analysis is the *mora*. A mora is a weight unit and it is on the level below the syllable in the prosodic hierarchy. Syllables are usually monomoraic, but syllables that are foot heads are (at least) bimoraic. Vowels in the input form count as one mora, but in a syllable that is a foot head, they can be two moras. In the syllable with main stress, and in the syllables following that one, coda consonants are also moraic. A bimoraic vowel is normally realised as a 'long' vowel, and a monomoraic vowel as a 'short' vowel.

4.4 Constraints

There exists a rather well established set of constraints for the treatment of stress within OT. Most constraints come from Prince & Smolensky 1993 and McCarthy & Prince 1993. We shall now suggest a set of constraints that can be used for the analysis of Swedish stress. We will base this both on the metrical analysis in 2.3.1, and the rule system for Swedish stress in 4.1. We will also include some general constraints, which follow the system used by Gussenhoven forthc., who analyses the stress in Dutch.

4.4.1 An OT account of the metrical parameters. Let us repeat the metrical analysis of Swedish:

- Boundedness: YES
- Quantity sensitivity: YES
- Foot headedness:LEFT
- Word headedness: RIGHT
- Directionality: RIGHT-TO-LEFT

Transferring this to constraints in the OT framework, we get the following constraints:

(7)   FOOT-BINARITY
                Feet consist of two syllables *or* two moras.

(8)   WEIGHT-TO-STRESS PRINCIPLE (WSP)
                Bimoraic syllables are feet heads.

(9)   RHYTHMTROCHEE
                Feet are left-headed.

(10)   F'RIGHT
                Words are right-headed; the right edge of the word is aligned
                with the right edge of a strong foot.

(11)   ALIGN-FOOT-RIGHT
                Feet are formed from left to right in the word.

4.4.2 General constraints. The following constraints will also be used:

(12)   GRWD=PRWD
                A grammatical word must be a prosodic word.

(13)   STRESS-TO-WEIGHT PRINCIPLE (SWP)
                Feet head are (minimally) bimoraic.

(14)   SUPERHEAVY-TO-STRESS PRINCIPLE (SHSP)
                Trimoraic syllables are strong foot heads.

(15)   NONFIN
                Main stress does not come on the final syllable.

(16)   NOCLASH
                Foot heads are not adjacent.

(17)   SYLMON
                Syllables are monomoraic.

(18)   WEIGHT-BY-POSITION' (WBP')
                Starting at the main stressed syllable, coda consonants are
                moraic.

(19)   HEADMATCH(FT)
                A foot head specified in the input form is also foot head in the
                output form.

4.4.3 Comments on the constraints. The first constraint, GRWD=PRWD, (12), demands that a grammatical word must have a foot. The prosodic hierarchy says that a prosodic word must have a foot as head, so the demand for a prosodic word implies a demand for a foot. The effect of this is to force at least one foot in the word, explaining why monosyllabic words have stress. This constraint has a high ranking and will be presupposed in the following analysis.

Constraints (8) and (13) will be collapsed into one below, and will create the combined constraint that stressed syllables are heavy and heavy syllables are stressed. In mora terms this means that foot heads have at least two moras and that the weak syllable in a foot is monomoraic.

SHSP, (14), will be used for final stress and is similar to WSP, but a stricter version of it.

RHYTHMTROCHEE, (9), is ranked high and will be taken for granted in the following discussion. This means that candidates with feet without initial head (non-initial prominence) will be rejected without showing this in tableaux.

The default pattern of penultimate stress is realised by (15), NONFIN, that forbids final stress, and (10), F'RIGHT, that impose main stress on the final foot. Together with RHYTHMTROCHEE, this favours a final left-headed foot (=penultimate stress).

NOCLASH, (16), prohibits two adjacent stressed syllables, which means that monosyllabic feet only occur word finally.

The constraint FOOTBIN, (7), demands binary feet, either at the mora or syllable level. Note that both monosyllabic and trimoraic feet are allowed. This constraint is highly ranked and will not be shown in all tableaux.

The mora counting is treated by SYLMON, (17), WBP', (18) and WSP. The default rule says: one syllable = one mora (SYLMON) but the main stressed syllable has at least two (WSP). From the main stress and onward (post-stress position), coda consonants also count as moras (WBP'). Pre-stress coda consonants do not count (Gussenhoven forthc.). This is important in final stressed words (see below).

HEADMATCH(FT), (19), takes care of exceptions.

4.5 Monomorphemic words

In Tableau 2 the evaluation of /amøba/ is shown. The winning candidate satisfies all constraints. NOCLASH eliminates candidate b, and this makes the pre-stressed syllable extrametrical. Candidates c and d violate F'RIGHT, which forces the right edge of the strong foot to be aligned with the right edge of the word. Candidate e has stress on the final syllable and it is, therefore, rejected by NONFIN. Candidate f, finally, is trisyllabic and violates FOOTBIN.

Tableau 2. Evaluation of /amøba/.

/ amøba /	FOOTBIN	NOCLASH	NONFIN	WSP / SWP	F'RIGHT
☞ a. a'(mø:.ba)					
b. (ɑ:)'(mø:.ba)		*!			
c. '(ɑ:.mœ)ba					*!
d. '(ɑ:.mœ)(bɑ:)					*!
e. (ɑ:.mœ)'(bɑ:)			*!		
f. '(ɑ:.mœ.ba)	*!				

The analysis of words with closed penult, i.e. *gorilla* 'gorilla' gives the same result. The only difference is that the candidates corresponding to c and d in Tableau 2 will also violate WSP/SWP, since they have a heavy (bimoraic) syllable in the weak position in the foot. In words with a closed penult, e.g. *armada* 'armada', the candidate corresponding to a. may be accused of violating WSP/SWP, since under bimoraic analysis the antepenult has not formed a foot. The bimoraic candidate will, however, also violate WBP'. If the consonant *is not* counted as a mora (satisfying WBP') the pre-stressed syllable does not form a foot, which gives the same result as Tableau 2. See Tableau 3.

Tableau 3. Evaluation of /armada/.

/ armada /	NoClash	WSP / SWP	F'Right	WbP'
☞ a. μ ar'(mɑ:.da)				
b. μμ ar'(mɑ:.da)		*!		*
c. (ɑ:r)'(mɑ:.da)	*!			*
d. '(ɑ:r.ma)da			*!	
e. '(ɑ:r.ma)(dɑ:)			*!	

Note that there are exceptions, like *ättika* 'vinegar' and *paprika* 'paprika', which have initial stress. These words are analysed as having a prespecified foot pattern, which forces stress on the right syllable by adding a highly ranked constraint that demands that the foot structure in the input form and the winning candidate must be the same, i.e. HEADMATCH(FT). More on this in 4.6.

In words with a closed final syllable the interaction between WSP/SWP and F'RIGHT is important. By ranking WSP/SWP higher, the right candidate emerges as winner both with open and closed penult. The analysis is shown in Tableau 4. Candidate 1a violates F'RIGHT but not WSP/SWP; both foot heads are bimoraic and the only weak syllable is monomoraic. The competing candidates are ruled out through violations of higher ranked constraints. A closed penult, however, causes a violation of WSP/SWP regardless of where main stress is (2a-d.). This means that F'RIGHT decides.

In bisyllabic words with closed final syllable and penultimate stress we see that NOCLASH and NONFIN are ranked higher than WSP/SWP, meaning that it is more important to avoid stress clash and final stress than that heavy syllables are unstressed. This is shown in Tableau 5.

It remains to show how final stress is realised. Monosyllabic words are handled by GRWD=PRWD, but in polysyllabic words candidates with final stress are ruled out by NONFIN. However, by using a prespecified superheavy syllable in the input form and ranking SHSP higher than NONFIN, finally stressed candidates may be winners, see Tableau 6. Note also that the ranking SYLMON >> WSP/SWP rules out candidate d, since this has more bimoraic syllables (looking back at Tableau 5 we can also establish the ranking NONFIN >> SYLMON, since otherwise candidate b would have won the evaluation of /anis/). This also causes the foot to become a syllabic trochee, cf. the foot inventory in 1.4.

Tableau 4. Evaluation of /maraton/ and /reaktor/.

/ maraton /	NoClash	NonFin	WSP / SWP	F'Right
☞ 1a. '(mɑ:.ra)(tɔn)				*
1b. ma'(rɑ:.tɔn)			*!	
1c. (mɑ:)'(rɑ:.tɔn)	*!		*	

/ reaktor /	NoClash	NonFin	WSP / SWP	F'Right
2a. '(re:.ak)(tɔr)			*	*!
☞ 2b. rɛ'(ak.tɔr)			*	
2c. (re:)'(ak.tɔr)	*!		*	
2d. '(re:.ak)tɔr			**!	
2e. (re:)'(ak)(tɔr)	*!*			*

Tableau 5. Evaluation of /anis/.

/ anis /	NoClash	NonFin	WSP / SWP	F'Right
☞ a. '(ɑ:.nIs)			*	
b. a.'(nIs)		*!		
c. '(ɑ:).(nIs)	*!			*
d. (ɑ:).'(nIs)	*!	*		

Tableau 6. Evaluation of /katastro:f/.

/ katastro:f /	NoClash	SHSP	NonFin	SylMon	WSP / SWP	F'Right
☞ a. (ka.ta).'(stro:f)			*	*	*	
b. '(kɑ:.ta).(stro:f)		*!		**		*
c. ka'(tɑ:.stro:f)		*!		**	*	
d. (kɑ:.ta).'(stro:f)			*	**!		

The reason that the superheavies must be specified is that *both* super-heavies and normal heavy syllables can occur in final position, e.g. compare *anis* with *polis* 'police', where the latter has final stress. Only the superheavy receives stress, so they must be specified in the input form. However, many of them occur in syllables that seem to be 'submorphemic', e.g. that are affixes

etymologically. It is possible that they can be listed, and in that way reduce the number of words where it is necessary to prespecify a superheavy syllable (see also 4.6).

4.6 Problems
There are a few problems in the present analysis. We have not motivated why we regard penultimate stress as the best default rule. Formally, the default rule could also predict final stress, and penultimate stress marked in the lexicon. We take some support from similar analyses of Dutch and German, where the penult has been used as default pattern, and claim that the similarities within the Germanic language family support this analysis for Swedish.

There is also a larger number of monomorphemic words with penultimate stress than with final or antepenultimate stress. The number of mono-morphemes is perhaps not a relevant factor; the daily use (the frequency of occurrence of each word) is probably more important.

Another reason is that it is easier to find patterns (submorphemic similarities) at the end of a word than in the middle. Some of the words with a superheavy final syllable can be identified by their final syllable, e.g., the syllables *-åb, -ad, -id, -age* (orthographic representation) are all stressed.

The same case can be made for the prespecified foot patterns that were used in trisyllabic words. Whenever there is variation in the data, one must determine a default rule and then use exceptions, exceptions from the exceptions, etc. We believe that the default patterns we have chosen cover a lot of cases, and that the words that are treated as exceptions in many cases can be handled by other linguistic factors, such as submorphemic patterns, and schwa vowels (which never carry stress).

A third problem is that we may have followed Gussenhoven's argumentation for non-moraic pre-stress coda consonants too rigidly. Riad 1992 states that it has more to do with the sonority of the consonant than the position in the word, and Swedish and Dutch may differ in this respect. But this is an empirical question that we will leave unsolved at present.

4.7 Compound words
Compound words receive a special stress pattern in Swedish. They often consist of two or more words or morphemes with one real word stress each, but only one of them is realised with main stress in a compound word. Main stress goes to the leftmost stressable element, while the last stressable element receives secondary stress. Other stresses (in compounds with more than two

parts) are not realised, but they may affect the rhythmical pattern between main and secondary stress.

In order to treat this, the clitical group level is used. When two prosodic words form a grammatical unit on this level, each prosodic word projects its own head. But, since they are grouped together only one of these heads is realised as main stress. By adding the constraint (20), which says that the head of a clitic group should be to the left, main stress on the first part of the compound is realised.

(20)   MAIN-LEFT(C)
            A clitic group (C) is left-headed

As long as there is only one prosodic word, the head of the clitic group end up on the same unit as the head of the word (CCC in 2.2). This makes the last foot carry main stress. When two or more words are grouped together in a clitic group, the head of the group will be in the domain of the first prosodic word, which gives main stress to the last foot of the first prosodic word. See (21). Note that each prosodic word first produces a head, then the position of main and secondary stress is determined.

(21) Two one-word phrases (two prosodic words, *maskin* 'machine' and *fonetik* 'phonetics'):

```
C          (      x)            (              x)
PWd        (      x)            (              x)
Ft         <σ> ́(x)           (x̌    .)  (x)
           ma "Íi…n            fÁ      nE "ti…k
```

One compound phrase (one prosodic word, *maskinfonetik* 'machine phonetics', opposed to ear phonetics):

```
C          (      x                    )
PWd        (      x)        (          x)
Ft         <σ> ́(x)       (x̌    .)(x)
           ma  "Íi…n       fÁ    nEÆti…k
```

4.8 Affixes

The influence of affixation on stress was mentioned in 4.1.2. The affixes follow the weight sensitivity mentioned above. Some affixes do not influence the stress pattern at all, since they do not contain any heavy syllable. Other affixes introduce a new heavy syllable, except the one in the root of the word. This means that the resulting word contains two or more heavy syllables. The stress pattern of the word then follows the rules for compound words, see 4.7.

Depending on whether the affix is a prefix or a suffix, the affix will get main stress or secondary stress.

Another group of affixes has a heavy syllable, and deprives the root of stress. These suffixes cause a change in the morphology of the root, so that a heavy syllable in the root becomes light, see (22). A way of analysing this is to assume that these suffixes have prespecified information that says that a syllable in the suffix must be the head in the clitic group. The other syllables have to adjust to this. Since only one heavy syllable remains, only one prosodic word is formed. Therefore, word stress will appear on the heavy syllable in the suffix.

```
(22)  C      (x      )              (              x      )
      PWd    (x      )              (              x      )
      Ft     (x    . ) <σ>          (x    . )  (x        . )
             l"… ra    rE            l"    ra       ri…n   a
```

It should be emphasised that the interaction between morphology and prosody is a lot more complex than presented here. Our main purpose is to show the necessity of using the clitic group in treating the stress pattern in compounds and in morphologically complex words, since prosodic words have right-bound main stress, while compounds have left-bound main stress. This is an area where a more extensive analysis is needed.

5 Conclusions

We have shown that the phonology of Swedish stress can be treated within optimality theory using a correct constraint ranking hierarchy. The metrical analysis provides a useful framework, and this is extended with mora and syllable structure information. Swedish does show variation from what the rules predict, and in the present analysis we explain this by assuming lexical features in the deviating words.

The most important features of monomorphemic words is that a grammatical word must have at least one foot, and that there is a preference for left-headed, binary feet finally in the word. The basic foot type is the moraic trochee, but in pre-stress position syllabic trochees may occur. Final stress is avoided, unless marked in the lexicon. In order to realise this we have established the following constraint rankings:

I. RHYTHMTROCHEE, FTBIN, GRWD = PRWD, MAIN-LEFT(C): highest rank
II. {NOCLASH,NONFIN} >> WSP/SWP >> F'RIGHT
III. SHSP >> WSP/SWP
IV. NONFIN >> SYLMON >> WSP/SWP

Complex words (compound words and derivatives with more than one morpheme) must be treated on a higher level than the prosodic word, since monomorphemic words prefer stress to the right in the word, whereas compound words are left-headed.

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