No Sympathy for Opacity

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1. Introduction

The treatment of generalizations that are contradicted by surface forms (i.e. that are "opaque"), has always been at the center of Generative Phonology. A generalization is opaque when there are 'unexpected' outputs that either unexpectedly fail to conform to it (underapplication; the generalization is not surface-true) or unexpectedly do conform to it (overapplication; the generalization is not surface-apparent).

In this artcle, we investigate to what extent opaque generalizations can be accommodated in an approach to phonology that acknowledges only a (uni-representational) phonological level.[1] Our theory draws on the frameworks of Government and Dependency Phonology (Anderson & Ewen 1987; Kaye, Lowenstamm & Vergnaud 1990; van der Hulst & Ritter 1999). Our goal will not be to structure the model in such a manner that all opaque generalizations that have been formulated in other people's analyses *can* be expressed. We simply wish to make explicit the predictions and capabilities of our own model. If it turns out that certain generalizations *cannot* be expressed, we can raise the question as to whether this is to be seen as harmful to the model, or in fact desirable. Whether one or the other conclusion must be drawn will depend on the extent to which we can derive and test independent predictions that prove the generalization to be spurious or not.

The structure of this article is as follows. In section 2 we discuss the various approaches toward dealing with the phenomenon of opacity which have been found in the literature. The following section (3) then addresses the notions of 'level', and 'representation' in our model. Section 4 outlines our approach called *Head-Driven Phonology* (HDP). In section 5, we present a sampling of different types of opacity-effects that can be accommodated in this theory. Section 6 then follows with our conclusions.

2. Background on approaches to opacity

Early Generative Phonology advocated the view that 'related' surface forms (allomorphs) had to be derived, if at all possible, from a common underlying source by means of phonological rules that perform operations in terms of natural relations between the change and the context, avoiding reference to non-phonological information. This led to analyses in which the unexpected outputs were assigned abstract underlying shapes that would account for their behavior vis-a-vis the generalization. Forms that unexpectedly fail the generalization or rule would be assigned an underlying form that does *not* trigger the rule in question, whereas forms that unexpectedly undergo the rule would be given an underlying form that does trigger it.

Such analyses always necessitated an extrinsically ordered later rule that would then introduce (counterfeeding, 1a) or remove (counterbleeding, 1b) the relevant conditions in these forms:

(1) a. counterfeeding

Underlying form	/CED/
i. $A \rightarrow B / C \_\_ D$	not applicable
ii. $E \rightarrow A$	[CAD]

b. counterbleeding

Underlying form	/CAD/
i. $A \rightarrow B / C \_\_ D$	[CBD]
ii. $D \rightarrow E$	[CBE]

Alternatives to this derivational approach have involved the prohibition against either extrinsic rule ordering or rules that are contradicted on the surface (cf. Natural Phonology, Hooper 1976; Declarative Phonology, Scobbie 1997). In approaches of this type, the reality of opaque generalizations has either simply been denied (causing the storage of allomorphs in the lexicon), or the generalizations in question are marked with exceptions or morphological conditions (i.e. non-phonological information). In both cases, the result is that there is no longer an opaque generalization: in the former case because no generalization is made at all, and in the latter case because the generalization is made transparent by brute force, i.e. by limiting its scope to the appropriate lexical items or morphological environments.

The availability of such alternatives makes it clear that 'opacity' is not a property of the facts of languages, but rather of analyses, or rather of the rules or generalizations that figure in the analyses of these facts.

Another approach maintains the existence and strict phonological character of the SPE-type generalizations (thus avoid reference to non-phonological information) without appealing to extrinsic rules. Instead, rules are allowed to apply simultaneously whenever their structural description is met (Kenstowicz and Kisseberth 1977: 178 ff.):

(2) a. counterfeeding

Underlying form	/CED/	
	|	(1a.i) = n.a., (1a.ii) applies
Surface form	[CAD]	

b. counterbleeding

Underlying form	/CAD/	
	| |	both (1b.i) and (1b.ii) apply
Surface form	[CBE]	

If rules apply simultaneously, no rule can feed or bleed another rule, thus only counterfeeding and counterbleeding effects result. A problem with this 'two-level' approach is that it cannot deal with feeding and bleeding effects, unless further levels are postulated.

An alternative theory, not facing this problem, proposed in Goldsmith (*Harmonic phonology*, 1993) and Lakoff (*Cognitive phonology*, 1993) makes use of simultaneous rule application for dealing with opacity without extrinsic rule ordering. In addition, however, this model postulates three levels of representation (Morpheme-, Word-, and Phonetic) along with interlevel and intralevel rules. The following description of the three levels is taken from Goldsmith (1993: 32):

(3) M-level, a morphophonemic level, the level at which morphemes are phonologically specified.
W-level, the level at which expressions are structured into well-formed syllables and well-formed words, but with a minimum of redundant phonological information; and
P-level, a level of broad phonetic description that is the interface with the peripheral articulatory and acoustic devices.

Each level can be subject to an unordered set of *intralevel* rules. Levels are then related in terms of the *interlevel* mapping rules. In a model like this, a rule at an earlier level can bleed or feed (or, in fact, counterbleed or counterfeed) a rule at a later level.

The issue of opacity has been extensively addressed in another recent approach, namely *Optimality Theory* (OT; Prince & Smolensky 1993; McCarthy ms.), specifically because critics of OT like to point out that OT cannot deal with many of the generalizations that have figured in analyses in the SPE-tradition. Actually, the correctness of this criticism depends rather crucially on the variant of OT that is considered. As McCarthy (ms.) points out, the so-called 'parse-and-fill' version of OT was quite capable of handling most opaque generalizations in a manner that actually comes close to the account proposed in the HDP model. For reasons external to the opacity-issue, the parse-and-fill theory has been abandoned, however.[2] Rather than concluding that the resulting version of OT predicts that the SPE-type opaque rules embody spurious generalizations, McCarthy designs an ingenious device (called 'Sympathy Theory') to reconstruct, in OT terms, all the SPE-analyses that incorporate opaque generalizations. We believe that this is the wrong way to go. It seems to us that one must take the predictions of a theory seriously

and not take generalizations that are expressed in other models as having any real existence outside these analyses.

Even though we do not ourselves adhere to the optimality theory of constraints and their ranking, we note that our treatment of opacity is compatible with a parse-and-fill OT approach that assumes that syllable structure (and other forms of head-dependent relations) forms part of the input. It would seem therefore that OT, like our approach, needs no "sympathy" (cf. McCarthy ms.) for opacity.

To give the reader a flavor of our approach, let us briefly look at one of the typical and most often cited examples of an opaque rule. In traditional generative analyses of Tiberian Hebrew, two rules interact in the analysis of surface forms like *deše* 'grass'.

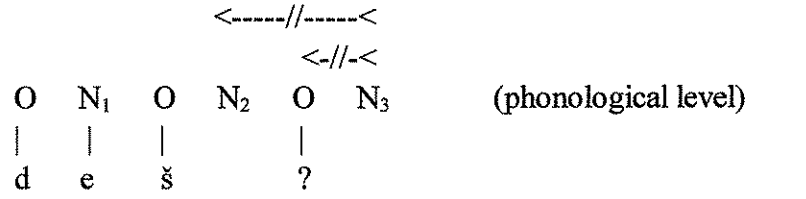
According to McCarthy (ms.), the underlying form for this word is /deš?/. Two rules derive the surface form: e-epenthesis and ?-deletion:

(4) counterbleeding

Underlying form	/deš?/
i. Epenthesis	[deše?]
ii. ?-deletion	[deše]

Our analysis of the Tiberian Hebrew example is illustrated in (5):

(5) a.



(phonological level)

b. d e š e (phonetic interpretation)

For the sake of simplicity, we display the phonetic interpretation as a string of segmental symbols; we explain the notion of 'phonetic interpretation' in the next section.

According to the theory that we will explain below in section 4, surface-final consonants (in languages that allow them) are always represented as onsets followed by an empty, silent nucleus. For Tiberian Hebrew we then assume that, since N_3 is empty, it is not substantively strong enough to license a preceding onset's laryngeal content. Thus, /?/, a laryngeal element, remains phonetically uninterpreted, i.e. unpronounceable. Since N_2 is also empty and as such (being non-final) must be governed by a contentful N (in this case to its right) to remain silent on the surface, N_2 must be realized since it cannot be governed properly by N_3 (recall N_3=empty). In this approach, phenomena such as 'epenthesis' and 'deletion' are thus not something that 'happen' to the phonological representation, but rather are labels for specific types of

discrepancies between the phonological representation and the phonetic interpretation, a kind of two-way mismatch in effect.

(6) a. a phonetic event (e.g. [e] in (5) above) need not correspond to phonological segmental content, and
b. the absence or non-interpretation of a phonetic event need not correspond to the phonological absence of segmental content (e.g. <?>).

The central part of our theory is concerned with specifying the circumstances under which the discrepancies in (6) can arise. In specifying these circumstances, we attribute a central role to, what we call, head-dependent relations that are part and parcel of the phonological representation.

3. The monostratal nature of Head-Driven Phonology

Head-Driven Phonology (HDP; van der Hulst & Ritter 1999; in prep.) is a development of Government Phonology (Kaye, Lowenstamm and Vergnaud 1990; Kaye 1990, 1995) and Dependency Phonology (Anderson & Ewen 1987). HDP is a 'non-derivational' theory that only acknowledges a phonological representation, subject to an unordered set of 'intralevel' operations or *licensing mechanisms*.

The intra-level operations that HDP deems necessary are, in essence, merely meant to check the well-formedness of the input string (i.e. all phonological units must be licensed), and, also, to inform the 'phonetics' on how to phonetically interpret the lexical form.

The phonetic interpretation is not to be understood as a phonetic level. In our model, we do not subscribe to a separate *phonetic* level. The phonetic interpretation corresponds to the (idealized, careful) pronounciation of lexical items, which is directly read off of the single level, phonological representation. Having said this, we must add, however, that, in order to account for the fact that for every lexical item there exists an (infinite) array of actual pronunciations (the choice of which is determined by the sentential context, as well as by factors involving rate and style of speech), we assume, in fact, that there is a further set of operations, or processes, which, in our view, apply in the *post-lexical component.* In this article, we do not discuss the architecture of this post-lexical component (cf. van der Hulst, to appear).

Compared to the Harmonic/Cognitive Phonology model in (3), HDP conflates, so to speak, the M- and W-level into the lexical phonological level. The P-level in (3) would seem to correspond to our post-lexical component if we were to follow Pierrehumbert's (1980) suggestion that the post-lexical representation *is* the phonetic interpretation. Be this as it may, we wish to keep the post-lexical component distinct from the lexical phonetic interpretation which properly speaking represents the way the word 'ought to be pronounced'.

Turning back to the notion of checking, HDP achieves this by formulating licensing mechanisms that establish head-dependency relations

between the units that make up the lexical phonological form. Such structural relations would, in traditional terms, be called syllable structure, metrical structure and (the result of) autosegmental spreading (as in long vowels, vowel harmony, etc.).

A certain amount of 'structure' is, in fact, assumed to be inherently present in the lexical representation. This concerns onset and rhyme structure. The reason for this is that the onset and rhyme status of phonological content largely determines the 'manner properties'. Another reason relates to the lexical presence of so called empty nuclei, i.e. nuclei that have no content.[3]

A notorious example of a checking mechanism is what has been termed 'proper government' in the literature. As just mentioned, HDP assumes that lexical forms may contain empty nuclei, and which, as such, are inaudible in the phonetic signal. However, such units are severely restricted in their distribution in that they must be flanked by an adjacent nucleus that is audible. A lexical string that contains adjacent empty nuclei will be realized phonetically with one of these being audible.

Other relations that are subsumed under the intralevel operations correspond to foot-like metrical structure in other frameworks. HDP claims that no rules or operations are needed which crucially add phonological elements to representations, i.e. phonological representations are never 'underspecified' and always 'fully interpretable'.

Perhaps it could be assumed that all these head-dependency relations are part and parcel of the lexical forms. This would not, however, obviate the need for intralevel operations to be active because such relations (involving stress or vowel harmony) must also be established for productively derived complex words, including inflected words.

HDP distinguishes morphological rules in terms of whether or not they create a domain that is visible to the phonology, thus creating a 'derived' environment. Roughly speaking, these morphological operations are those that create *b*-domains in the theory of Inkelas (1989), or 'analytic' domains in our model. Morphological operations that create strings that are indistinguishable from strings that are morphologically simplex are like Inkelas' *a*-domains. A domain that has no phonologically relevant embedding is called 'non-analytic' or 'synthetic' in HDP.

The synthetic/analytic distinction (which is reminiscent of the level I/level II distinction in lexical phonology) is not an inherent property of affixes, although there are regular correlations. Despite these correlations, a certain affix that is regularly analytic may be synthetic in specific words. (This expresses what traditionally is meant by 'lexicalization'.)

Summarizing, HDP's view on 'derivation' is limited in that operations add relationships, applying whenever they are triggered by the lexical input string. In technical terms, this makes the derivation 'monotonic'.

In intuitive terms, we therefore display HDP in terms of the following diagram:

(7) The phonological level (HDP)
phonological representation <---> Operations (unordered)
|
phonetic interpretation

In the practice of HDP, one will sometimes encounter a residue of 'destructive' operations, i.e. operations that remove vacuous blocks of empty onset and rhyme structure. The view in (7) is sometimes called 'strictly monostratal'.

4. An outline of the Head-Driven Phonology model

The fundamental contribution of Dependency Phonology has been the claim that phonological structure involves head/dependency relations at all levels of organization (including intrasegmental organization). Intrasegmental feature classes, segments themselves, syllabic constituents (like onsets and rhymes), syllables themselves, feet, phonological words, and so on are all depicted as headed constituents. In fact, it is explicitly stated (in the form of the *Structural Analogy Hypothesis*) that the notion of a headed, binary constituent structure defines what is in common between morpho-syntactic and phonological (often called prosodic) structure.

4.1. Principles

We formulate the central head/dependency relations as follows:

(8) Head/Dependency Principle:
an object is either a head or a dependent; if a dependent, it can only exist if it is in a relationship with a head to which it is adjacent at some level.

This principle, as it will be shown, subsumes all sorts of relations which are given in (9):

(9) HD-relations
i. Structural relation of sisterhood: (H D) (H governs D)
ii. Structural relation of domination: H
(paradigmatic) |
D
iii. Syntagmatic relation: (H D) or H) (D
> > > > > >
(the linear order of H and D may also be the opposite)

Example (9ii) bears on the melodic content of skeletal positions and on the structural content of higher units. (9iii) will be argued to exist with reference to the content of skeletal positions only.

Another principle that we claim is an innate and necessary part of UG is the *Binarity Principle*.

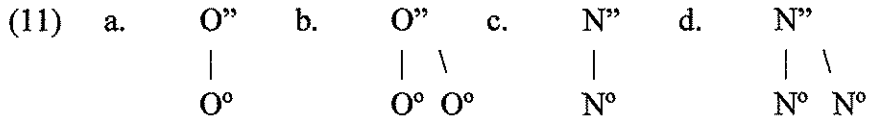
(10) Binarity Principle:
all head/dependent relations are maximally binary.

These two principles in (9) and (10) allow for the presence of either a head alone, or a head and a dependent, but never a dependent alone, nor combinations of more than one head or more than one dependent.

4.2. Structure in HDP

HDP assumes that all constituents are strictly binary. The consequence of banning ternary structure is that only the following syllabic constituents are acknowledged:

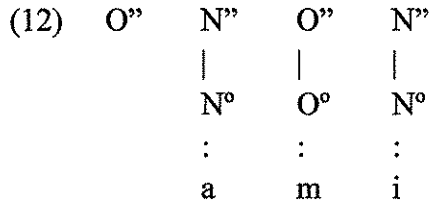
(11)



We stipulate (as in government phonology) that the direction of the government head/dependent relation is non-parametric, universally left to right (left-headed) within the most minimal of constituent domains, i.e. at the zero-level within the onset constituent (cf. 11b) and within the nuclear constituent (cf. 11d).

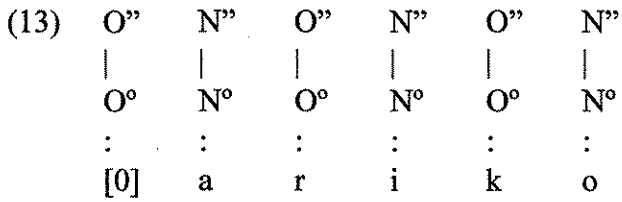
It should be noted that in our approach we notationally replace the traditional notion of skeleton (a string of so-called x-positions) with 'zero' positions (X°).[4] Constituents that do not have zero-level terminal heads merely serve as representative cognitive placeholders in the structural schema but do not contribute to any interpretation per se. For instance, words that begin with a vowel on the surface and also phonologically behave as vowel-initial will have a structure in which the initial onset constituent may be representationally present but its zero-level head will not be present, as in the French word *ami* 'friend' (masc. sing.) illustrated in (12) below (cf. Tranel 1987):

(12)



In cases, however, where an initial onset *is* claimed to be phonologically relevant, although it lacks any segmental content and appears silent on the surface, the onset constituent is headed by a zero-level position (O°). Example (13) gives an illustrative representation of the phenomenon that has been described as *h-aspiré* in French, in which apparent vowel-initial words act as if they begin with a consonant, as with *haricot* 'bean' below.

(13)

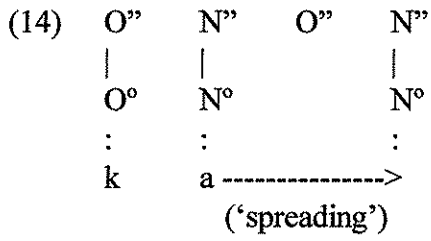


Thus a contrast with respect to the presence or absence of the zero-level head is claimed to exist in the case of onsets which accounts for the variance in phonological relevancy of onset constituents which appear silent on the surface.

Whereas nuclei can co-occur with onsets that lack a zero-level position, it is not our position that the reverse situation is possible. In fact, we claim that onsets cannot occur with nuclei that lack a zero-level head. A nucleus always contains a zero-level-head. This asymmetry between onsets and heads is motivated in van der Hulst & Ritter (1999).

The branching nucleus structure is used for vowel-consonant sequences (VC), and *not* for long vowels. We therefore propose to represent all long vowels as in (14):

(14)



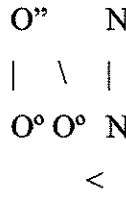
The vowel melody of the first nucleus 'spreads' to the second nucleus in the phonetic interpretation of this structure. We refer to van der Hulst & Ritter (in prep.) for further extensive discussion of long vowels.

In the branching nucleus structure in the HDP model, the second member of such units includes glides (or approximants), liquids, homorganic nasals[5] and left halves of geminates[6] This move also seems supported by the typological facts. The presence of long vowels does not imply the presence of closed syllables, and vice versa. If both are the consequences of parametrically allowing branching nuclei, then this mutual implication would be the expected result.

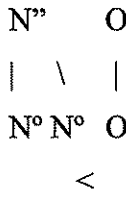
With respect to this post-nuclear position (traditionally called the 'coda'), we claim that the licensing relationship between a coda and a following onset falls under the generalization in our model that postulates that each dependent must be licensed by a following audible head. This is in keeping with Charette's (1990) principle of *Government Licensing* which demands that an onset dependent can only occur when its head onset is licensed to govern the dependent by a following nuclear head (cf. 15a below). We argue that the required result in this case can be derived from a syntagmatic licensing relation that also subsumes the coda licensing relation (displayed in 15b). This means that all zero-level positions are now formally 'linked', as shown in (16), either

in terms of left-headed constituent government (>) or in terms of right-headed interconstituent syntagmatic licensing (<); *licensing* is thus the thread that holds the 'zero-level beads' together:

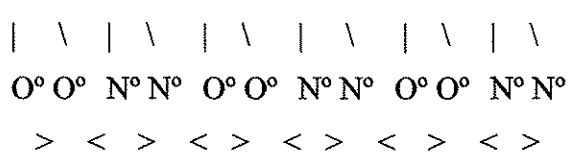
(15) a.



b.

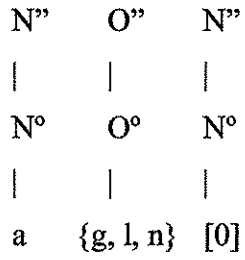


(16)

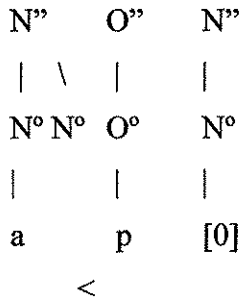


Assuming that the coda position can contain glides (or approximants), liquids, nasals and left-halves of geminates, and adopting coda licensing as a necessary relation, we enforce that word-finally, glides, liquids and nasals (in addition to obstruents) must be onsets followed by an empty silent nucleus (cf. 17a). Final geminates would, of course, necessarily involve a final empty nucleus (17b):

(17) a.



b.

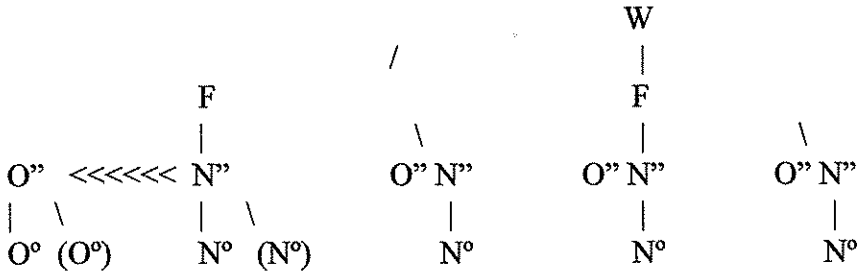


4.3. Syllables, feet and words

The syllable as such is not recognized in HDP as a constituent in the prosodic hierarchy. Onsets are placed outside the prosodic hierarchy. They are 'adjoined' to the nucleus. At the adjunction site of O" and N", where N" is the head, the licensing relation is a right-headed one, following from the claim that prosodic structure (composed of nuclei only) is the foundation on which the onset is anchored.[7]

Feet and words are strictly binary, either left- or right-headed. Example (18) illustrates the hierarchical architecture, based on this notion of government relations, up to the word level:

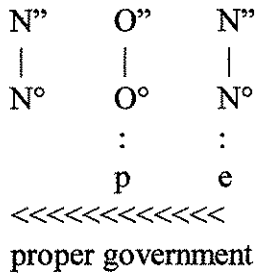
(18)



At this point, we must mention a few words about another central mechanism of HDP, viz. *Proper Government* (PG). We have seen that, in HDP, a nucleus is allowed to be empty, i.e. contain a skeletal point that does not contain any content. In order to avoid a proliferation of silent nuclei, HDP demands that empty nuclei be licensed. This demand is stated in the form of the so-called *Empty Category Principle*: An empty nucleus must be licensed in order to be inaudible.[8]

There are several licensing mechanisms pertaining to empty nuclei, which we discuss in van der Hulst & Ritter (1999). The most important of these is proper government. In essence, proper government obtains if the empty nucleus has a neighboring nucleus that is audible, i.e. either contentful or an empty unlicensed nucleus (and thus phonetically interpreted) . In most HDP accounts, PG is a right-to-left (iambic) relation:[9]

(19)



PG can be 'blocked' if there is an intervening consonant cluster (either a coda-onset sequence or a branching onset). This means that such consonant clusters cannot be preceded by an empty silent nucleus. cf. Kaye, Lowenstamm & Vergnaud (1990) for details. Proper government thus, in fact, creates a foot-like organization (cf. van der Hulst & Rowicka 1997).

4.4. Licensing relations

In this section, we give a very brief outline and description of licensing relations in the HDP model, as referred to in the previous section. We refer the reader to van der Hulst & Ritter (1999, in prep.) for a fuller and more complete discussion of this topic.

4.4.1. The structural relation of sisterhood

Structural relations of sisterhood are the framework for hierarchical constituent structure. In this type of head-dependent relation known as 'government', a head is able to project a constituent by virtue of its potential to form a

governing domain with an adjacent sister dependent. We have discussed the HDP view on constituent structure in section 4.2 above.

4.4.2. The paradigmatic relation

4.4.2.1 Structural paradigmatic relations

Paradigmatic licensing relations are top/down, head/dependent relations making reference to the constituent status of a position as either a head (i.e. a governor), or a dependent (i.e. a governee), with respect to the structural complexity which such a position is able to license, precisely because of its status. This type of licensing produces the effect that head positions allow greater complexity than dependent positions and that dependent positions display effects of neutralization (cf. Dresher and van der Hulst 1995, 1999). The typical head-dependent asymmetry involves the notion of 'branching' such that the head position licenses a branching daughter (as well as the less complex non-branching structure), while the dependent position only allows a non-branching dependent.

4.4.2.2. Content paradigmatic relations

This type of licensing relation bears on the *content* of zero-level positions. In understanding this type of licensing, we view head positions as positions of maximal contrast, i.e. the state of being a zero-level head licenses the ability of a whole array of segments to appear in such a position; thus a zero-level head position licenses its dependent segmental content to be segments from a large set of possibilities from the phonemic inventory of a language. Correlatively, structurally dependent, zero-level positions are claimed to typically allow less options, and thus select from a smaller, restricted set of possibilities. In comparison with their heads, then, dependent positions appear to be positions in which neutralization of contrast is seen. For instance, it is typically the case that only a limited set of consonants can occur in the onset constituent's dependent position (typically only liquids or approximants). Moreover, it is also the fact that the nuclear dependent in the case of a heavy diphthong only allows vowel melodies like /i/ and /u/. The head/dependent relation that this approach promotes thus predicts in which positions we find neutralization of contrast (cf. van der Hulst & Ritter 1999, in prep. for a fuller discussion of this topic). [10]

4.4.3. The non-structural syntagmatic relation

The third type of licensing that we propose occurs between adjacent units at the zero-level. In this type of licensing, the content of the head has bearing on the type of content that can occur in the dependent. This results in what is usually called phonotactic restrictions. Non-structural content-licensing can occur within a constituent (in which case it happens to co-exist with structural licensing as well), but it can also occur across constituents.[11] Intraconstituent content-licensing accounts for effects such as dissimilation (e.g. *#pw..) while interconstituent content-licensing is claimed to account for, e.g., the

assimilatory relations of coda-onset relations as realized by the phenomena of nasal homorganicity and partial geminates (cf. section 4.2 above).

All examples of interconstituent relations are right-headed, while those of intraconstituent relations are left-headed. We conclude, at this point, that the opposite does not occur in line with the 'beads-and-thread'-model proposed in (16) above.

4.4.4. Summary of licensing relations

We have outlined three types of licensing relations:

(20)	structural	sisterhood	-> involves building structure
	paradigmatic	domination	-> involves restrictions on positions (with respect to both structure and content)
	content	non-structural	-> involves restrictions on zero-level positions (i.e.content only)

5. Opacity in Head-Driven Phonology

In this section, we will further illustrate the HDP approach to opacity. As anticipated in section 2, we account for opacity by proposing that within our representational theory of phonology, discrepancies may arise between the phonological representation and its phonetic interpretation. In HDP, "processes", such as deletion and epenthesis, are dealt with in terms of non-phonetic interpretation of phonologically present material (as per 6b) or phonetic exponents in well-defined environments that do not correspond to phonological content (as per 6a).

Our assumption is that the relevant, and, in fact, only phonological level is comprised of the head/dependent licensing relations discussed in section 4 above. This thus consequently obviates the need for 'intermediate levels'.

5.1. Opacity in Tiberian Hebrew

We repeat here example (5) discussed in section 2 above.

(21)	O	N_1	O	N_2	O	N_3
	|	|	|		|	
	d	e	š		?	

The HDP-analysis is this: the final empty nucleus N_3 (which is itself licensed finally) cannot license the preceding onset's content; thus /?/ remains phonetically uninterpretable, i.e. unrealized. The preceding nucleus N_2, being ungoverned, must be realized phonetically. Thus, crucially, the second nucleus is non-final and this is not changed by the non-realization of /?/.

'Epenthesis' is not a phonological process, but a matter of a difference between the phonological representation and its phonetic interpretation, as is 'deletion'. This case of 'counterbleeding opacity' can be dealt with in HDP because of mismatches, between the phonological representation and its phonetic interpretation, which we stated under (6), here repeated as (22):

(22) a. a phonetic event (i.e. [e]) need not correspond to the phonological presence of segmental content, and
b. the absence of a phonetic event need not correspond to the absence of segmental content (i.e. <?>)

We will now apply this strategy to a number of other well-known cases of opacity.

5.2. Other cases of opacity

5.2.1. Opacity in Icelandic

This case again concerns a counterbleeding relationship between epenthesis and /j/-deletion:

(23)		/b I l j - r/	'storm'
	j-deletion	b I l - r	
	epenthesis	b I l u r	

Given the occurrence of epenthesis, there is no apparent motivation for j-deletion to take place.

The analysis that HDP allows is the following:

(24)

O	N_1	O	N_2	O	N_3	O	N_4
|	|	|		|		|	
b	I	l		j		r	
			[0]		⇑		

The empty content of N_4 is licensed by being in final position. The effect of epenthesis is a consequence of the fact that N_3 is not properly governed and therefore has to be phonetically audible. By being audible, N_3 is able to properly govern N_2 to remain phonetically silent or uninterpretable.

The effect of j-deletion is a reflection of the fact that N_3, being phonologically empty of segmental content, cannot license a /j/-onset. The segmental content (i.e. /j/) of the onset, therefore, remains uninterpreted. Crucially, N_3 functions phonologically as an empty nucleus even though it is phonetically realized.

5.2.2. French

Gussenhoven & Jacobs (1998) give the following example of a counterfeeding effect in French:

(25)		/pətit/ (m.)	/pətit-ə/ (f.)	"small"
	Final consonant deletion	pəti		
	Schwa-deletion		pətit	

The analysis in HDP runs as follows. The masculine form ends in an empty nucleus and, apparently (simplifying the matter) in French, a final empty nucleus does not license a preceding consonant. The feminine form, however, does not end in an empty nucleus, but, rather, in a nucleus that contains a schwa. In our view (cf, van der Hulst & Ritter 1999), a lexical schwa is *not an empty nucleus* (although a phonetic 'schwa event' can be the phonetic interpretation of an unlicensed empty nucleus).[12] Therefore the /t/ in the feminine form is licensed and is interpreted. What remains to be accounted for is the fact that the final schwa in the feminine form is not pronounced. In HDP there can only be one reason for this: in French, final schwas are not licensed. HDP admits 'edge licensing' mechanisms and the case of French illustrates that one such licensing mechanism may prohibit a final lexical schwa.

5.2.3. The case of Lardil

This example set from Lardil is discussed in both Goldsmith (1993) and Lakoff (1993). In this language, we find a set of alternations (first described and analyzed in Hale 1973) with the postulation of stem forms that contain segments that change or disappear in various inflected forms.

Lardil does not allow:

(26) a. final clusters (C → 0 / C _ #)

b. final non-apical consonants (C [-apic] → 0 / _ #)

c. final high vowels (i,u → e,a / _ #)

d. final vowels in 'more than bisyllabic words' (V → 0 / VCVC _ #)

In HDP, all these effects must be derived from a single level of representation. The non-occurrence or 'change' must somehow result from constraints on the 'word-level' (i.e. the synthetic domain) form of 'uninflected nouns'. (The limitation to this category must be expressed by allowing constraints to contain grammatical information.)

The claim in all cases, except (26c), is that the material that does not show up in the uninflected form does not have to be 'deleted' (as per 6/22b). It is there, but it receives no phonetic interpretation because it is not licensed. For example, word-final empty nuclei only license apical consonants. These consonants, in turn, do not have the ability to coda-license a preceding 'coda' consonant. This accounts for the effects of (26a) and (26b). As for final vowel deletion in (26d), this must be a prosodically conditioned process that operates in such a way that the relevant vowel remains 'unparsed' (i.e. unlicensed).

Example (26c), which presents a case of alleged 'insertion' (i.e. of the 'low' element A), must be a phonetic effect of the phonological licensing (as per 6/22a). Insertion is not possible in HDP. What looks (or sounds) like insertion can be the consequence of phonetic interpretation. This is the case with 'vowel insertion' which amounts to the phonetic realization of an empty unlicensed nucleus.

Lowering of word-final /i/ and /u/ looks like the result of inserting the element |a|, but let us consider an alternative. The Lardil vowel system is as in (27a)

(27)	a.	i	u	e	a
	b.	(I,a)	(U,a)	(A,i)	(A,u)

(heads are capitalized)

We propose that the representations in (27b) are the elemental structures of the corresponding vowels in (27a). The licensing constraint in (28) explains the lowered variant of /i/ and /u/:

(28) Dependent |a| is not licensed word-finally

This treatment involves no insertion or change. Word-final /i/ and /u/ 'change' to /e/ and /a/ because the low element A can only be a head in that position.

5.2.4. Yawelmani (or Yowlumne)

Goldsmith (1993) presents a longer example concerning 'Yawelmani Yokuts' (for expositions of the relevant data see: S. Newman 1944; Kuroda 1967; Kisseberth 1969).

An HDP-compatible analysis of 'epenthesis' and 'closed syllable shortening' is given in Rowicka (1999); however, she does not deal with the facts of vowel harmony. The problem here concerns the process known as 'lowering'. Lowering creates 'disharmony', i.e. it renders vowel harmony opaque. High long vowels are phonetically realized as low (cf. final lowering in Lardil above):

(29)	"unpack" aorist pass.	/su:gnit/
	vowel harmony (VH)	su:gnut
	lowering (L)	so:gnut
	closed syllable shortening (CSS)	sognut

L must follow (counterbleeding) VH because the suffix shows up as /u/, i.e. it rounds and, according to VH, this only happens if the trigger and target of VH are of equal height. CSS must follow (counterbleeding) L because short high vowels do not lower.

In HDP, the representation of this form is as follows:

(30)	O	N_1	O	N_2	O	N_3	O	N_4	O	N_5
	|	|			|		|	|	|	
	s	u---------->			g	[0]	n	u	t	

All effects (VH, L, CSS) and their interaction can be understood in terms of the representation in (16):[13]

(31) a. VH is an internuclear 'agreement' relationship
b. CSS is the effect of N_3 being unable to government-license N_1 (the head of the long vowel)
c. Lowering (cf. below)

CSS involves no deletion; N_2 is not deleted. The long/short alternation in HDP is handled by saying that a doubly -linked melody is interpreted as long only if there is a following non-silent nucleus which can government-license the head of the long vowel (cf. Yoshida 1992).

The vowels will be represented as follows:

(32)	a.	i	u	a	o	i:	u:	a:	o:
	b.	( )	(U)	(A)	(A,u)	(I,a)	(U,a)	(A)	(A,u)

To account for the 'lowering-effect', we must assume the following phonetic interpretations:

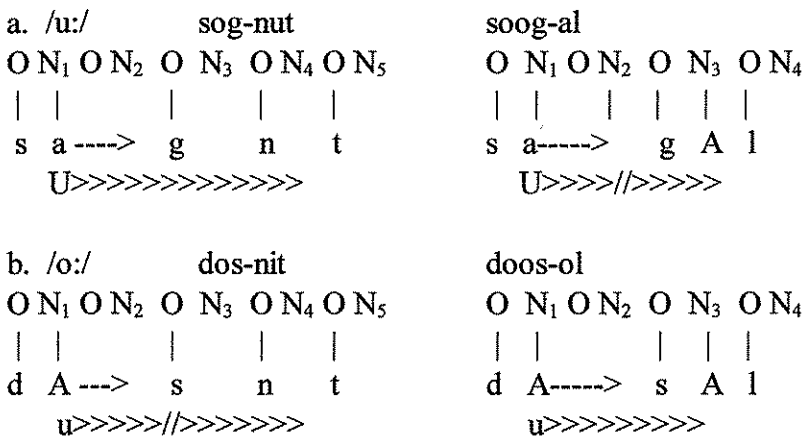
(33) a. (I,a) = [e]
b. (U,a) = (A,u) = [o]

The phonological form of 'high' suffixes has an empty nucleus. This empty nucleus is phonetically interpreted as [i], unless it is properly governed.

Traditionally it is said that vowel harmony applies between vowels of equal height. *AIU*-approaches face the apparent problem of being unable to characterize the notion of 'equal height' (cf. Ewen & van der Hulst 1988) since high vowels do not share a common element and there is no formal way of referring jointly to |i| and |u|. Here, we propose that the key to the solution lies in the notion of 'headedness', or rather 'role-preservation' (possibly to be seen as a manifestation of the 'projection principle'). Given the vowel structure in (32), the element |u| spreads as a dependent if the source is a low vowel /o/, or as a head if the source is a high vowel /u/. Let us now assume that the head/dependent role of the spreading element must be preserved and that this accounts for the equal-height constraint. Thus a head |u| cannot spread to a target that has a head A since a double-headed construction is illformed. Also, a dependent |u| cannot spread to an empty nucleus; this would create (-,u), a headless segment, which the Yawelmani vowel inventory does not license.

Let us concentrate here on analyzing the difference in behavior between /u:/ (a 'high' vowel) showing up as [o:]/[o] and /o:/ (a low vowel) also showing up as [o:]/[o].

(34) Harmony



This analysis of Yawelmani neither appeals to any extrinsic ordering, nor any insertion or deletion of phonological material.

6. Summary and conclusions

In this article we have shown that HDP can deal with 'opacity' effects by showing how certain units in a phonological representation (i.e. units that are not licensed in terms of an appropriate HD-relation remain without a phonetic interpretation. Conversely, events that are present phonetically (like the phonetic realization of unlicensed empty nuclei), do not correspond to the phonological presence of a vowel. Mismatches of this type between the phonological representation and the phonetic interpretation, in fact, embody the raison d'etre of phonology.

Notes

[1] In our model, which is elaborated upon in section 4, we do not subscribe to a separate phonetic level within the lexicon. Rather, phonetic interpretation is directly read off of the single level phonological representation that is comprised of various licensing relations. That is not to say, however, that once an item leaves the lexicon and becomes an "utterance", where phrase-structure context, social conditions, etc, play a role, that processes such as fast speech reduction, et alia cannot occur. On the contrary, in our view, such processes occur in what we term the "post-lexical" component, a component which is strictly distinguishable from the lexical/phonological component; cf. section 3 for an elaboration of this point.

[2] However, see Goldrick & Smolensky (1999) for an account close to ours.

[3] Not all manner properties follow from syllabic structure. Ritter (1997) argues that finer distinctions are represented in terms of lexical HD-relations between phonological elements.

[4] For ease of exposition, in most of our example analyses we suppress the distinction between the double-bar and zero-level.

[5] The limitations arise from a syntagmatic requirement of homorganicity with the following onset (sect. 4.4.3), or paradigmatic restrictions on the position itself (sect. 4.4.2). We assume here that 'glides' can be in the nuclear dependent position, to form diphthongs, i.e. when they pattern with the closed syllables. In other cases, when they pattern with long vowels, diphthongs will be bi-nuclear; cf. van der Hulst & Ritter (in prep.).

[6] At this point it might be better to replace the use of the term nucleus by the term rhyme.

[7] Onsets and rhymes are represented on different planes and thus not linearly ordered. Since, in HDP, the onset and rhyme constituents are part and parcel of the phonological representation, we could also assume that the linear order of segments within these constituents is not encoded phonologically. This issue is discussed in Golston & van der Hulst (1999), and in van der Hulst & Ritter (1999, in prep.).

[8] In early versions of Government Phonology (Kaye, Lowenstamm and Vergnaud 1990) empty nuclei would contain an 'identity element' or 'cold vowel'. This element would have no phonetic interpretation, producing an *inaudible* nucleus, unless the nucleus it was contained in was not licensed. In the absence of licensing, the identity element would be phonetically audible as a high, central vowel [+]. Alternatively, this element would, in such a case, receive the company of an 'inserted' element, like [A], producing a schwa-like sound. In later versions of Government Phonology, the identity element has been eliminated (cf. Kaye 1995), thus making an 'empty' nucleus truly empty. We abstract away from such distinctions here, the relevant point being that an empty nucleus must be licensed to remain inaudible, and will be audible if not licensed.

[9] Van der Hulst & Rowicka (1997), Rowicka (1999) make use of 'trochaic' proper government.

[10] In our theory, non-obstruent consonants also occur in the nuclear dependent position, i.e. the 'coda' position. This seemingly implies that the nuclear dependent position allows more contrast than the nuclear head. This paradox is addressed in van der Hulst & Ritter (in prep.)

[11] An issue that needs further attention is to what extent inter-constituent licensing relations are bound to 'higher' constituents, such as the foot.

[12] In van der Hulst & Ritter (1999), we differentiate 'empty nuclei' from lexical schwas by positing that empty nuclei are empty *zero-level positions* whereas lexical schwas are, instead, *empty segments*. By 'empty segment' we mean that the zero-level position dominates minimal segmental content in the form of a bare 'root node' only (i.e. the place node is absent).

[13] Epenthesis, which is not demonstrated here, results when an empty nucleus is not properly governed.

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