Morphophonology (ms no. 53036)

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Abstract

Morphophonology is the interaction between morphology and phonology, and these two linguistic disciplines are defined in section 2 within a structuralist tradition of linguistics. Section 3 presents three case studies of morphophonological interaction, departing from phonotactics (regular inflectional morphology of English), prosody (the Danish laryngeal prosody stød in its relation to word structure), and phonological variation (German and Danish stem change in plural formation). In section 4, finally, the stages in a morphophonemic analysis are outlined, predominantly as part of a discovery procedure and within a structuralist tradition.

Keywords
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1. Introduction: terminology

The term morphophonology is here taken in a broad sense, in agreement with its composite parts morpho- and -phonology, as covering the interaction between the linguistic components, or modules, morphology (cf. Spencer & Zwicky 1998) and phonology (cf. Goldsmith 1995). Accordingly, it is not to be understood as a separate linguistic component (such as morphology, phonology or syntax, for example). There are two further terms which are sometimes used in the same or in a closely related sense, viz. morphonology and morphophonemics.

Morphonology (in German Morphonologie, French morphonologie) was the term which the leading founding father of Prague phonology used (Trubetzkoy 1929, 1931). More recently, it has been the title of Dressler's (1985) book Morphonology: the dynamics of derivation. Morphophonemics has been a favorite term in American structuralism since Menomini morphophonemics by its leading founding father (Bloomfield 1939). The term morphophonemics suggests more emphasis on the segmental building blocks in linguistic structure than the other terms which are neutral with respect to the distinction between segments and prosody.

2. Linguistic disciplines and the sign

2.1. The linguistic sign and basic linguistic disciplines

The sign (French signe) is a key notion in structuralist linguistics, in the tradition following the Swiss linguist Saussure (1916). The sign is a unit—psychic and social—with two sides, viz. content (French signifié 'what is being signified'), or meaning, and expression (French signifiant 'what is signifying'), or sound. [Content and expression is the terminology of Hjelmslev (1943), and there is a comprehensive and complicated history of the linguistic sign, with linguistically central names like Peirce (e.g. 1965), and up to today's cognitive linguistics, e.g. in works by Langacker (1987).] One of Saussure's examples is the sign 'horse' (French 'cheval'). Its content is, according to Saussure, not the animal in blood and flesh—the animal is just being referred to—but the concept of a horse; nor is the expression the concrete sounds (neither articulatorily nor acoustically), the expression is an acoustical image (French image acoustique).

The relation between content and expression in a linguistic sign is, according to Saussure, arbitrary (French arbitraire: 'le signe linguistique est arbitraire'); i.e. there is no natural connection between the two: the relation is due to a social convention (normally not an explicit and conscious one, however). A sign like 'horse' cannot be decomposed into smaller signs: it is one linguistic building block. Its content may be decomposed into smaller semantic elements (such as 'animal', 'four-legged', and so on); and its expression can be decomposed into smaller
phonological elements (like initial /h/ and final /s/, etc.). But there is no general correspondence between the content elements and the expression elements (as there would be in the counterfactual state of affairs where /h/ would correspond to 'animal', and so on). Such minimal signs (as 'horse' in our example) are called morphemes. The arbitrariness of the sign is a characteristic of morphemes only, not of linguistic signs in general. When smaller signs are combined into larger and more complex signs, the relation between content and expression is no longer arbitrary, but motivated, viz. by the individual signs and by the construction(s) they enter into; e.g., when black and bird are compounded to blackbird, the meaning (of a particular ornithological species) is motivated, but not determined, by the meaning of black and bird.

The basic linguistic disciplines--'language-internally', excluding 'hyphen-disciplines' like socio(-)linguistics, psycho(-)linguistics and text(-)linguistics, for example--can be defined departing from the linguistic sign: Semantics is concerned with the content-side of language; and phonology with the expression-side of language (cf. 2.3). Sign combinatorics represents the traditional linguistic discipline grammar, divided into syntax and morphology (cf. 2.2). When we depart from semantics and transcend the border between language-internal and language-external phenomena, we meet pragmatics. And when we transcend the border between language-internal and language-external phenomena from phonology, we meet phonetics (cf. 2.3). Thus both pragmatics and phonetics contain language-internal as well as language-external aspects. Lexicon, finally, as a linguistic discipline is concerned with the arbitrary aspects of language, viz. of the relation between content and expression of morphemes (and partly words).

2.2. Morphology and the word

Grammar can thus, from a strictly structuralist point of view, be characterized as the linguistic discipline which treats sign combinatorics, i.e. it is concerned with the syntagmatic (concerned with the linear order of elements in the speech chain) – as opposed to paradigmatic (concerned with choices on a particular position in the speech chain) axis; grammar is subdivided into two (sub)disciplines, viz. syntax and morphology. The notion word is crucial to define the difference between those two: in syntax, the building blocks are words and the frame is (primarily) the sentence; and in morphology, the building blocks are morphemes and the frame the word. Therefore, the definition of a word is essential for morphophonology—the interaction between phonology and morphology.

The term word designates a central linguistic unit, and this term is, in distinction to most other units used in linguistic descriptions, by linguists, also a word used frequently by linguistically naïve speakers in general. This is related to the fact that the word is a unit with some
psychological reality [and also to the fact that words are separated by space in orthography].
The most appropriate linguistic definition of a word is by means of *distributional*
characteristics: a word can occur in isolation, it can be moved around in an utterance, and its
morphemes occur in a fixed internal order, all these criteria being interrelated and connected to
its psychological reality. On the other hand, the word cannot be defined exclusively by
semantic criteria—as suggested by the existence of lexicalized phrases, idioms (e.g. *kick the
bucket*), complex lexical items, etc.—nor can it be defined cross-linguistically by phonological
criteria. It is language-dependent to which degree word boundaries have a phonetic
manifestation of any sort, i.e. languages differ typologically in this respect.

2.3. Phonology and its subparts

*Phonology* is the linguistic discipline concerned with the expression side of linguistic signs. [I
disregard the analysis of written language in this article, and thus the issue of graphemes,
letters, etc., cf. 4.1.] Whereas morphemes are the building blocks of morphology, *phonemes* are
the primary building blocks of phonology. Phonemes are established by means of the
*commutation test* using minimal pairs, cf. 4.2. Phonemes are not linguistic signs, and they have
no semantic content as opposed to morphemes, but they build up the expression of signs,
together with prosodic elements. The basic subdivision of phonological units falls between
*segmental* units, viz. phonemes—vowels and consonants—and *suprasegmental* units, i.e.
*prosodies*. The latter category encompasses syllable prosodies and word accents (such as word
stress, tonal word accents and the Danish stød, cf. 3.2) and intonation. A particular subpart of
phonology is *phonotactics*, i.e. combinatorics of phonemes, and this subdiscipline plays a
pertinent role in morphophonology (see Dressler and Dziubalska-Kołaczyk 2006 on
'morphonotactics'), cf. 3.1.

*Phonetics*—the discipline concerned with language sounds (cf. 2.1)—is a crucial discipline for
phonology, although it is not—within the structuralist linguistic tradition—considered a
subdiscipline of phonology; but phonetics is a necessary condition for phonological analyses
and descriptions that aim to be psychologically and physically realistic as well as testable, cf.
2.4.

2.4. Non-change of phonetic content between levels: a principle of naturalness

*Lemmas* are lexical units. They can be divided into those which do not have several different
expressions phonologically, but only one ('non-alternating lemmas') and alternating lemmas
with more than one phonological expression (cf. 3.3). For non-alternating lemmas, the
phonological representation in the lexicon is, I shall propose, the (phonetic) surface form,
disregarding only rather superficial phonetic details. This means, for example, that lemmas
which do not enter into a particular morphological alternation—for example involving the Danish syllabic prosody stød, cf. 3.2—are lexically specified accordingly (as having stød or not having stød). This is the null-hypothesis within the present framework. Thus, a lexical specification of a certain phonological property implies constancy of this property, irrespective of the morphological context, except for surface phonetic adjustments. A number of predictions with respect to alternations, in different paradigms and types of words, follow from this approach to the lexicon (see Basbøll 2005, 2006). The fact that the symbols in the lexical representation are identical to symbols in the phonetic representation is an expression of the naturalness principle and holds not just for the relation between phonetics and phonology, but also in the morphology and the lexicon.

3. Interaction between phonology and morphology: three examples

3.1. Phonotactics and morphology: English regular inflections

The typical pattern for regular inflectional morphology in English can be illustrated by the plural formation of nouns [similar principles apply to 3d person pres. tense, and (with -ed) to past tense]. The ending is either [z], [s] or [iz], depending on the final segment of the stem, e.g. hens, dogs, cats, busses [henz dɔgz kaets 'bʌsɪz]. Rather than listing all possible final segments of stems, the phonetic/phonological category of this segment can be represented through characterizations like ‘voiced non-sibilant’, ‘voiceless non-sibilant’ and ‘sibilant’—for the final segments combining with [z], [s] and [iz], respectively—typically using distinctive features (for voicedness, sibilance, etc., as suggested above, but their exact inventory is controversial). Furthermore, the rules for the use of [z], [s] and [iz] can be simplified by being applied in a specified sequence.

What are the phonemes that are realized as [z], [s] and [iz] (as morphological endings, e.g. for plural)? According to the standard Bloomfieldian principle of ‘once a phoneme, always a phoneme’ (see 4.2), the phonemic analysis is straightforward: [z] is a realisation of /z/, [s] of /s/ and [iz] of /iz/ (or /əz/, a difference which is insignificant here). According to a Praguian analysis, [z] and [s] would be analysed differently: plural [z]—in examples like hens, viz. where the stem ends in a sonorant, e.g. a vowel or a nasal—would be a realisation of the phoneme /z/ since in this position there is a contrast between [s] and [z], cf. buzz, bus [bʌz ˈbʌs]. In examples like dogs, on the other hand (where the stem ends in a voiced obstruent), plural [z]
would not be a realisation of the phoneme /z/, however, since there is no contrast to [s] in this position (e.g. *[dogs] is not a possible phonetic form in English). Similarly, plural [s] would not be a realisation of the phoneme /s/ since there is no contrast to [z] in this position (e.g. *[kætz] is not a possible phonetic form in English). Plural [s], as well as plural [z] after obstruents, therefore realizes a neutralization product—an 'archi-phoneme'—according to Praguian principles, i.e. a phonological unit which represents what is common to [s] and [z], without being phonologically specified for voicedness or voicelessness (even though [z] is phonetically voiced and [s] phonetically voiceless), cf. 4.2.

Since the English plural ending [s] only occurs where [z] is phonotactically impossible, the following procedure (Basbøll 1972, 2006) determines the choice of plural endings without any reference to phonetic or phonological content (such as segments, distinctive features, etc.):

1. Is [z] (phonotactically) OK? If yes: choose [z], if no: go to (2)
2. Is [s] (phonotactically) OK? If yes: choose [s], if no: choose [iz]

Illustrated with hens, dogs, cats, busses as examples:
(1) [henz dɔgz] are (phonotactically) OK; but *[kætz], *[bæsz]
(2) [kæts] is (phonotactically) OK; but *[bæss] not, so: ['bæṣiz]

Since we know that speaker-hearers, including small children acquiring the language, are sensitive to phonotactical patterns in the language around them—even though we do not know the details of this mechanism—this is an interesting proposal not only because it is simple, but also from a psycholinguistic perspective. But where does the order [z] before [s] before [iz] come from? An obvious answer is frequency—as plural endings—in the language (and we know that frequency plays a role in language acquisition).

In addition to this completely regular pattern, English exhibits pl. forms identical to the sg. (as sheep), and a limited number of forms with the suffix -en (e.g. oxen, sg. ox), forms with stem change (as men, sg. man), and forms with a combination of stem change and suffix (as children, sg. child), cf. 3.3. A morphophonologically interesting subpattern of stem change + suffix can be illustrated by lives, loaves, houses (sg. life, loaf, house—the latter pronounced with [s] whereas the plural form has intervocalic [z]). The stem change only concerns the final obstruent, it is a simple phonological change from voiceless (in the sg. stem) to voiced (in the
pl. stem), and the principles of regular plural formation reviewed above apply to the pl. stem: [z] is selected as the plural suffix.

3.2. Prosody and morphology: Danish stød in word structure

The Danish stød is a laryngeal syllable rhyme prosody (somewhat resembling creaky voice). It only occurs in heavy (bimoraic) syllables which can be defined as those having a long sonority rhyme—a long vowel, or a short vowel followed by a sonorant consonant (e.g. a nasal or [l])—and primary or secondary stress (in a three degrees of stress-system), see Basbøll 2005: 82-87, 265ff. Stød is contrastive, and there are many minimal pairs (i.e. pairs of words whose pronunciation is identical except for the presence or absence of stød, cf. 2.3 and 4.2), e.g. musen 'the mouse', definite form of the indefinite muse ['muːsʰən 'muːsə] vs. musen 'the mouse', definite of the indefinite mus ['muːˈsən muːˈsə]. The grammatical distribution of stød is extremely complex, but it can be accounted for in Basbøll's Non-Stød Model. The relation between the syllable prosody stød, and word structure in Danish, is revealing for the interaction between phonology and morphology, viz. for morphophonology.

The Danish word has a three-layered structure as follows: { ( ( stem P1) P2 ) P3 } where P1, P2 and P3 are positions for suffixes and where the position of the suffixes follow general principles of integration of suffixes into stems (in the word structure), see Basbøll 2005: 351ff. The minimal word, in '( ... )', the basic word, in ' [ ... ]', and the maximal word, in '{ ... }', each define a phonological domain, i.e. a sequence within which certain phonological rules apply. The unmarked situation in the native vocabulary is that heavy (bimoraic, see above in 3.2) syllables have stød. There is, however, a principle of non-stød which applies to penultimate syllables in a minimal word, and to monosyllabic stems before a syllable in the basic word. Examples are the pl. form huse 'houses', sg. hus [ˈhʉsɔ huːˈsə] where huse has non-stød just like the monomorphic word muse above (penultimate syllable of the minimal word); the past form talte 'spoke' versus the compounded verb with the same monosyllabic second part udtalte 'pronounced' ['tːɑ:lˀɑ ˈuðtʰɑ:ˀldɑ] (basic words [ ( tal ) te ] and [ ( udtal ) te ], respectively), i.e. a monosyllabic versus a polysyllabic stem before a syllable in the basic word. In all these cases, the position of the suffix in word structure is predicted by the model, P1 being the position for integrated non-verbal suffixes (such as the plural suffix -e, the non-integrated pl. suffix being -er), and P2 for integrated verbal suffixes (such as the past tense suffix -te, the non-integrated past tense suffix being -ede). The definite suffix -en (in musen 'the mouse' above) always occurs on P3, thus stød is retained in the definite form of mus above since the following syllable occurs outside the basic word. Accordingly, the distribution of stød and non-stød (in
heavy syllables), a prosodic phonological phenomenon, cannot be predicted by the phonetic or phonological context alone, but crucially depends on grammatical structure, wherefore its description belongs in the realm of morphophonology.

3.3. Phonological variation and morphology: stem change in German and Danish plurals

In both German and Danish, noun plurals are formed with either a suffix alone (incl. zero), or stem change alone, or a combination (incl. pl. = sg.), cf. 3.1. The following three-way gradation of stem change, in the dimension of transparency vs. opacity, based upon general phonological principles, has been proposed as a hypothesis applicable to languages exhibiting stem change as a morphophonological mechanism (Basbøll et al. 2011, Laaha et al. 2011):

(1) 'No change': no phonological change of the plural stem when compared to the singular stem (e.g. *bil, biler 'car', 'cars' [biːl, 'biːlə]). The category no change does not preclude purely phonetic changes, however, cf. 4.1.

(2) 'Weak change': a phonological change of the plural stem which is either prosodic or due to an automatic segmental process. The category weak change, as far as segmental phonological changes are concerned (cf. 2.3), involves changes in the string of concrete phonemes—in a Bloomfieldian sense (cf. 4.2)—but not in morphophonemes. For German this can be illustrated with the pl. Bilder 'pictures', pronounced with [d], sg. Bild pronounced with [t]; these two sounds are in contrast initially (/t/ vs. /d/), but finally there is no [d] due to the automatic segmental process of devoicing, and thus no final phoneme */d/ (cf. 4.2);

morphophonologically, on the other hand, there would be ld in both sg. and pl. Whereas an automatic segmental process does not qualify as a phonological change, obviously, the reversal of such an automatic segmental process does, viz. German revoicing of the stem-final obstruent in the case of Bild-Bilder since it is not automatic, cf. e.g. Welt 'world', pl. Welten, both pronounced with [t].

Prosodic changes can be illustrated by Danish stød changes (stød drop and stød addition, cf. 3.2). The distinction between prosodic and segmental phonological changes is relevant, also psycholinguistically, as illustrated by the fact that Danes, when asked to reverse the syllables of the girl's name Mona ['mɔna] produce ['næmo] and not *[næ'mɔː], thereby suggesting that the prosodic frame including stress and vowel length is stored separately from the string of segmental phonemes (Grønnum 2007: 42-44).

(3) 'Strong change': a segmental change of the plural stem which is phonologically non-automatic and primarily motivated by morphology. Umlaut—also 'metaphony', a change in stem vowel as in e.g. English mouse, mice—in both German and Danish is a case in point. From a synchronic point of view, the relations between the singular and the plural stem in words with
Umlaut are phonologically unmotivated (in German \( \text{a u o} \) \( \text{aw} \) in sg. (e.g. \( Fass, Fluss, Knopf, Haus \) \( \text{fas flus knøpf haws} \)) correspond to \( \text{e y o} \) \( \text{oj} \) in pl. (\( Fässer, Flüsse, Knöpfe, Häuser \) \( \text{'fëser 'flyssø 'knøepfø 'høyza} \)), and in Danish \( \text{a a o} \) \( \text{al} \) in sg. (e.g. \( and, barn, fod, hånd \) \( \text{'an² bɔn² foð² hɔn²} \)) correspond to \( \text{e ø e} \) \( \text{el} \) in pl. (\( ænder, børn, fødder, hænder \) \( \text{'en² bøeg²n 'foø∂e 'hɛn²} \)). There is nothing in the phonological context—as against the morphological one—in today’s languages that dictates the strong stem change. Furthermore, these stem changes apply to a limited (fewer in Danish than in German) subset only of morphemes, but very far from all, and there are obvious ambiguities in either direction (e.g. in Danish, sg. \( \text{lal} \) can correspond to pl. \( \text{løl or løl, and pl. løl to sg. lal or løl} \)). All this shows that we are dealing, for strong stem change, with morphophonology, not phonology (cf. 4.3).

Since stem change produces opacity which supposedly makes acquisition more difficult, no change, weak change and strong change, defined cross-linguistically as above, are predicted to delay acquisition in this order. Furthermore, from these hypotheses it is predicted that strong change in German will be less difficult for children than strong change in Danish since it is more homogeneous and has a higher type frequency (there are far more lemmas in German than in Danish representing each strong change). These predictions have been successfully tested in a large experiment with (Austrian) German and Danish children by Laaha et al. 2011.

4. Morphophonemic analysis

4.1. Before morphophonemic analysis can start

The procedures surveyed below presuppose that the language is known to the phonologist undertaking the phonemic analysis. To segment the sound chain into words and to identify phonetic realisations as referring to the same word is no trivial task, due to inherent characteristics of the speech signal. The acoustic signal [in contradiction to the written language with spaces between words] consists of a continuous sound string with unclear or non-existing markings of boundaries between syllables and such higher level units as words. Furthermore, the variability in the sound shape of individual words—both due to speaker characteristics and to the communication situation—makes it difficult to identify different acoustic realisations of the same unit as referring to the same linguistic entity, e.g. a word. Speakers can draw on prosodic cues such as stress, fundamental frequency (the main phonetic correlate of tone) and sonority (German \( \text{Schallfülle} \), e.g. so that vowels, nasals and obstruents in that order have decreasing inherent sonority) in order to segment words in the sound chain, as well as on distributional—including phonotactical—patterns in the input.
The linguist's phonemic analysis is not undertaken directly on the basis of the sound chain itself—on concrete unanalysed utterances—but departs from a phonetic transcription, i.e. a rendering of the continuous speech chain in terms of a string of phonetic symbols (for vowels and consonants), with or without diacritics (small marks added to phonetic symbols)—e.g. for aspiration, lowering, syllabic, etc.—and with or without symbols for prosodic properties like stress, word tones, etc. Such a notation is discrete in the mathematical sense, with a finite and well defined number of symbols, e.g. taken from the International Phonetic Alphabet (IPA-symbols). But note that a huge amount of analysis, explicit and/or implicit, underlies any competent use of such a phonetic transcription system.

There is a fundamental distinction between a transcription of a concrete token (one individual instance, by a particular individual on a particular occasion) of speech—whether 'on-line', e.g. in field work, or from tape etc., these two cases being clearly different—and a transcription of a pronunciation type (a single abstract pronunciation, representing an infinite number of possible tokens). The latter task demands a systematic transcription within explicit conventions and presupposes knowledge of the particular speech form. Only phonetic distinctions that either convey differences in meaning within the speech norm in question, or differences with sociolinguistic significance (e.g. sexual, sociological, regional or chronological), are typically rendered in a systematic phonetic transcription. As far as individual differences are concerned, level of distinctness ('register'), is a relevant parameter. For the procedures of phonemic analysis surveyed in this article, the phonetic transcriptions concern a high level of distinctness within a well defined speech norm. Furthermore, the stream of speech contains segmental and prosodic information intertwined, and the extraction of prosody from the segmental chain is anything but straightforward.

4.2. Input level to morphophonemic analysis: phonemes

In the phonemic analysis, in order to establish contrastive segments, the *commutation test* using *minimal pairs* is applied (cf. 2.3). Thereby both contrastive segments and positions in the sound chain are established as phonemically relevant entities. For example, taking the Danish word *sat* 'sat (ptc.)' [sad] as point of departure, the minimal pairs *sat*, *hat* 'hat' [had], *nat* 'night' [nad] establish [s], [h] and [n] as three different contrastive segments before [ad]; the minimal pairs *sat*, *sot* 'comforter (for babies)' [sud], *sit* 'his/her/its (refl. poss.)' [sid] establish [a], [u] and [i] as three different contrastive segments between [s] and [d]; and the minimal pairs *sat*, *SAS* '(the common Danish pronunciation of the Scandinavian Airlines System)' [sas], *sand* 'sand' [san'] establish [d], [s], and [n] (with stød) as three different contrastive segments after [sa]. By the
very same procedure, three different phonologically relevant positions are being established, i.e. there are exactly three positions ('places') in the sound chain [sad] where the segments can be contrasted with other segments, and this is established through the minimal pair or commutation test.

The analysis into phonemes is based upon a distinct pronunciation of single words in the norm chosen. The path from contrastive segments to phonemes is constituted by the following steps, observing the biuniqueness condition, viz. the principle that it is possible to infer both the phonemes from the contrastive segments, and also the contrastive segments from the phonemes (according to the phonological rules for the norm in question):

(A) Phonetically closely related sounds which are not in contrast—in the sense that they form minimal word pairs, or potential minimal word pairs—are identified phonemically. Typically, two such sound symbols will be in complementary distribution—viz. each sound symbol only occurs in contexts of sounds where the other is excluded—but they might be free variants too (i.e. occur in contexts which are wholly or partly identical, but with no difference in meaning). The identification is based upon phonetic similarity not shared by any other sound segment in the phonetic notation. With reference to a well defined analysis of distinctive features, the sound symbols to be identified phonemically should possess a cluster of distinctive features not found together in any other sound. Examples of such identifications in Danish are [j] and [ı] to /j/, and [σ] and [g] to /r/.

(B) Further identifications of phonetically closely related sounds which do not contrast in any specific context, can be made, still respecting the principle of biuniqueness, i.e. one and the same sound can be identified in two different ways phonemically, presupposing that the phonemic context is different. It is a condition for this kind of phonemic identification that the realization is motivated by a systematic phonological principle (such as, for Danish, vowel colouring by an adjacent /r/, pronounced as [σ] or [g] dependent on position, in the direction of this /r/). An example of such an identification in Danish is the assignment of [ε] after a [σ] belonging to the same syllable ('tautosyllabic') and of [e] not after a tautosyllabic [σ] to the phoneme /e/ (e.g. bredt, lidt 'broad (neuter), little (adv.)' [bʁe̞ːt lɪd̥], and the assignment of [a] after a tautosyllabic [σ] and of [e] not after a tautosyllabic [σ] to the phoneme /e/ (e.g. ret, let 'straight, easy' [rɛ̞t lɛ̞]). On this procedure, including phonological fusion, i.e. bi(morpho)phonemic interpretation of a single phonetic, or phonemic, segment, see Basbøll 2006.

The relation between contrastive segments and positions (in the sound chain) are looked upon in very different ways by different schools or traditions of phonology (cf. Fischer-Jørgensen
1975). In my view there is still genuine insight to be gained from structuralist phonology, and from combining an eclectic structuralist approach with more modern ways of considering phonology-phonetics and phonology-morphology-lexicon interrelations.

At one end of the scale we find the strict (post-) Bloomfieldians (Bloomfield 1933, cf. Bloch & Trager 1942, Joos 1957) with the tenet 'once a phoneme, always a phoneme', i.e. when a contrastive segment has been established in one position, it is phonemic in all positions. When /p/ and /b/ are established as contrasting allophones (word-initially in German, for example (cf. the minimal pair Pein 'torment' pronounced with initial [p] and Bein 'leg' with initial [b]), the sound [p] (word-finally must be an allophone of /p/, even though the sound [b] does not occur (word-)finally wherefore there can be no contrast in this position either; the phoneme /b/ is then said to be defectively distributed. A consequence of this analysis is that Lob 'praise', Lobe (dat.) [loːp], [ˈloːbə] exhibits a morphological alternation between /p/ and /b/ (syllable-initially). E.g. the stop in Rad 'wheel' [ˈʁaːt] and Rat 'council' [ˈʁaːt] are pronounced identically word-finally (and hence syllable-finally), but enter different morphological alternations, cf. Rade 'wheel (dat.)' [ˈʁaːdə] and Rate 'council (dat.)' [ˈʁaːta]. According to the Bloomfield-school, this can be analysed so that the phoneme /t/ word-finally can alternate with either of the phonemes /t/ or /d/ syllable-initially. Both of the morphophonemes [t] and [d] are thus realised by the phoneme /t/ in word-final position.

In Prague phonology (cf. Trubetzkoy 1939), there would be neutralization word-finally in German, i.e. a particular phonemic entity, an archiphoneme, would occur in the position of no contrast, e.g. a segment which is phonetically voiceless but has no specification for voicing phonologically and is thus neither a /p/ nor a /b/, but something which is common to the two (cf. 3.1). Such an incompletely specified segment is given a separate phonological notation, e.g. /P/ (as in Lob [loːp]) for a segment which is phonetically a voiceless plosive like initial /p/, but is not in contrast (opposition) to a /b/ (which is in contrast to /p/ initially). A consequence of this analysis is that Lob, Lobe (dat.) [loːp], [ˈloːbə] exhibits a morphophonological alternation between /P/ (word-finally and hence syllable-finally too) and /b/ (syllable-initially).

4.3. From phonemes to morphophonemes: introducing morphological relatedness

Phonetic and phonemic transcriptions rely exclusively on input from sound. By contrast morphophonemic transcriptions (between vertical strokes) involve also morphological information. Heuristically, two phonemes can be identified morphophonemically if they occur in parallel positions in different forms of the same morpheme—e.g. in different inflectional
forms belonging to the same paradigm—if it applies to a significant set of morphemes in a systematical way. A Danish example would be /j/ in spøge 'make jokes' ['sbøːgə] ~ ['sbøːi], and /g/ in its past participle spøgt [sbøgd], which may be considered as representing the same morphophoneme |g|. There is no claim of biuniqueness (cf. 4.2) between morphophonemes and sound chain, viz. the same phoneme in the same phonemic context can represent different morphophonemes—as /v/ [u] in sagfører ‘barrister’ ['sɑʊfɔrə] represents the morphophoneme |g|, cf. føre sag 'litigate' [fɔr 'sæːt], contra |v| in savklinge 'saw blade' ['sɑʊkʰlɛŋə], cf. sav 'saw' [sæː'ʊ].

The morphophonemic analysis should make phonological patterns simpler and more general, e.g. with simpler phonotactics and more general principles of realization. An example from Danish could be: |p|, |t|, |k| are always realized as plosives, whereas |b|, |d|, |g| have variable realizations as either plosive or approximant, depending on their position in the phonological syllable.

In Danish, the position just before a stressed (non-native) suffix, like -i, -ik, -at, -ere is revelatory for the morphophonemic identity of consonants undergoing consonant gradation. Thereby the morphophonemic analysis of the syllable-final phonemes /b/, /d/, /g/, /ð/ leads to the following alternations and identifications (i) through (v). The generalizations only pertain to a segment in word-final position alternating with a segment in morpheme-final position just before a stressed (non-native) suffix beginning with a vowel.

(i) syllable-final /d/ alternates with syllable-initial /t/, both representing the morphophoneme |t| (e.g. in vat 'cotton wool' [vad], vattere 'quilt' [va'te:rə] and demokrat 'democrat' [demɔˈkrat]d], demokrati 'democracy' [demɔˈkrati];

(ii) syllable-final /g/ alternates with syllable-initial /k/, both representing the morphophoneme |k| (e.g. in lak 'lacquer, n.' [lak], lakere 'lacquer, v.' [laˈkreːv] and patriark 'patriarch' [patʰˈriːk], patriarkat 'patriarchate' [patʰˈriːkʰ];

(iii) syllable-final /b/ alternates with syllable-initial /p/ in some (non-native) words, thus representing the morphophoneme |p| (e.g. in mikroskop 'microscope' [mikʰsɔsɡoːb], mikroskopi 'microscopy' [mikʰsɔsɡoːpʰiːt]).
(iv) syllable-final /b/ alternates with syllable-initial /b/ in some (non-native) words, thus representing the morphophoneme /b| (e.g. in *hydrofob* 'hydrophobe' [ˈhɪdrəʊfoːb], *hydrofobi* 'hydrophobia' [ˈhɪdrəʊfoːbiː]);

(v) syllable-final /ð/ alternates with syllable-initial /d/ in (non-native) words, thus representing the morphophoneme /d| (e.g. in *abbed* 'abbot' [ˈæbəd], *abbedisse* 'abbess' [ˈæbədiːsə]).

### 4.4. Morphophonemes as candidate lexical segments

Section 4 until now was an attempt to characterize morphophonemic transcriptions *from below* ('bottom-up'), i.e. from sound via phonemes to morphophonemes, as part of a *discovery procedure* (cf. Harris 1951). But morphophonemes can also be considered candidates for *underlying segments* in the lexicon.

Whereas the morphophonemes are derivable from the surface structure, by means of a bottom-up procedure, *lexical segments* are the units posited as underlying. There is not a unique string of morphophonemes corresponding to every string of phonemes or sounds, but rather there may be different solutions, so to speak, to this discovery procedure, depending on which sets of morphological alternations are to be accounted for.

The relation between phonemes and morphophonemes is not biunique: whereas it is in general possible in Danish—for the main speech norm chosen here—to derive the phonemes of a given word form from the morphophonemes, by means of phonological principles and mechanisms, the opposite is not true: Such a biuniqueness presupposes an explicit exhaustive enumeration of the word forms that are considered formally related and non-suppletive (i.e. not phonologically unrelated forms like English *be, is, was*). In many cases, in many specific phonemic contexts, several morphophonemes correspond to the same phoneme, and vice versa: the same morphophoneme corresponds to several phonemes. From the point of view of the addressee, and not least of the person acquiring the language, there will be several candidates for lexical segments in many cases, and an ongoing change in the lexical representations can be expected, according to (increased) awareness of morphophonological relations, i.e. morphological relations paired to their phonological realizations.

A decision on such issues depends on whether we are talking about

(i) hypotheses about speakers, i.e. about psycholinguistics and psychological reality; or

(ii) methodological principles for the analysis, regardless of any relation to the behaviour of real speaker-hearers.
In the case of (i), speakers’ knowledge and awareness of orthography must be expected to play a substantial role in alphabeticized cultures, and this issue should be subjected to empirical investigation. If we are to speculate about the psychological reality for speakers of Danish of two equally possible morphophonemic transcriptions |brav| and |brag| for Danish [bær/ʊ], which may mean either 'brave' or 'crash' (neither word enters into morphological alternations which might reveal the underlying identity of the stem-final consonant), it may be relevant, for example, that |brav| 'brave' is written with the letter v, finally, that occurs initially in words pronounced with [v] (/v/), and the homophonous |brag| 'crash' with the letter g that occurs initially in words pronounced with initial [g] (/g/), cf. vi, gå 'we', 'go' [vi], [gɑː²]. Furthermore, different speakers’ ideas of relatedness between word forms—whether historically founded or not—may be relevant for their lexical representations, and also this matter should be investigated empirically. These issues represent the strong sense of morphophonemes as candidate lexical segments.

In the case of (ii), naturalness can be chosen as a methodological guideline for the relation between different levels (see 2.4): the correspondence between the contrastive segment [X] and the phoneme /X/ is more natural than between [X] and /Y/, and the correspondence between the phoneme /X/ and the morphophoneme |X| is more natural than between /X/ and /Z|. This is not just a question of arbitrary labels: both contrastive segments and phonemes have phonetic content, even though the degree of abstraction is not the same; and morphophonemes as well have phonetic content— and can be analyzed in terms of distinctive features, and so on—even though they also encode information about morphological alternations which may have consequences for the phonetic content.

5. Concluding remarks

Morphophonemic analysis in the narrow sense is a 'bottom-up'-procedure from phonemes, e.g. established from sound by means of the commutation test, to morphophonemes. But the morphophonemic analysis in the broad sense—inversely—can also proceed the other way round, viz. as a 'top-down'-procedure, called synthesis in the narrow sense [e.g. in Hjelmslev's (1943) terminology]. In section 4.4, a perspective of synthesis in this sense was taken, viz. when morphophonemes were considered as candidate lexical segments. From that perspective, a phonological description—to avoid the term 'analysis' in order not to confuse the narrow and the broad sense of this term—can be given from lexical segments until phonemes, and further on via contrastive segments to phonetic segments. Such a description involves realisation principles or rules of some sort, e.g. as those used in different versions of generative phonology in the broad sense, and somehow recalling basic descriptive principles behind Bloomfield’s (1939) Menomini morphophonemics.
Note
Sections 3.1 and 4 are based upon Basbøll 2006. The IPA-transcription of Danish follows Basbøll 2005, however without diacritics for voicelessness (Danish [b d g] are voiceless). I am indebted to Nina Grønnum for numerous valuable stylistic and other suggestions.

See also: Linguistics (overview); Morphology, in linguistics; Phonology; Suprasegmentals; First language acquisition cross-linguistically; Linguistic typology

References


