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Basbøll, Hans; Kjærbæk, Laila; Lambertysen, Claus

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THE DANISH NOUN PLURAL LANDSCAPE

by

Hans Basbøll, Laila Kjærbaek & Claus Lambersen
University of Southern Denmark


Contact:
Hans Basbøll
Institute for Language and Communication
University of Southern Denmark
Campusvej 55
DK-5230 Odense M
e-mail: hba@language.sdu.dk
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Abstract
This article examines the Danish noun plural system in spoken language, i.e. we depart from a – radically new – sound perspective. We consider suffixes where the categorisation is not isomorphic with the orthographically determined categories. We give an overview of phonological stem changes, and we find interesting patterns of stød change in monosyllables. We identify 25 different combinations of suffixation and stem change and give lexical frequencies for them. We consider two aspects of plural formation that are relevant for the investigation of first language acquisition, viz. the gradation of stem change and the predictability of plural suffixes from gender and from stem-final phonology; we detect four classes of stem-final phonemes, i.e. segment types, which have different patterns of plural suffixation, and we point to some reasons why just these distinctions – mainly in sonority – can be relevant.

1. Introduction
For the study of the early phases of morphological acquisition one needs a reliable grammatical description of the morphological system to be acquired. But even the largest grammars and dictionaries of Danish – and undoubtedly of many other languages – are in all essentials based upon orthography, despite scattered remarks on spoken language. This has serious consequences, e.g. for the analysis of noun plural morphology, and there is no isomorphy between the written-language based categories employed in grammars and dictionaries, and the spoken language categories.

Danish noun plural formation employs two mechanisms, viz. suffixation and stem change, whose phonetic manifestation is the focus of the present paper.

The nouns *lærer* ['læːrɛ] ‘teacher’ / *lærer-e* ['læːrɛː] ‘teachers’ and *aborre* ['aboːr] ‘perch’ / *aborre-r* ['aboːrʀ] ‘perches’ illustrate the problem in suffixation: grammars will tell you that the plural suffixes are -e and -r, respectively, just as in *hund* [ˈhʊŋd] ‘dog’ / *hund-e* [ˈhʊŋdɛ] ‘dogs’, with e-schwa suffix (ə), and *bamse* ['bɑmsə] ‘teddy bear’ / *bamse-r* ['bɑmsər] ‘teddy bears’, with a-schwa suffix (ə). But in the spoken language, *lærer-e* is formed with a-schwa suffix – just like *bil* [ˈbiːl] ‘car’ / *bil-er* [ˈbiːlɛr] ‘cars’ – and *aborre-r* is a “zero plural” – just like
mus [muːs] 'mouse' / mus [muːs] 'mice'. Furthermore, there is an intricate system of stem changes, which are at best very partially treated, even in the most comprehensive grammars and dictionaries.

Since our starting point is spoken language, not written language, the present analysis differs markedly from traditional descriptions of Danish plural formation. The most detailed pronunciation dictionary of Danish, viz. Brink et al. (1991), gives a phonetic description of plural formation (p. 1641-1645), but the point of departure is a purely orthographic distinction between the markers “-e” and “-r”, which is not isomorphic with the distinction between e-schwa and a-schwa. Furthermore, the authors treat stem changes only sporadically. In the new large standard grammar of Danish, viz. Hansen and Heltoft (2011), the analysis of noun plural inflection (p. 486-500) is based exclusively on orthography, except for a few scattered remarks, most importantly (p. 490) that the plural ending -e after words whose singular indefinite ends in -r, e.g. lærer/lærer-e 'teacher/teachers', cannot be distinguished from the ending -er. The authors only consider stem changes that are reflected in the orthography, viz. umlaut, but not r-insertion, and no prosodic stem changes.

The pronunciation forms used in this paper are uncontroversially Standard Danish. More specifically, we take Modern Standard Copenhagen as the point of departure in agreement with modern dictionaries, etc. The phonetic notations are rather broad IPA, with practically no use of diacritics, i.e. they presuppose a normalisation for vowel qualities – in agreement with those used by Grønnum (e.g. 2007, 1998) and Basbøll (2005). Voicelessness is not indicated for the stop series [b d g], nor is aspiration/affrication for the stop series [p t k].

Throughout the paper we take isolated distinct pronunciations as our point of departure, and our level of analysis is broad transcription. It is clear, however, that at the outset, the relevant input to the child is sound, not analysed linguistic units. Thus all the phonetic variation (due to reduction, etc.) which the child meets, is relevant in the study of first language acquisition, but is ignored in this paper; see Basbøll et al. (2011) for our project “From sound to word – in Danish children 9-30 months old” where real child language input as well as output is used as data.

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1 e-schwa and a-schwa are the phonemes /ə/ and /ɐ/, respectively, see section 3.2.
We use our computational system OLAM\textsuperscript{2} for the phonological and morphological analyses of the different plural patterns, and throughout the paper we give figures for all nouns in our database as well as “Prosodically Basic Nouns”, abbreviated PBN. PBNs are defined as having primary stress on the first syllable and no further stress – be it primary or secondary. Frequencies for the PBNs are supposedly more relevant for first language acquisition than lexical frequencies for all nouns.

“Plural” is abbreviated PL and “definite” DEF, but “singular” and “indefinite” are “sg.” and “indef.”, respectively, in order to distinguish between marked morphological categories – in capital letters with no period – and their corresponding unmarked categories – in lower-case letters and period. The marked categories are supposed to be present in the language structure in contradistinction to the unmarked ones. Thus, we do not accept zeroes as morphemes in unmarked morphological categories – and absolutely not, e.g., a sequence of morphological zeroes in *kat* ‘cat’ for sg. plus indef. plus non-possessive; see also Basbøll (2009). In the present paper we speak about a zero suffix, e.g. in *mus* ‘mice’, but not in *mus* ‘mouse’. Furthermore, we distinguish between overt PL suffixes and zero, since zero is different from a non-null suffix in being inaudible. Finally, a word of warning in this connection. PL with insertion of /\textipa{r}/ and /\textipa{n}/, as in *fætter* [f\textipa{fet\textipa{r}}] ‘cousin’ / *fætre* [f\textipa{fet\textipa{r}}] ‘cousins’ and *øje* [\textipa{ʌj\textipa{e}}] ‘eye’ / *øjne* [\textipa{ʌj\textipa{n}}] ‘eyes’, have two defensible analyses according to the principles we adopt: (1) They can be considered as having a non-null PL suffix, i.e. a-schwa and e-schwa, respectively, combined with the phonemic stem change and syncope; this is the analysis we have used in work with our international partners, see Laaha et al. (2012). (2) They can be considered – more radically, perhaps – as having a zero PL suffix, and then the phonemic stem change (insertion of /\textipa{r}/ or /\textipa{n}/) will be the only overt PL marker; this is the analysis chosen in the present paper.

\textsuperscript{2}OLAM is a computational system for Danish developed by Claus Lambertsen, Hans Basbøll and Thomas O. Madsen on the basis of Peter Molbæk Hansen’s *Dansk Udtale* (Molbæk Hansen 1990). The OLAM-database consists of a coding system (OLAM-code) and an analysis system (OLAM-search). The OLAM-database contains about 43.000 lexical entries all accompanied by orthographic, morphological, phonological and segmentation information (cf. Madsen et al. 2002, Basbøll & Jørgensen 2011).
2. Inflection of Danish nouns

Danish is an inflectional-fusional language, which may be on its path towards becoming isolating, cf. Herslund (2001, 2002). The structure of the inflected word can be formulated as follows, cf. Basbøll (2005, 437ff), where one has to reckon with – at least – two positions for inflectional suffixes:

STEM – INFL1 – INFL2 – CLIT

where CLIT indicates a clitic, viz. the POSS marker |s| – pronounced [s] or [øs], or, optionally, zero after sibilants. This |s| may be dissociated from the head of its construction, just like in English. This is particularly noteworthy in the spoken language, as in, e.g., hende jeg mødte i går mand er forresten ansat i kommunen, literally ‘her I met yesterday’s husband is by the way employed in the municipality’. Note that POSS |s| is generally called an inflectional suffix (“flexive”) in Danish grammars, in spite of the fact that it can always be disregarded where stød is concerned, in contradistinction to true inflectional suffixes (cf. tal-s [tals] ‘number’s’ which is stødless just like tal [tal] ‘number’ as opposed to tall-et [ˈtal̚eɻ] ‘the number’ with stød; see further section 3.3 below). POSS |s| is the only clitic in Danish.

PL in Danish is an inflectional category in certain pronouns and in adjectives as well, but we consider only PL formation in nouns here. For nouns, the formula above can be specified as follows:

STEM – PLsuff – DEFSuff – POSSclit

as in, e.g., bil-er-ne-s [ˈbiːlɐn̩s] ‘the cars’. The fact that POSS |s| is most often (en)cliticised to the noun – with its inflectional suffixes – rather than to other word classes, makes it relevant to consider POSS |s| in relation to inflectional noun suffixes. From the point of view of PL identification, POSS |s| contributes to the opacity of PL suffixes for the child, since |s| must be disregarded or
dissociated from the preceding string, in order to get to the PL suffix (as in bil-er-s [ˈbl̩eːrs] ‘cars’).

Something similar applies to the DEF suffix, which is a typologically characteristic feature of Scandinavian languages, cf. bil-er-ne ‘the cars’. The distribution of DEF suffixes must be considered in relation to DEF and indef. articles. Note that semantic factors are not taken into account here, but they are of course relevant for a complete understanding.

For the nouns bil ‘car’ (common gender) and skib ‘ship’ (neuter), the four main forms are given in Table 1:

<table>
<thead>
<tr>
<th></th>
<th>Indef.</th>
<th>DEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sg.</td>
<td>(en) bil ‘(a) car’</td>
<td>bil-en ‘the car’</td>
</tr>
<tr>
<td></td>
<td>(et) skib ‘(a) ship’</td>
<td>skib-et ‘the ship’</td>
</tr>
<tr>
<td>PL</td>
<td>bil-er ‘cars’</td>
<td>bil-er-ne ‘the cars’</td>
</tr>
<tr>
<td></td>
<td>skib-e ‘ships’</td>
<td>skib-e-ne ‘the ships’</td>
</tr>
</tbody>
</table>

Table 1. The forms of the lemmas bil, skib (common and neuter gender, respectively) cross-classified with respect to number and definiteness – expressed here by inflectional suffixes.

With an attributive adjective added, e.g. stor ‘big’, the result is shown in Table 2:

<table>
<thead>
<tr>
<th></th>
<th>Indef.</th>
<th>DEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sg.</td>
<td>en stor bil</td>
<td>den stor-e bil</td>
</tr>
<tr>
<td></td>
<td>et stor-Ø skib</td>
<td>det stor-e skib</td>
</tr>
<tr>
<td>PL</td>
<td>stor-e bil-er</td>
<td>de stor-e bil-er</td>
</tr>
<tr>
<td></td>
<td>stor-e skib-e</td>
<td>de stor-e skib-e</td>
</tr>
</tbody>
</table>

Table 2. Phrases containing the lemmas bil, skib (common and neuter gender, respectively) preceded by the adjective stor, cross-classified with respect to number and definiteness – the latter expressed here by an article or, in the adjective, an inflectional suffix.

Accordingly, a DEF inflectional suffix does not occur on the noun when the noun is preceded by an adjective. In that case definiteness is expressed by a DEF article occurring at the beginning of the noun phrase in question. The different use of DEF articles vs. DEF inflectional suffixes is thus a matter of syntactic context, in particular whether there is an attributive adjective – which in Danish always occurs before its head noun. Note that the DEF articles, common gender den, neuter gender det, PL de – which is gender-neutral in Danish – are unstressed, whereas the homographic demonstrative pronouns den, det, de are
stressed. The demonstrative pronouns are used irrespective of the occurrence of attributive adjectives in a position where DEF articles (unstressed) are not found, as in *den bil, det skib, de bil-er, de skib-e ‘that car, that ship, those cars, those ships’. Note that “double definiteness” as e.g. *den stor-e bil-en ‘the big car’ is impossible in Danish, unlike Swedish and Norwegian.

In this way, the DEF inflectional suffix |nø| (n+e-schwa), or the POSS clitic |s|, or their combination attribute to the opacity of PL markings, since they occur to the right of the PL suffix: PL+DEF dreng-e-ne ‘the boys’, PL+POSS dreng-e-s ‘of boys’, PL+DEF+POSS dreng-e-ne-s ‘of the boys’, cf. PL dreng-e ‘boys’. It therefore is not as easy to segment the PL suffix in Danish as in languages where PL suffixes are always word final.

3. Plural marking of Danish nouns: suffixes and stem changes
The system of nominal pluralisation in Danish consists of a number of PL suffixes, sometimes combined with stem change.

In the OLAM-database there are 42,954 lemmas – lexical entries – of which 22,914 are nouns (53.3 %). Of those 22,914 nouns, 18,768 (81.9 %) have both PL and sg. forms. 4,019 (17.5 %) occur only in the sg., as in, e.g., dår ‘baptism’. A corresponding PL could be dårshandlinger ‘acts of baptism’, PL of dårshanding. 127 nouns (0.6 %) occur only in the PL, as, e.g., penge ‘money’.

3.1. Plural suffixes: orthography
The orthographic PL suffixes registered in OLAM, including lexical doublets, are displayed in Table 3.
PL suffix | Nouns  | % of nouns |
-----------|--------|------------|
-er        | 11,081 | 59.0       |
-r         | 3,045  | 16.2       |
-e         | 3,126  | 16.7       |
Ø          | 1,295  | 6.9        |
-s         | 120    | 0.6        |
-a         | 83     | 0.4        |
-i         | 18     | 0.1        |
Total *    | 18,768 | 99.9       |

* 4,019 nouns with no PL and 127 nouns with only a PL form are excluded in the figures.

Table 3. Distribution of orthographic PL suffixes in OLAM (lexical frequency), all nouns incl. doublets.

Doublet forms
One way to address the problem of lexical doublets, like leksikonner or leksika from sg. leksikon ‘encyclopedia’, is to remove non-first forms in the database and retain only the first alternative as registered by Molbæk Hansen’s (1990) pronouncing dictionary. In this way, the figures in Table 3 decrease as shown in Table 4. There are 1,445 noun doublets in OLAM. In the remainder of this paper, doublet forms are excluded unless otherwise specified.

PL suffix | Nouns  | % of nouns |
-----------|--------|------------|
-er        | 10,297 | 58.5       |
-r         | 3,027  | 17.2       |
-e         | 2,969  | 16.9       |
Ø          | 1,211  | 6.9        |
-s         | 51     | 0.3        |
-a         | 35     | 0.2        |
-i         | 4      | 0.02       |
Total *    | 17,594 | 100.0      |

* 3,750 nouns with no PL and 125 nouns with no sg. form are excluded in the figures.

Table 4. Distribution of orthographic PL suffixes in OLAM (lexical frequency), all nouns excl. doublets.

Including prosody: Prosodically Basic Nouns (PBNs)
In the following, we consider a subset of the nouns in OLAM, viz. those which we have termed Prosodically Basic Nouns (PBNs). They are nouns with primary stress on the first syllable and no further stress – whether primary or secondary, as in bil [biːl] ‘car’ but not bagage [baɡæːʒe] ‘luggage’. PBNs are calculated on the basis of the sg. indef. form, which means that nouns with no sg. indef.
form are not PBNs. We might have included PL nouns with no sg. indef. without significant impact on our results, but elected to exclude them. PBNs are just one possible way to establish subsets of the lexicon. Smaller subsets of “child-relevant” lemmas could be relevant as could larger subsets based upon occurrence in comprehensive text corpora. But PBNs can be defended on two grounds. Firstly, a large number of grammatically complex and otherwise difficult words are excluded, making the vocabulary more similar to the typical input to a small child. Secondly, it has been shown that a dominant, language-specific, prosodic pattern plays a role in both early perception and production, cf. Vihman (1996, 93ff, 199ff) on the importance of phonological templates.

When we include only PBNs, the result is that compounded nouns as well as many derived nouns, and many foreign nouns, are excluded. In general, we consider PBNs to be a more relevant lexical measure in first language acquisition than all nouns. Table 5 repeats the information from Table 4, but reduced to PBNs. In OLAM there are 6,565 nouns with first syllable stress and no further stresses (30.6 % of the 21,469 nouns). 5,340 (81.3 %) of them are PBNs, i.e. they have both PL and sg. forms, whereas 1,225 (18.7 %) have only a sg. form.

<table>
<thead>
<tr>
<th>PL suffix</th>
<th>PBN</th>
<th>% of PBN</th>
</tr>
</thead>
<tbody>
<tr>
<td>-er</td>
<td>2,195</td>
<td>41.1</td>
</tr>
<tr>
<td>-r</td>
<td>1,157</td>
<td>21.7</td>
</tr>
<tr>
<td>-e</td>
<td>1,222</td>
<td>22.9</td>
</tr>
<tr>
<td>Ø</td>
<td>718</td>
<td>13.4</td>
</tr>
<tr>
<td>-s</td>
<td>27</td>
<td>0.5</td>
</tr>
<tr>
<td>-a</td>
<td>17</td>
<td>0.3</td>
</tr>
<tr>
<td>-i</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>*5,340</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* 1,225 nouns with no PL form are excluded in the figures.

Table 5. Distribution of orthographic PL suffixes in OLAM (lexical frequency). Prosodically Basic Nouns (PBN).

Table 5, like Tables 3 and 4, displays a dominant form -er – in particular when -r and -er are identified to be contextual orthographic variants, but -e and Ø are also relatively frequent lexically, whereas -s, -a and -i are rare.
Integration of foreign words
It appears from the tables that the PL suffixes -s, as in *drink/drink-s* ‘drink/drinks’, -a, as in *leksikon/leksik-a* ‘encyclopaedia/encyclopaedias’, and -i, as in *konto/kont-i* ‘account/accounts’, have an extremely low lexical frequency. The Danish counterparts to *leksika* and *konti* are *leksiko*nn-er and *konto-er*, respectively, and note that the learned suffixes are added to an abbreviated, apocopated, form of the stem. – PLs in -s, -a and -i are restricted to non-assimilated (relatively) foreign words and are supposedly rare as input to small children, with one exception: the isolated PL form *høn-s* used as a collective form, in distinction to the regularly formed PL *høne-r* ‘hens’ to *høne* ‘hen’ signifying the female parallel to *hane/hane-r* ‘cock/ cocks’. PL -s, -a, -i are excluded in the statistics to follow.

3.2. Plural suffixes: phonology
So far we have exhibited data for orthographic forms. In this fashion, other text corpora may be used to supply quantitative, statistical data for comparison. But if the data are to reveal anything about first language acquisition – as well as many other linguistic purposes – we need to consider spoken language data. The orthographic PL forms generally have a morphophonemic rather than a phonemic or concrete-phonological – not to say phonetic – foundation, cf. Basbøll (2005, 88-105). Accordingly, we need to look at the relation between the classifications of Table 5, as well as 3 and 4, and the spoken language correspondences.

-er: the morphophonemes |etections of Table 5, as well as 3 and 4, and the spoken language correspondences.

-er: the morphophonemes |e|schwa| plus |r| are obligatorily fused to a pharyngeal neutral vowel – an “a-schwa” [ɐ]/[ɐ]; there are, in Modern Danish, *only morphophonological* arguments in favour of a bi-segmental analysis of [ɐ], cf. Basbøll (2005, 72). The suffix spelled -er is always realised as the phoneme a-schwa, /ɐ/, from underlying morphophonemes |e|.

-r only occurs when the sg. ends in a completely unstressed e, normally corresponding to the phoneme e-schwa, a non-pharyngeal neutral vowel, /ɐ/. In that case the stem-final schwa is deleted, and the PL suffix is realised as a pharyngeal neutral vowel, an a-schwa, /ɐ/; as for -er, one can argue that the
ending is morphophonemically |œr|, and that |œœ| fuse to |œ|, cf. Hansen (1977, 13) and Basboll (2005, 309).

-e occurs, according to orthographically based descriptions, obligatorily – and fully productively – after lemmas ending in unstressed -er. They include complex stems like, e.g., nomina agentis -er, as in laser [|le:œə|] ‘reader’ / laser-e [|le:œəe|] ‘readers’, ending in “a monosyllabic and a bisyllabic” a-schwa respectively. In all such cases, the realisation is as a pharyngeal neutral vowel, an a-schwa, /œ/; the same thing applies if the stem ends in another pharyngeal vocoid, cf. Basboll (2005, 152-4). In all other cases, viz. after segments other than pharyngeal vocoids, the suffix spelled -e is realised as a non-pharyngeal neutral vowel, an e-schwa, /ə/, which is often assimilated or dropped.

-s, -a and -i as PL suffixes are, as mentioned above, very limited in Danish. They are realised as /s/ (or /øs/), /a/ and /i/, respectively, i.e. they are phonologically unrelated to the other PL suffixes.

The point of departure for an analysis of spoken PL endings, rather than orthographic or abstract morphophonemic patterns, therefore has to be a-schwa and e-schwa in addition to Ø (and the marginal -s, -a and -i). Accordingly, the figures in Table 6 differ considerably from those in Tables 4 and 5, a-schwa, /œ/, being clearly more dominant.
The two important non-null PL suffixes for Danish nouns are in fact phonologically related: they are the two neutral vowels in Danish and thus constitute a phonologically natural class, cf. Basbøll (2005, 143-146).

a-schwa and e-schwa are both contrastive segments and phonemes, /ə/ and /ø/, [ø] and [ø], cf. Basbøll (2005, 28-32, 39-42) and Basbøll (2006); e-schwa is a morphophoneme, |ə|, but not a-schwa: there is no *|ø|.

Reduction processes with dropping of the e-schwa-suffix often result in a PL form which is almost identical to the sg. form – just like pure zeroes, as in tov [tɔw] ‘rope’ / tov-e [tɔwə] – or very distinct [tɔwə] ‘ropes’. If the singular has stød, like skov [skɔw] ‘forest’, then that will presumably keep it distinct from PL skov-e [skɔwə] ‘forests’, but without stød in the singular, there is not much to distinguish it from the PL in normal pronunciation. See further Basbøll (2005, 293-304).

3.3. Stem change in plural formation: stød, stress, phonemic change
The different forms of stem change presented in this section will subsequently be graded into a three-level system of stem transparency in section 5.1.

Stød and productive stød addition
Stød is a laryngeal syllable rhyme prosody. Only syllables with a long vowel, or a short vowel followed by a sonorant consonant, and with primary or
secondary stress can have stød; such syllables are said to have stød-basis, or be heavy = bimoraic. Both the presence and the absence of stød on heavy syllables can be a signal of morphological structure; see Basbøll (2003; 2008; 2005, chapters 13-16) for a detailed analysis. Stød is a potential indicator of segmentation, or more precisely, absence of stød from a syllable whose sound structure permits stød, is a signal that a following (weak) syllable morphologically speaking is part of what precedes it, as in the following two examples. (1) In klaedte [klaɛ:да] stød on the disyllable ending in schwa indicates that this schwa is not morphologically an integrated part of what precedes it. It is the PL/DEF ending of the past participle of the verb klaede ‘dress’, i.e. klaed+t+e, whereas there is no stød in the homographic preterite form of the same verb, klaedte [klɛ:да] klæd+te. This difference is predicted by Basbøll’s Non-Stød Model (see the next subsection): the +t in the former form klaed+t+e is not the fully productive suffix; that would be +et. +t therefore has to fill a slot inside the basic word, wherefore the final +e must occur outside the basic word boundary and thus cannot lead to Morphological Non-Stød. +te in the latter form klaed+te, on the other hand, must be integrated in the basic word, since +te is not the fully productive suffix; that would be +et. +te therefore leads to Morphological Non-Stød. (2) Tals [tals], possessive of tal [tal] ‘number’, lacks stød. This is a monosyllabic structure which would otherwise have compulsory stød, cf. hals [hæl’s] ‘throat’. The absence of stød in tals means that [s] is not part of the word; it is a clitic, POSS [s]. Basbøll (2005, 432-63) gives a detailed treatment of the whole pattern of “integration of morphological inflectional endings” in the different word classes.

There is a significant interplay between stød and the noun PL suffix with respect to a kind of psycholinguistic productivity which can be illustrated by online produced ad hoc PL forms. For instance, the PL form of a proper name like French Zola, in Danish [sóla], is [sóлаe’te]. Or take a conjunction like som (relative pronoun) [som], which is [som’te] in the PL, i.e. in the sense of ‘instances of som’. Thus, these ad-hoc PL forms are formed with compulsory stød-addition, even though stød is not dictated by sound structure per se. In other words, there are no syllable types which must have stød without exception. But there are syllable types which never allow stød. If these PL forms of Zola and som – which can be multiplied ad infinitum – are considered to be revealing of the system, the linguistically relevant classification of PL suffixes should be reconsidered.

Stød change in plural forms of monosyllables
In order to illustrate the psychologically relevant stød-system in Danish PL formation, we shall take a closer look at a subset of the native forms, viz. monosyllables. There are two reasons why monosyllables are interesting in this context: First, the stød alternations, i.e. stød addition and stød drop, are more general in monosyllables, because polysyllables as the main rule do not undergo stød alternations. Second, the monosyllables belong to the core of the native vocabulary.

The distribution of monosyllables vs. polysyllables exhibits typological variation, and in Danish there are significantly fewer monosyllables among verbs than among other major parts of speech; this is relevant to child language research (cf. Stokes et al. forthcoming).

The challenge in accounting for stød alternations in monosyllables can be illustrated by the existence of all the logical combinations of stød and non-stød in sg. vs. PL in words of the same simple structure, viz. monosyllables with a short vowel followed by a single sonorant consonant, as in hal [hål] ‘hall’ / hall-er [‘halls’, both with stød; ven [væn] ‘friend’ / venn-er [væn-ɐ] ‘friends’, both without stød; sum [‘sʊm̥] ‘sum’ / sum-er [‘sʊm̥-ɐ] ‘sums’, stød in sg. but not in PL; and han [han] ‘male’ / hann-er [‘hæn-ɐ] ‘males’, stød in PL but not in sg. Note that there are no geminates, neither phonetically nor phonologically, in the PL forms.

Table 7 and 8 below include doublet forms, because we are looking for systematic, or structural, principles, i.e. to discover which forms exist and which do not. Accordingly, all alternations are relevant, whether or not some forms, e.g. a particular PL form, are lexical doublets. If we exclude doublets, we may overlook examples which falsify our hypothesis. So for methodological reasons, we are forced to search for the maximum number of potential counterexamples to the theory which is our point of departure, viz. Basbøll’s Non-Stød Model.

According to the Non-Stød Model (Basbøll 2005, 2008), stød is a signal for the second mora of a syllable, and stød is therefore the unmarked case for heavy syllables in the native-like vocabulary, which includes loans from Classical Greek and Latin and from Low and High German. Thus principles must be given for the absence of stød in heavy = bimoraic syllables, i.e. syllables with stød-basis.
The Morphological Non-Stød principle is dependent on the word structure with slots for suffixes with different degrees of integration with the preceding stem according to the following formula:

\[
| \{ \{ ( \text{STEM P1} ) P2 \mid P3A \mid P3B \} P4 \} |
\]

where P1 is the position for fully integrated suffixes; P2 for lexicalised verbal suffixes; P3A for default suffixes that can be lexicalised, e.g., PL; P3B for default suffixes that cannot be lexicalised, e.g., DEF; and P4 for the clitic, POSS isl. All non-default suffixes, e.g., PL isl, are lexicalised, i.e. they occur within the basic word, on P1 or P2. A few examples suffice:

\[
| \{ ( \text{bi} ) \} \mid \text{ar no} \} | s | \text{bil-er-ne-s ‘of the cars’} |
\]

\[
| \{ ( \text{hus e} ) \} \mid \text{ne} \} | s | \text{hus-e-ne-s ‘of the houses’} |
\]

Lexical Non-Stød – which applies as the marked case in the native-like vocabulary, and throughout in the non-native-like vocabulary – applies as follows: (1) A word-final consonant is ignored in the building up of the syllabic-moraic structure. It is “extra-prosodic” in the terminology of Kristoffersen (2000), as in the final /n/ of \textit{ven} [vɛn] ‘friend’. In this way the syllable becomes monomoraic when the word is pronounced in isolation – in contradistinction to, e.g., \textit{pen} [pɛn] ‘pen’. (2) The second mora of all syllables are marked for non-stød, like \textit{torsk} [tɔ:sg] ‘cod’ or \textit{team} [ti:m] ‘team’; see Basbøll (2005) and (2008) for details. Extra-prosodicity effects are revealed throughout the non-native-like vocabulary and are fully productive, like stød addition in the PL forms \textit{balkon} [baldkən] ‘balcony’ / \textit{balkon-er} [baldkənər] ‘balconies’ and \textit{pâté} [pate] ‘pâté’ / \textit{pate-er} [pateːr] ‘pâtés’.

Table 7 displays the percentage of monosyllables out of all nouns and out of PBNs for the three native PL suffixes. Since monosyllabic nouns are prosodically basic by definition, it follows inevitably that percentages of all nouns will be considerably smaller than percentages of PBNs. The large majority of nouns taking the e-schwa PL suffix are monosyllables, viz. more than 60% of all nouns and nearly 90% of PBNs. On the other hand, monosyllables constitute
only a small fraction of nouns with the (dominant) a-schwa PL suffix, and monosyllables with Ø PL are in between the two overt suffixes.

<table>
<thead>
<tr>
<th>PL suffix</th>
<th>% of all nouns</th>
<th>% of PBN</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-schwa /æ/</td>
<td>4.7</td>
<td>16.7</td>
</tr>
<tr>
<td>e-schwa /ə/</td>
<td>61.3</td>
<td>88.9</td>
</tr>
<tr>
<td>Ø</td>
<td>38.9</td>
<td>70.2</td>
</tr>
</tbody>
</table>

Table 7. Monosyllables (N=1,841) in % of all nouns and of Prosodically Basic Nouns (PBNs). Doublet forms are included. 620 monosyllables without a PL form are excluded, as are 31 plurals with -s PL suffix.

Of the 642 monosyllables with Ø PL, one isolated example, viz. gås [ɡɔːˈsː] ‘goose’ / gæs [ɡɛs] ‘geese’ with umlaut, has stød drop, and there are no instances of stød addition. Thus, the general principle is unambiguous: **monosyllables with Ø PL do not exhibit stød alternation.** This is also what Basbøll’s Non-Stød Model predicts, since zero is not allowed to fill any slot in the word structure model and therefore cannot lead to Morphological Non-Stød.

Among the 439 monosyllables with PL suffix e-schwa, there are no instances of stød addition. All 316 nouns with stød in sg. drop it in PL, like hus [ˈhusː] 'house' / hus-e [ˈhʉːsː] ‘houses’. The principle is evident: **Monosyllables with stød and PL suffix e-schwa have compulsory stød drop.** This compulsory stød drop in monosyllables with PL suffix e-schwa is predicted by Basbøll’s Non-Stød Model: since e-schwa is not the fully productive PL suffix – that is a-schwa – it must be integrated into the basic word, whereby Non-Stød becomes compulsory, just as it is in monomorphemic disyllables ending in e-schwa.

The real challenge is to unravel the system of stød alternations for PL forms of monosyllables taking the PL suffix a-schwa; see Basbøll (2005, 432-442) for a complete account of stød alternations and non-alternations in noun inflection in his word structure model. To understand how all four logically possible combinations of stød/non-stød and sg./PL can occur in native words, as in hal, ven, sum, han above, we need to consider the syllable structure, in particular the notion of stød-basis: only syllables with a long sonority rhyme – either a long vowel or a short vowel followed by a sonorant consonant/glide – can have stød. There is also a prosodic condition of primary or secondary stress,
but this is irrelevant for monosyllables which are invariably stressed in isolation. Furthermore, and trivially, only monosyllables with stød can undergo stød drop in an observational sense, and – similarly – only monosyllables without stød, but with stød-basis, can undergo stød addition. When the monosyllables taking PL suffix a-schwa are organised according to syllable structure and stød in the sg. form in the vertical dimension, and to stød alternations sg./PL, i.e. stød addition, no stød change, and stød drop, respectively, horizontally, the result is as depicted in Table 8.

<table>
<thead>
<tr>
<th></th>
<th>Stød addition</th>
<th>No stød change</th>
<th>Stød drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stød basis</td>
<td>n.a.</td>
<td>(270) 35.6%</td>
<td>n.a.</td>
</tr>
<tr>
<td>Stød in sg.</td>
<td>n.a.</td>
<td>(264) 34.8%</td>
<td>(117) 15.4%</td>
</tr>
<tr>
<td>No stød in sg., sg.</td>
<td>(32) 4.2%</td>
<td>(14) 1.8%</td>
<td>n.a.</td>
</tr>
<tr>
<td>ends in V(Cson)#3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No stød in sg., sg.</td>
<td>0^4</td>
<td>(62) 8.2%</td>
<td>n.a.</td>
</tr>
<tr>
<td>has V:C or VCsonC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8. Numbers in parentheses and percentages of monosyllables with PL suffix a-schwa /æ/ according to stød change. N=759. Doublets are included.

About 15% of the monosyllables with PL a-schwa have stød drop and should have an integrated, i.e. lexicalised, suffix according to the model. The distinction between the third and fourth rows is interesting for the Non-Stød Model: the third row represents monosyllables with an extraprosodic final sonorant consonant, whereas the fourth row represents monosyllables which are unambiguously heavy.

The hypotheses of the Non-Stød Model are in agreement with the results depicted in Table 8. Of the 108 monosyllables with stød-basis but no stød in the sg., the majority, viz. 62 in the fourth row, have an unambiguously heavy syllable, and they are always stød-less, as they are predicted to be from the Non-

^3 “Cson” is in parentheses since the formula also covers cases with a final short vowel, like vj, vy-er 'view(s)', where the vowel is always lengthened and with stød-addition, just like Zola’er above.

^4 The database gives one example, viz. shunt [ʃʌnt] / shunt-er [ʃɔnt’er] 'shunts', pronounced with the English and the Danish vowel qualities in sg. and PL, respectively, but this pronunciation pattern is unknown to us; nor does it agree with Brink et al. (1991). This word is excluded in Table 8.
Stød Model. Of the remaining 46 in the third row, which have a heavy syllable but are subject to extra-prosodicity effects, the majority, viz. 32, have stød-addition, and the minority, viz. 14, have no stød change. These latter nouns must be marked for Lexical Non-Stød, in so far as they belong to the native vocabulary. In other words, all four different combinations of stød/non-stød in sg./PL can be accounted for within the principles of the model, granted marking for Lexical Non-Stød; furthermore, the model predicts the productive stød addition in ad hoc PL forms like Zola’er mentioned in the beginning of the section 3.3. There are therefore good arguments to the effect that Basbøll’s Non-Stød Model is a psycholinguistically relevant approach to morphological stød change, even though the principles appear decidedly language-specific; nonetheless, they follow from general linguistic and cognitive principles, as argued in Basbøll (2005).

Prosodic stem change: stød addition and stød drop

Even though, as we have just established, the stød changes observed in our data follow from the Non-Stød Model, we shall take stød-addition and stød-drop in the PL form compared to the sg. to be parameters of classification in PL markings, analogous to umlaut in this respect. Stød will accordingly be considered in the following in relation to stem transparency and suffix predictability. Stød is distinctive, or contrastive, in Danish and it is never compulsory from the point of view of pure sound structure, i.e. when no information on word boundaries, morphological structure, part of vocabulary, etc. is considered. In other words, there are no syllable types which always, without exception, have stød. From the point of view of language acquisition there is a strong language-internal motivation for this approach: At the outset, the small child naturally does not have access to any stød-system; this is something which can only be established through development. What the stød system constitutes for an adult, in a cognitive sense, is an empirical issue which should also be addressed experimentally. Grønnum & Basbøll (2007, forthcoming) discuss a tendency, inferred from a number of Grønnum’s observations, to stød-additions based upon purely formal, phonological aspects of word structure, without regard to morphological or semantic content; see also Grønnum (2005, 214-42, in particular 238-41) and Basbøll (2008). An important research question arises as to when and how the child – whose linguistic environment has a stable stød system – can access and internalise such a system.
Prosodic stem change: stress shift

In a rather small group of nouns, the PL formation involves a stress shift to the right, combined with the addition of a PL suffix – which is always a-schwa (/ɐ/) in these cases, e.g. motor [ˈmɔː.tər] ‘motor’ / motor-er [ˈmɔː.tər.ər] ‘motors’. Such a stress shift in the PL is registered in 295 lemmas in the OLAM database, corresponding to 1.4% of the sum total of nouns. 30 of them are PBNs, i.e. 2.5% of the total number of PBNs. This is the only type of stress shift in inflections in Modern Danish. Stress shift is common in word formation, particularly in derivation, as in violin [ˈvʊ.ə.lɪn] ‘violin’, violinist [ˌvɪ.ə.lɪn.ɪst] ‘violinist’ but also in compounding, as in skærsommer [ˈskə.ɹə.ɹəm] ‘midsummer’, vis-à-vis the more common stress pattern in sensommer [ˈsɛn.ɹə.ɹəm] ‘late summer’. In the figures above, doublet stress forms are excluded, and some of the words with (registered) stress shift also exhibit normalisation of the stress pattern, in fact in both directions, mostly so that the stress of the sg. form is generalised to the PL, but there are also examples of the opposite generalisation, viz. that the stress of the PL form is generalised to the sg., see Basbøll (2005, 422-5). Differences in token frequency between the sg. and PL forms must be taken into account regarding these patterns.

Phonemic stem change: umlaut and insertion of /r/ and /n/

Umlaut, which is a phonemic stem change together with r-insertion and the completely isolated case of n-insertion in oje [ˈo.jə] ‘eye’ / øjne [ˈø.ɹə.nə] ‘eyes’, is also a parameter in the Danish noun PL system, even though it is rare in the lexicon. Umlaut has the following realisations in Danish:

1) the low vowel lal ([a, ɑ]) is fronted and raised to lɛl ([ɛ, æ]) as in and [aŋt] ‘duck’ / and-er [ˈæn.tər] ‘ducks’;

2) the low vowel lal ([a, ɑ]) is rounded and raised/fronted to løl ([ø, œ]) as in barn [ˈba.ɹən] ‘child’ / barn [ˈba.ɹə.nə] ‘children’;

3) the rounded back mid vowels lo, ɔl ([o, ɔ]) are fronted to løl ([ø, œ]) as in fodd [ˈfo.ɹə] ‘foot’ / fodd-er [ˈfo.ɹə.ɹə] ‘feet’;
4) the rounded back mid vowel $l$ ([ə, ʌ]) is unrounded and fronted to $l$ ([ɛ]) as in $hænd$ ['hænd] ‘hand’ / $hænd$-er ['hænd-e] ‘hands’.

There are 25 roots with umlaut in Danish. Four of these roots are suffixless exclusively with umlaut, like $barn$/$børn$ ‘child/children’, whereas the other 21 take the a-schwa suffix. None of these words take the e-schwa suffix.

Umlaut may be combined with $r$-insertion, as in $datter$ ['dáttə] ‘daughter’ / $døtre$ ['dødərə] ‘daughters’. $r$-insertion occurs, though lexically heavily restricted, in nouns ending in a-schwa, as in $søster$ ['søsdə] ‘sister’ / $søstre$ ['sødərə] ‘sisters’. The completely isolated example $øje$ ['ʌjə] ‘eye’ / $øjne$ ['ʌjnə] ‘eyes’ – historically a dual form – exhibits $n$-insertion. Since umlaut is restricted to a very limited number of nouns in Danish, we do not expect it to be overgeneralised, and the same goes for $n$-insertion.

Are syncope and apocope stem changes?

Syncope, as in $gaffel$ ['ɡafəl] ‘fork’ / $gafl$-er ['ɡafle] ‘forks’, is a phonological stem change, i.e. it is not purely phonetically conditioned, since we have both options: deleting a syllable or retaining all syllables in the PL formation. Thus, $cykel$ ['sɪɡəl] ‘bicycle’ / $cykl$-er ['sɪɡle] ‘bicycles’ has compulsory deletion of the e-schwa syllable, whereas in $dekk$en ['dɛɡən] ‘horse blanket’ / $dekk(ke)n$-er ['dɛɡ(ə)nə] ‘horse blankets’ deletion of the e-schwa syllable is optional, cf. Basbøll (2005, 289). Note that the normal pronunciation of these three sg. forms is with assimilation of $[ə]$ resulting in a final syllabic sonorant consonant.

Apocope, i.a. truncation of final schwa before a vowel-initial suffix, is not counted as a stem change here, since there is no alternative to deletion of a syllable peak in PL formation in forms like $bamse$ ['bəmsə] ‘teddy bear’ / $bamse$-r ['bamsə] ‘teddy bears’, never *['bamsəe] which is an impossible structure.

4. Classification of plural markings in nouns
Allan et al. (1995, 21-38) give a detailed account of PL formation in their comprehensive grammar aimed at foreign students of Danish; it contains much information, but the authors employ a mixture of orthographic, phonetic/phonological and other criteria which makes it difficult to grasp the main structural principles. Janikowski (1982), on the other hand, must be acknowledged as a competent contrastive analysis of Danish and German morphonology (allomorphy).

Before we turn to the final classification of spoken PL markings in Danish nouns in Table 10, we shall exemplify the orthographically organised analyses of Tables 3-5, supplemented by inclusion of stød change and umlaut in Table 9. Even though this might seem like a mixing up of phonology and orthography in the system, this is in fact what grammars and dictionaries often do in practice if they consider speech at all, cf. section 1. This table is therefore easier to compare with other classifications in the literature than the purely phonology-based tables elsewhere in this paper.
<table>
<thead>
<tr>
<th>PL marker</th>
<th>Example</th>
<th>Gloss</th>
<th>All nouns</th>
<th>% of all nouns (N=17,594)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-er</td>
<td>hal</td>
<td>hall/er</td>
<td>5,407</td>
<td>30.7</td>
</tr>
<tr>
<td>-er +ʔ</td>
<td>han</td>
<td>henn-er</td>
<td>4,491</td>
<td>25.5</td>
</tr>
<tr>
<td>-er +R + S</td>
<td>spekter</td>
<td>spektr-er</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>-er + R + S-2</td>
<td>alder</td>
<td>aldr-e</td>
<td>23</td>
<td>0.1</td>
</tr>
<tr>
<td>-er + S</td>
<td>gaffel</td>
<td>gafte-er</td>
<td>253</td>
<td>1.4</td>
</tr>
<tr>
<td>-er + S</td>
<td>single</td>
<td>single-r</td>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>-er + S + N</td>
<td>øje</td>
<td>øjn-e</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>-er + U</td>
<td>fod</td>
<td>fodd-er</td>
<td>29</td>
<td>0.2</td>
</tr>
<tr>
<td>-er + S + U</td>
<td>bonde</td>
<td>bonde-r</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>-e + U</td>
<td>datter</td>
<td>dotr-e</td>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>-e + U + R</td>
<td>bror</td>
<td>brod-e</td>
<td>16</td>
<td>0.1</td>
</tr>
<tr>
<td>Ø + U</td>
<td>mand</td>
<td>mænd</td>
<td>18</td>
<td>0.1</td>
</tr>
<tr>
<td>Ø + U -2</td>
<td>gøds</td>
<td>gøs</td>
<td>2</td>
<td>0.01</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>17,594</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5 Only words which end in e.
6 Only words where stød is excluded.
Table 9. Distribution of PL markers in OLAM (lexical frequency), all nouns. PL suffixes are based on orthography, whereas stem changes are based on sound.

“+S” in Table 9 indicates syncope, “+R” indicates r-insertion, “+N” indicates n-insertion, “+ʔ” indicates stød addition, “-ʔ” indicates stød drop.

The full classification of PL markings of Danish nouns which we are going to use in the following will be based strictly upon the sound shape of the PL suffix and the changes with respect to stød, stress, umlaut, syncope, r-insertion and n-insertion as argued in section 3.3. Stød change (from sg. to PL) will henceforth be indicated in all cases observed, as will subclasses involving umlaut and other phonemic stem changes from sg. to PL. The category n-insertion, which applies only to the lemma øje [əjə] ‘eye’ / øjne [øjə] ‘eyes’, is introduced as category 3f.
<table>
<thead>
<tr>
<th>PL-marker</th>
<th>Nouns</th>
<th>% of all nouns (N=21,466)</th>
<th>% of nouns with PL form (N=17,594)</th>
<th>PBN</th>
<th>% of all PBN (N=6,565)</th>
<th>% of BPN with PL form (N=5,340)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a er</td>
<td>7,599</td>
<td>35.4</td>
<td>43.2</td>
<td>1,418</td>
<td>21.6</td>
<td>26.6</td>
</tr>
<tr>
<td>1b (e)r</td>
<td>2,802</td>
<td>13.1</td>
<td>15.9</td>
<td>1,060</td>
<td>16.1</td>
<td>19.9</td>
</tr>
<tr>
<td>1c er+</td>
<td>4,313</td>
<td>20.1</td>
<td>24.5</td>
<td>1,105</td>
<td>16.8</td>
<td>20.7</td>
</tr>
<tr>
<td>1d erA+</td>
<td>196</td>
<td>0.9</td>
<td>1.1</td>
<td>103</td>
<td>1.6</td>
<td>1.9</td>
</tr>
<tr>
<td>1e er-</td>
<td>157</td>
<td>0.7</td>
<td>0.9</td>
<td>124</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>1f erS</td>
<td>257</td>
<td>1.2</td>
<td>1.5</td>
<td>171</td>
<td>2.6</td>
<td>3.2</td>
</tr>
<tr>
<td>1g erUR</td>
<td>16</td>
<td>0.1</td>
<td>0.1</td>
<td>3</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>1h erU</td>
<td>29</td>
<td>0.1</td>
<td>0.2</td>
<td>17</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>1i (e)rU+</td>
<td>1</td>
<td>0.005</td>
<td>0.01</td>
<td>1</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>2a e</td>
<td>169</td>
<td>0.8</td>
<td>1.0</td>
<td>121</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td>2b e-</td>
<td>457</td>
<td>2.1</td>
<td>2.6</td>
<td>309</td>
<td>4.7</td>
<td>5.8</td>
</tr>
<tr>
<td>2c e(+)</td>
<td>35</td>
<td>0.2</td>
<td>0.2</td>
<td>24</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>2d eA</td>
<td>15</td>
<td>0.1</td>
<td>0.1</td>
<td>11</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>3a Ø</td>
<td>1,312</td>
<td>6.1</td>
<td>7.5</td>
<td>775</td>
<td>11.8</td>
<td>14.5</td>
</tr>
<tr>
<td>3b ØR</td>
<td>98</td>
<td>0.5</td>
<td>0.6</td>
<td>32</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>3c ØUR</td>
<td>4</td>
<td>0.02</td>
<td>0.02</td>
<td>2</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>3d ØR-</td>
<td>23</td>
<td>0.1</td>
<td>0.1</td>
<td>11</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>3e ØU</td>
<td>18</td>
<td>0.1</td>
<td>0.1</td>
<td>3</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>3f ØN</td>
<td>1</td>
<td>0.005</td>
<td>0.01</td>
<td>1</td>
<td>0.2</td>
<td>0.02</td>
</tr>
<tr>
<td>3g ØU-</td>
<td>2</td>
<td>0.01</td>
<td>0.01</td>
<td>1</td>
<td>0.2</td>
<td>0.02</td>
</tr>
<tr>
<td>4 s</td>
<td>51</td>
<td>0.2</td>
<td>0.3</td>
<td>27</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>5 a</td>
<td>35</td>
<td>0.2</td>
<td>0.2</td>
<td>17</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>6 i</td>
<td>4</td>
<td>0.02</td>
<td>0.02</td>
<td>4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>7 PLonly</td>
<td>125</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8 NoPL</td>
<td>3,747</td>
<td>17.5</td>
<td>-</td>
<td>1,225</td>
<td>18.7</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>*21,466</td>
<td>100.2</td>
<td>100.2</td>
<td>6,565</td>
<td>100.6</td>
<td>100.1</td>
</tr>
</tbody>
</table>

*Three nouns which occur only in sg. DEF are excluded in the table.

Table 10. Distribution of PL markers in OLAM (lexical frequency). All nouns and Prosodically Basic Nouns (PBNs).
“er” in Table 10 indicates the use of the a-schwa suffix, “e” indicates the use of the e-schwa suffix, “Ø” indicates the use of the zero suffix. “+” indicates stød-addition and “−” indicates stød-drop. “A” indicates change in a-quality accompanied by vowel length.7 “S” indicates syncope. “R” indicates r-insertion. “U” indicates umlaut. “N” indicates n-insertion. “s” indicates the use of the /s/ suffix, “a” indicates the use of the /a/ suffix and “i” indicates the use of the /i/ suffix. “PLonly” indicates a form which is inherently PL, like forældre ‘parents’. “NoPL” indicates that there is no PL form of the noun.

The 25 resulting classes can be illustrated by the following words:

(1) [1a] banan/bananer ~ ba'naeː/n/ba'naeː:'ne ‘banana/bananas’
(2) [1b] bamse/bamser ~ 'ba mesa/ba mesa ‘teddy bear/teddy bears’
(3) [1c] baby/babyer ~ 'be bi/be biː ‘baby/babies’
(4) [1d] sofa/sofaer ~ 'so fa.so faeː ‘sofa/sofas’
(5) [1e] bord/borde ~ boː/?boː ‘table/tables’
(6) [1f] gaffel/gafler ~ ’ga fel/ga fel ‘fork/forks’
(7) [1g] bror/brødre ~ ’bro ʔ/r bro ʔ ‘brother/brothers’
(8) [1h] ko/køer ~ koː/?koːː ‘cow/cows’
(9) [1i] bonde/bønder ~ 'bo na/bœn ʔ ‘farmer/farmers’
(10) [2a] blik/blikke ~ bleɡ/’ble ɐ ‘gaze/gazes’
(11) [2b] bjørn/bjørne ~ ’bje ɾ/’bje ɾ ‘bear/bears’
(12) [2c] gamling/gamlinge ~ ’gam leŋ/gam leŋ ’ə ‘oldie/oldies’
(13) [2d] blad/blade ~ blaːd/blaː ə ‘magazine/magazines’
(14) [3a] mål/mål ~ moː/?moːː ‘goal/goals’
(15) [3b] fætter/fætre ~ ’fe de/’fe de ‘cousin/cousins’

---

7 Vowel lengthening is not registered as a stem change unless it is combined with a change in vowel quality, cf. “A”. This is because vowel length is generally unstable before vocoids, and processes of both lengthening and shortening of vowels abound, cf. Gronnum (2007, 14ff, 16ff) and Basbøll (2005, 79ff).
5. The noun plural system: two aspects relevant for acquisition
Throughout this paper, we have been describing the PL formation of Danish nouns by means of two different mechanisms, viz. suffixation and stem change. All four logical combinations of these two mechanisms are found, cf. *bil* ['bil] ‘car’ / *bil-er* ['bi/:lær] ‘cars’: overt suffixation alone; *mand* [man] ‘man’ / *mænd* [mæнд] ‘men’: stem change alone; *fod* [fød] ‘foot’ / *fødd-er* [føed/ær] ‘feet’: overt suffixation and stem change; and *mus* [mu:s] ‘mouse’ / *mus* [mu:s] ‘mice’: neither overt suffixation nor stem change. Note that zero is not counted as a suffix in this context, since a zero suffix is inaudible (cf. Basbøll 2009). From this point of view, the child is therefore faced with a double task in the acquisition of (the form side of) noun PL morphology, viz. for any PL form to acquire the suffix and to acquire the stem change. In this section we shall give some linguistic prerequisites for studying aspects of these two tasks, viz. “to what degree is the PL stem transparent – when compared to the sg. stem?” and “to what degree is the PL suffix predictable – from gender and stem-final phonology?”.

5.1. Stem transparency
Stem change is a blurring factor in noun PL formation and is hypothesised to render processing and acquisition more complex, cf. Laaha (2011) and Laaha and Dressler (forthcoming). In contrast to PL suffixation, stem change has often not been taken into account in previous studies on the acquisition of noun plurals; see, e.g. Marcus et al. (1995) and Clahsen (1999). There are various degrees of stem change, even distributed along different dimensions in different languages. One of the aims of the present paper, as of Laaha et al. (2012) which follows the same principles as those adopted here, is to present a clear-cut definition of stem change which will allow us to assign stem changes to three discrete categories, in a way which is independent of any specific language, cf. Kjærbaek and Basbøll (2011). We propose the following three degrees of stem change, with increasing opacity:

1. “No change” means no phonological change of the PL stem when compared to the sg. stem.

2. “Weak change” means a phonological change of the PL stem which is either prosodic or an automatic segmental process.

3. “Strong change” means a segmental change of the PL stem which is phonologically non-automatic and primarily motivated by morphology.

Obviously, this scalar distinction of stem changes expresses an interaction between sound structure and morphology. The system is equally valid for other grammatical categories exhibiting stem change. When this three-degree system of stem change is applied to Danish, the following classification results, cf. section 3.3:

- **No stem change**: Apocope, i.e. dropping an e-schwa before a schwa-vowel, as in *bamse* [baːmsə] ‘teddy bear’ / *bamse-r* [baːmsə] ‘teddy bears’, never the impossible structure *bamsə*, is considered to be an instance of no stem change here, cf. section 3.3.

- **Weak stem change**: Prosodic stem change mainly concerns stød addition and stød drop as far as the vocabulary of first language acquisition is concerned, as well as syncope. Since syncope concerns syllable structure, cf. section 3.3, it is also considered a prosodic stem change here. Stress shift, too, is a weak prosodic stem change according to our definitions, but it is hardly relevant for...
the early phases of first language acquisition since it only concerns loan words, like professor [pʰoʃərs] ‘(university) professor’/ professor-er [pʰoʃəsər] ‘(university) professors’.

*Strong stem change:* This is umlaut, r-insertion and the isolated case of n-insertion which all result in a change in the string of segmental phonemes of the stem.

Table 11 displays the distribution of the three degrees of stem change, in relation to all nouns and to PBNs.

<table>
<thead>
<tr>
<th>Degree of stem change</th>
<th>All nouns</th>
<th>% of all nouns</th>
<th>PBN</th>
<th>% of PBN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>11,972</td>
<td>68.0</td>
<td>3,422</td>
<td>64.1</td>
</tr>
<tr>
<td>Weak change</td>
<td>5,430</td>
<td>30.9</td>
<td>1,847</td>
<td>34.6</td>
</tr>
<tr>
<td>Strong change</td>
<td>192</td>
<td>1.1</td>
<td>71</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td><em>17,594</em></td>
<td>100</td>
<td><strong>5,340</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

* 3,750 nouns with no PL form and 125 nouns with no sg. form are excluded in the figures. ** 1,225 PBNs with no PL form are excluded in the figures.

Table 11. Distribution of degree of stem change in OLAM (lexical frequency). All nouns and Prosodically Basic Nouns (PBNs).

This classification can be used for cross-linguistic comparisons, as shown in Laaha et al. (2012).

### 5.2. Suffix predictability: gender and stem-final phonology

The use of PL suffixes may be more or less predictable. We will investigate to what extent the choice of PL suffix is predictable on the basis of item gender and stem-final phonology, sonority in particular, always building upon lexical frequencies. Our analyses aim at differentiating the effect on the PL suffix of the two parameters, gender and stem-final phonology – in contradistinction to the analyses in Ravid et al. (2008) where gender and stem-final phonology are combined throughout.

*Suffix predictability: gender*

Table 12 displays the distribution of the three native PL suffixes according to the two grammatical noun genders, common = utrum and neuter, as percentages of all nouns and of PBNs; cf. section 2 and in particular Table 2 above on Danish gender in relation to PL and DEF. There are 14,806 common and 2,696 neuter nouns, i.e. 84.6% and 15.4% respectively of all nouns, and 4,347 common and
943 neuter PBNs, i.e. 82.2% and 17.8% respectively, so common nouns are very clearly dominant, but not to the same degree for the three PL suffixes.

Both of the overt PL suffixes, a-schwa and e-schwa, have a strong majority of common nouns, whereas the Ø suffix has a majority of neuter nouns. In order to see this pattern more clearly, two modifications are introduced in the presentation of the figures in Table 13: (1) the two overt suffixes are collapsed which results in just a binary distinction between overt PL suffix and zero, and (2) the percentages are given for each gender separately, maintaining the distinction between all nouns and PBNs, however.

Table 12. PL suffix according to gender in OLAM (lexical frequency). All nouns and Prosodically Basic Nouns (PBNs).

<table>
<thead>
<tr>
<th>Suffix Gender</th>
<th>% of all nouns (N=17,502)</th>
<th>% of PBN (N=5,290)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+e</td>
<td>+Ø</td>
</tr>
<tr>
<td>Common</td>
<td>78.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Neuter</td>
<td>9.9</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*3,750 nouns with no PL form, 125 nouns with no sg. form, 90 nouns with the PL suffixes -s, -a, -i and 2 nouns with no gender are excluded in the figures. **1,225 PBNs with no PL form, 48 PBNs with the PL suffixes -s, -a, -i and 2 nouns with no gender are excluded in the numbers.

Table 13 answers the question “To what degree can it be predicted whether there is an overt PL suffix or just zero, depending only on the gender of the noun?” For common gender, there is a very large majority of non-null PL suffix. The figure is expectedly somewhat smaller for PBNs than for all nouns, in part due to
the productivity of PL suffix a-schwa. For the neuter, zero is much more frequent than for common nouns, and for PBNs there is even a clear majority of neuter nouns with zero suffix. Since we hypothesise the category of PBN to be more relevant for first language acquisition than all nouns, the occurrence of zero suffix for neuter nouns should be tested in child language data.

Suffix predictability: stem-final phonology

In order to answer the question “To what degree are the three native PL suffixes predictable from stem-final phonology?”, we have used a classification of the final, concrete phoneme of the stem, i.e., the sg. form, into basic sonority types – vowels, glides, sonorant consonants, and obstruents – in agreement with Basbøll’s Sonority Syllable Model, cf. Basbøll (forthcoming). In addition, we have included stem-final a-schwa and e-schwa as categories, even though they are, strictly speaking, not sonority types of the same kind. The occurrence of the three suffixes for each of the six stem-final phonological categories are given in percentages of all nouns and of PBNs in Table 14. The occurrence of a-schwa PL suffix is expectedly the highest all-over, but there are differences in the different stem-final phoneme categories.

Table 14. PL suffix according to stem-final phonology in OLAM (lexical frequency), all nouns/Prosodically Basic Nouns (PBNs).

<table>
<thead>
<tr>
<th>Stem-final phonology</th>
<th>a-schwa suffix</th>
<th>e-schwa suffix</th>
<th>Ø suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>92.5/83.9</td>
<td>1.1/3.2</td>
<td>6.4/12.9</td>
</tr>
<tr>
<td>ø</td>
<td>89.0/85.8</td>
<td>0/0</td>
<td>11.0/14.2</td>
</tr>
<tr>
<td>Glides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>70.9/35.4</td>
<td>7.0/22.2</td>
<td>22.1/42.4</td>
</tr>
<tr>
<td>Consonants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>90.3/78.3</td>
<td>4.4/10.8</td>
<td>5.2/10.9</td>
</tr>
<tr>
<td>O</td>
<td>75.5/47.8</td>
<td>9.1/19.7</td>
<td>15.4/32.6</td>
</tr>
</tbody>
</table>

For all nouns: 3,750 nouns with no PL form, 125 nouns with no sg. form and 90 nouns with the PL suffixes -s, -a, -i are excluded in the figures. For PBN: 1,225 PBNs with no PL form and 48 PBNs with the PL suffixes -s, -a, -i are excluded in the figures.

According to Table 14, the six different stem-final categories fall into four groups as far as occurrence of PL suffixes is concerned: (i) stem-final e-schwa is very close to 100% before a-schwa PL suffix; (ii) next are stem-final full vowels, V, and a-schwa, two vowel categories which are similar in that they may be defined as non-reducible vowels; (iii) next in line are sonorant consonants, S, i.e. nasals and the lateral according to The Sonority Syllable Model, cf. Basbøll
(forthcoming); and (iv) the least common stem-final phonemes before a-schwa suffix are obstruents and, perhaps surprisingly, glides before a-schwa. These four categories constitute the rows in Table 15.

<table>
<thead>
<tr>
<th>Stem-final phoneme</th>
<th>a-schwa suffix</th>
<th>e-schwa suffix</th>
<th>Ø suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-schwa</td>
<td>99.9/99.9</td>
<td>0.04/0</td>
<td>0.1/0.1</td>
</tr>
<tr>
<td>Non-reducible vowels (V and Е)</td>
<td>90.4/85.1</td>
<td>0.5/1.2</td>
<td>9.1/13.7</td>
</tr>
<tr>
<td>Sonorant consonants</td>
<td>90.3/78.3</td>
<td>4.4/10.8</td>
<td>5.2/10.9</td>
</tr>
<tr>
<td>Obstruents and glides</td>
<td>40.6/45.5</td>
<td>4.7/20.1</td>
<td>54.7/34.4</td>
</tr>
</tbody>
</table>

For all nouns: 3,750 nouns with no PL form, 125 nouns with no sg. form and 90 nouns with the PL suffixes -s, -а, -i are excluded in the figures. For PBN: 1,225 PBNs with no PL form and 48 PBNs with the PL suffixes -s, -а, -i are excluded in the numbers.

Table 15. PL suffix according to stem-final phonology in OLAM (lexical frequency), all nouns/Prosodically Basic Nouns (PBNs).

The pattern of occurrence of PL suffixes according to stem-final phonology is now clearer. According to Table 15, stem-final e-schwa, which is alone among the stem-final vowels in being very susceptible to assimilation or elision, has an occurrence of almost 100% before PL suffix a-schwa. Stems ending in non-reducible vowels, whether a full vowel or a-schwa, have an occurrence before PL suffix a-schwa of about 90% (85% for PBNs), practically non-existing before PL suffix e-schwa, and about 10% with zero suffix. The figures for stem-final sonorant consonants resemble the non-reducible vowels, except that PL e-schwa suffix and zero are of the same order of magnitude. Final obstruents and glides differ significantly from the other three categories: PL suffix a-schwa and zero are of approximately the same order of magnitude, and there is a significant number of e-schwa PL suffixes too, particularly among PBNs. The fact that glides pattern with the obstruents, and not with the sonorant consonants, probably has a historical explanation: weakening of final obstruents has been an active process in Danish from medieval times. It has led to the occurrence of
glides and (non-lateral) approximants – which are vocoids and not contoids phonetically in the sense of Pike (1943) – in phonologically syllable final position, corresponding to obstruents in Swedish and Norwegian, cf. Basbøll (forthcoming) and Bleses et al. (2011). Regardless of this process of weakening of syllable final obstruents in Danish, their historical origin as obstruents still has an impact on their behaviour with respect to morphonology and morphophonotactics, i.e. phonotactics in relation to morphology, cf. Dressler and Dziubalska-Kołaczyk (2006).

6. Concluding remarks
We have tried to show that a sound-based analysis of the noun PL system – and other morphological systems as well, for that matter – is radically different from traditional orthography-based descriptions. The sound-based categorisation of PL suffixes, in 3.2, resulted in new patterns and had a significant quantitative impact. We have also, in 3.3, identified a complex system of stem changes, and we have shown some stød patterns – both productive and unproductive – in the PL formation of monosyllables that appear to be psychologically relevant. Finally, we have presented a general typologically relevant approach to gradation of stem changes, developed together with Laaha et al. (2012), and we have demonstrated interesting patterns in suffix occurrence, including an identification of four classes of stem-final phonemes that predict different distributions of PL suffixes. In this paper we have thus laid the groundwork for analyses of Danish morphology based upon speech and not, as is usually done, written language. The challenge now is to describe how speakers of Danish, including language-acquiring children, make use of the cues in speech when constructing their morphological and other linguistic systems.

Acknowledgements
Our sincere thanks go to Laurie Bauer, Nina Grønnum and Hans-Olav Enger for many useful suggestions that have ameliorated the presentation of the content of this paper significantly. We are also indebted to the Carlsberg Foundation, the Danish Research Council for the Humanities, and the University of Southern Denmark for support.
References


