# MULTIPLE LINKING IN JAVANESE[*]

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Over the past decade generative phonology has evolved along a number of lines that parallel developments in syntax. Ten years ago the model presented a simple conception of phonological representation (essentially a string of feature matrixes) and a powerful rule formalism for manipulating these representations. At present the model has a much enriched system of representation and a more articulated conception of the architecture of the grammar, leading, we hope, to a much more restricted rule format. Of course, this counts as real progress only if we have not simply shifted complexity and indeterminacy from the rule system to the representational system. Thus crucial to the entire enterprise has been the search for principles constraining the structure of phonological representations and the ways in which rules may refer to and manipulate such representations. To mention just a few here, there is the ban on crossing association lines of autosegmental phonology, the strict cycle principle of lexical phonology, and the peripherality condition on extrametricality in prosodic phonology. When phonological analysis is approached from this point of view there is thus a certain tension between extension of the representational system versus complication of the rule system. Also analysis and argumentation become more intricate and fragile in the attempt to formulate and defend general principles in the face of inevitable problems.

In this paper we will examine some material from Javanese from this perspective. The principle that will play a crucial role in



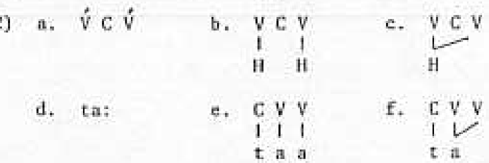


our discussion is the Obligatory Contour Principle (OCP) stated in (1) below.

(1) repetition of adjacent elements on a given autosegmental tier is prohibited

Recent research (e.g. McCarthy 1985) suggests that the OCP plays a basic role in a number of aspects of phonological organization. Here we shall be content with giving a couple of simple examples showing the role of the OCP in enforcing multiply-linked representations. Given an utterance with two successive high-pitched syllables (2a) the OCP will shun the singly-linked representation of (2b) in favor of the multiple-linking in (2c) since representation (2b) has two successive high tones on the tonal tier.

(2)



The OCP will also require representation of the long vowel of (2d) as a single phoneme a of the segmental tier spread over two successive positions of the skeletal tier (2f) instead of the representation in (2e) where two identical elements of the segmental tier are repeated one right after the other.[1]

As with any principle of grammar questions immediately arise concerning the scope of the OCP's operation. At what point or points in the grammar does it hold and over what domains? Intensive study of the properties of geminates over the past few years (see Steriade & Schein 1984 for a recent review) suggest that the domain of the OCP is the morpheme. There is also reason to believe that the OCP holds at the underlying representation but may "turn off" at a certain point in the grammar--perhaps at the end of the lexical phonology. The relevance of these scope questions will emerge at the end of the paper.

## Low-vowel Rounding

Our discussion of Javanese will focus on the vowels of the language. We will be relying heavily on the basic analysis worked out in the excellent description by Dudas (1975). Javanese has a ten vowel system, with the six vowels in (3a) as basic and the lax ones in (3b) derived by rule.

(3) a.

| | | |
|---|---|---|
| i | | u |
| e | ə | o |
| | a | |

b.

| | |
|---|---|
| ɨ | ʉ |
| ɛ | ɔ |

One source of the lax back vowel ɔ is the low-vowel rounding rule stated in (4a). This pervasive rule of Javanese phonology turns word-final a to ɔ, accounting for the alternations in the stem vowels of (4b).

(4) a. a → ɔ / ___ #

| | | | | | |
|---|---|---|---|---|---|
| b. | mejɔ | 'table' | meja-ku | 'my table' |
| | jiwɔ | 'soul' | jiwa-mu | 'your soul' |
| | təkɔ | 'to come' | nəka-ʔake | 'make come' |

A striking and pervasive feature of Javanese phonology is that when word-final a is preceded by an a in the syllable immediately to the left both a's round to ɔ.[2]

| | | | | |
|---|---|---|---|---|
| (5) kɔ.ncɔ | 'friend' | ka.nca-ku | 'my friend' |
| bɔsɔ | 'language' | basa-mu | 'your language' |
| wɔcɔ | 'to read' | maca-ʔake | 'read for someone' |

It is a descriptive generalization of Javanese that rounding of penultimate syllable a only takes place when a word-final a has changed to ɔ by rule (4a). Thus, initial-syllable a remains in the words of (6).

| | | |
|---|---|---|
| (6) | batu | 'stone' |
| | aso | 'relaxed' |
| | awan | 'mid-day' |

In order to account for the rounding of the penultimate syllable a's in (5) Dudas was forced to postulate an additional rule of low-vowel harmony changing a to ɔ when the following syllable contained an ɔ. However, as she shows, the simple rule of (7) is not sufficient since no rounding takes place in the forms in (8).

(7) a ↛ ɔ / ___ $C_0$ ɔ

| | | |
|---|---|---|
| (8) | katɔŋ | 'to appear' |
| | takɔn | 'to ask' |
| | atɔs | 'heart' |

Instead the harmony rule must be revised to the statement in (9) shifting a to ɔ before a syllable containing a word-final ɔ.

(9) a → ɔ / ___ $C_0$ ɔ #

The explicit mention of the word boundary in (9) is Dudas' way of identifying underlying a's which have changed to ɔ by the original low-vowel rounding rule (4a), since it is only those ɔ's that trigger the harmony process. However, the formulation in (9) is suspicious since the rule essentially repeats both the structural change [+round, -low] and the structural description a# of the



original word-final rounding rule (4a). Furthermore, even the formulation in (9) is not sufficient. The imperative suffix of Javanese is an underlying /a/ which shifts to ɔ by rule (4a). However, the word-final ɔ of the imperative does not trigger rounding in a preceding a, as shown by the data in (10).

| | | | | | |
|---|---|---|---|---|---|
| (10) dolan | 'to play' | ndolan-ɔ | (</ŋ-dolan-a/) | 'play!' |
| maŋan | 'to eat' | maŋan-ɔ | (</ŋ-maŋan-a/) | 'eat!' |
| sinaw | 'to study' | sinaw-ɔ | (</ŋ-sinaw-a/) | 'study!' |

In order to be consistent with data like that in (10) Dudas had to place an additional restriction on the harmony rule (9) requiring that the triggering word-final ɔ and the a undergoing the rule belong to the same morpheme.

From the perspective of current phonological theory this tautomorphemic condition on the harmony rule is a clue that another analysis is possible. Suppose we postulate that vowels and consonants are represented on separate tiers in Javanese. Then the OCP will force a multiply-linked representation for the roots with two a vowels, yielding the representations in (11).

```
      e a     a      a u    a ɔ     a       a  a
      | |    / \     | |    | |    / \     / \  |
(11)  CVCV  CVCCV   CVCV   CVCVC  CVCVC   CVCVC+V
     (mejɔ) (kɔncɔ) (batu) (katɔŋ) (maŋan) (maŋan-ɔ)
```

The original rule rounding word-final a (4a) will now not only apply to /meja/ but will also simultaneously round both a vowels in /kanca/ since the vowel of the first syllable and the vowel of the second syllable are literally the same vowel. Final rounding will fail to affect /batu/ and /katɔŋ/ since a is not the final vowel of these representations. In order to prevent the rule from affecting the final vowel of /maŋan/ it may be necessary to reformulate the rule as in (12) to look at the skeletal tier in order to identify the word-final segment.[3]

```
(12)  a → ɔ/ ___
              |
              V #
```

Finally, if the morpheme defines the scope of the OCP then the a of the imperative suffix and the root a of /maŋan+a/ will not be identified and hence final rounding will only apply to the suffixal vowel.

It should be clear that this analysis is a considerable improvement over Dudas' original one since the complicated harmony rule can be dispensed with entirely if the simple assumption is made that vowels are projected on a separate tier governed by the OCP. However, in the present framework where the principles and parameters of the system bear the major explanatory burden the decision to represent vowels on a separate tier has consequences that extend beyond just the data at hand to the entire grammar. If identical vowels in two adjacent syllables of the root are identified as one by the OCP then any phonological change in the root vowel of one syllable will necessarily be registered in the other syllable. Such across-the-board (ATB) changes are displayed by two additional processes in Javanese.

Mid-vowel laxing

The first of these additional ATB changes involves the mid vowels. Javanese has a general rule laxing mid vowels in closed syllables. We state this rule as (13).

```
(13)    [e,o] -> [ɛ,ɔ] / ___
                          |
                          V C]
                             syllable
```

This rule explains why the vowels in the final syllables of the words in (14a) are lax while those in (14b) are tense.

| | | | | | | |
|---|---|---|---|---|---|---|
| (14) | a. | ijɛn | 'alone' | b. | suwe | 'long time' |
| | | katɔn | 'to appear' | | cuwo | 'bowl' |
| | | aŋɛl | 'difficult' | | o.mbe | 'to drink' |
| | | | | | bodo | 'stupid' |

If both vowels of the stem are /o/ or both are /e/, however, then laxing of the final syllable vowel requires a corresponding laxing of the first syllable, even though it is open.

| | | | | |
|---|---|---|---|---|
| (15) | gɔdɔg | 'to boil' | lɛrɛn | 'to rest' |
| | ɔmɔŋ | 'to talk' | sɛlɛh | 'to lie down' |
| | bɔbɔt | 'weight' | lɛpɛn | 'river' |
| | kɔdɔ? | 'frog' | ɛlɛ? | 'ugly' |

But, crucially, laxing in the first syllable does not take place in roots where the first syllable is /e/ and the second /o/ or vice versa. Only the final-syllable vowel laxes in these cases.

| | | | | |
|---|---|---|---|---|
| (16) | je.ŋgɔt | 'beard' | doŋɛŋ | 'story' |
| | ketɔ? | 'to appear as a spirit' | olɛh | 'to get' |

Once again Dudas' framework required the postulation of additional rules--specifically the mid-vowel harmony rules of (17) laxing a mid vowel when the following syllable contains an otherwise identical mid vowel.[4]



(17) e -> ɛ / ___ C ɛ    o -> ɔ / ___ C ɔ

These rules are totally superfluous given our earlier decision to represent vowels on a separate tier in Javanese. This decision yields the representations in (18) for words such as <u>doŋɛŋ</u> and <u>lɛrɛn</u>. Given the multiply-linked representation of (18b) laxing of the final-syllable /e/ entails laxing in the initial syllable since /e/ is the vowel of both syllables.[5]

```
(18)        o e                 e
            | |                / \
      a.   CVCVC        b.   CVCVC

          (doŋɛŋ)           (lɛrɛn)
```

Habitual-Repetitives

The final example of an across-the-board effect that I have been able to detect in Javanese is a bit more complex than the first two we have discussed. It involves some vowel changes taking place in reduplicated structures Dudas refers to as Habitual-Repetitives. These structures have the meaning "to keep on Verbing" when the base is a verb and "to keep on saying X" when the base is a nominal. Limiting ourselves to disyllabic bases, the principle vowel change displayed in these structures is that illustrated in (19) where the rightmost vowel is replaced by an <u>a</u> in the first half of the reduplicated structure.

| | | | |
|---|---|---|---|
| (19) | eliŋ | elaŋeliŋ | 'remember' |
| | tuku | tukatuku | 'buy' |

Let us assume that the grammar stipulates a prefixal reduplicative template whose final syllable nucleus is prespecified as <u>a</u>, preventing the association of any other vowel to this position, as sketched in (20).

```
(20)    eliŋ   eliŋ
        \ \ \  ||||
        CVCVC+ VCVC
           |
           a
```

As we shall see momentarily, it will be crucial that the prespecified <u>a</u> of the reduplicative prefix be on a separate tier from the copied root material.

Additional vowel changes come into play when the vowel of the base is itself an <u>a</u>. When the first vowel of the base is an <u>a</u>, it is replaced by an <u>ɔ</u> in the first half of the reduplicative structure as shown in (21a); and when the final vowel of the base is an <u>a</u>

it is replaced by an e in the second half, as shown in (21b).

| | | | | |
|---|---|---|---|---|
| (21) | a. | lali | lolalali | 'forget' |
| | | adus | odasadus | 'bathe' |
| | b. | udan | udanudɛn | 'rain' |
| | | kumat | kumatkumɛt | 'have a relapse' |

If the final a of the root is replaced by e in the second half of a reduplicative structure and if CaCaC roots are represented with a single a spread over both syllables, then both syllables should change to e in the Habitual-Repetitive. This prediction is confirmed by the forms in (22).6

| | | | |
|---|---|---|---|
| (22) | salah | solahsɛlɛh | 'make a mistake' |
| | jaran | joranjɛrɛn | 'horse' |

We assume that the second half of these forms is derived as in (23).

```
(23)     a          e          ɛ
        /\         /\         /\
       CVCVC --> CVCVC --> CVCVC
```

In the first step /a/ is raised and fronted to /e/ followed by mid-vowel laxing.

So far we have seen across-the-board effects arising from the OCP collapsing together identical vowels at the underlying representation. There are certain cases where multiple linking must be established after the application of a rule. An example is provided by the a to e change found in the Habitual-Repetitive structures. When final-syllable a changes to e it will lax in a closed syllable. In underlying CeCaC roots we find that the initial syllable /e/ laxes to ɛ. The form for 'play' shows that the lax ɛ derived from /a/ does not induce laxing of a preceding /o/. Only a preceding /e/ laxes.

| | | | |
|---|---|---|---|
| (24) | edan | edanɛdɛn | 'crazy' |
| | rewaŋ | rewaŋrɛwɛŋ | 'servant' |
| | dolan | dolandolɛn | 'play |

Since we have no rule of harmony it will be necessary to assume that the two like root vowels that arise from the a to e change will be amalgamated by the OCP into a multiply-linked structure that can then undergo the laxing rule. We thus assume the derivation sketched in (25).

```
(25)   e a        e e         e          ɛ
       | |        | |        /\         /\
      CVCVC --> CVCVC --> CVCVC --> CVCVC
```



Given that the OCP may govern the output of the rule changing a → e in the second reduplicate it is now important for us to be able to say why the a introduced in the second syllable of the first reduplicate does not amalgamate with a preceding a to produce the incorrect *lololali instead of lolalali (26a). (Simply ordering the o → a change before the V → a one will not work, for it runs afoul of adɔh 'far' which has the habitual-repetitive form odahadɔh (26b).)

```
(26) a.   a i      a a       a         o
          | |      | |      /\        /\
          CVCV --> CVCV --> CVCV --> CVCV

     b.   a o      o o       o         a
          | |      | |      /\        /\
         CVCVC --> CVCVC --> CVCVC --> CVCVC

     c.   a i      o i
          |        |
          CVCV --> CVCV
            |        |
            a        a
```

This problem is avoided if V → a is not analyzed as a feature change of the root vowel but instead as prespecification of the second syllable of the first reduplicate as a (26c). The prespecified a will be on a tier separate from the root vowel and thus will not be amalgamated with it by the OCP. Consequently, the a → o change will not affect the prespecified vowel. The prespecification analysis will also explain why the CaCaC bases of (22) do not become CoCoC in the first reduplicate.

In the remainder of this paper we will examine a couple of problems with the proposal that vowels in Javanese are represented on a separate tier governed by the OCP. At this point it is unclear how serious these problems are; various solutions can be proposed but a proper assessment of their viability depends on a greater understanding of Javanese phonology than I possess at the moment. They are mentioned here in the hope that further study of Javanese will clarify their ultimate bearing (either positive or negative) on the major thesis of this paper--that the OCP enforces a multiple linking for adjacent identical vowels. One problem concerns cases where we do not observe ATB effects where we might otherwise expect them. The other problem is the inverse: a case where ATB effects appear to obtain in a situation where we do not expect them.

Problem I -- The High Vowels

The first case concerns the high vowels of Javanese, which systematically fail to display ATB effects. As shown in (27), high vowels are also laxed in closed syllables in Javanese. The underlying tenseness shows up in the stem-final vowels before the imperative suffix (27a) and the so-called locative (27b) since these vowel-initial suffixes open the stem-final syllable.

| | | | | |
|---|---|---|---|---|
| (27) | a. | tulis | 'to write' | nulis-ɔ |
| | | wəruh | 'to know' | wəruh-ɔ |
| | | jupu? | 'to go get' | jupu?-ɔ |
| | b. | etuŋ | 'to count' | ŋetuŋ-i |
| | | bəci? | 'good' | mbəci?-i |
| | | pilih | 'to choose' | milih-i |

Note that in jupu? and pilih we have stems with identical vowels in adjacent syllables of the underlying representation of the root. But laxing of the second vowel induces no corresponding change on the first vowel. Given the framework developed in this paper the data in (27) imply that /CuCuC/ and/CiCiC/ stems do not have multiply linked representations, at least at the point where the laxing of high vowels takes place. There are two ways in which current theory might explain the lack of multiple-linking for the high vowels. One involves an appeal to Archangeli's (1984) theory of underspecification and the other to McCarthy's (1985) notion of tier conflation. Let us examine each of these in turn.

The appeal to underspecification is prompted by C. Kisseberth's observation (personal communication) that in some Southern Bantu languages a string of high-toned syllables in the stem display ATB effects (all change to low by Meeussen's Rule) while a string of low-toned syllables behave as if they were singly linked. This contrasting behavior could be explained if we postulate that low is the default tone for Bantu while high tone is the specified one. The OCP will then enforce a multiple linking for high toned syllables in the underlying representation but will fail to do so for low-toned ones since they lack a specification (plus or minus) for the feature tone. Adapting this idea to the analysis of Javanese, we might posit the underspecified system of (28) for the vowels.

| (28) | i | u | e | o | ə | a |
|---|---|---|---|---|---|---|
| high | | | - | - | - | |
| low | | | | | | + |
| back | - | | - | | | |
| round | | + | | + | | |

In this system plus would be the default value for the feature high.



Consequently at the underlying level of representation the low and mid vowels will have a specification for a height feature (either [+low] or [-high]) while the high vowels will have no specification for a height feature at this point in the grammar. The OCP will thus enforce a multiple linking for roots with low or mid vowels but will fail to do so for roots with high vowels since they have no specified information on the height tier.

```
         [+low]        [-high]     [  ][  ]
          /|             /|           \  |
(29)    CVCCV          CVCVC         CVCVC
       (kɔncɔ)        (lɛrɛn)       (pilih)
```

If we assume that the OCP has turned off by the time that the default features are filled in then no multiple linking will be produced for the high vowels.

In order for this explanation to go through, however, we need to be able to say why identical underlying specifications for the features of round or back in CuCuC and CiCiC roots do not induce a multiple linking for the high-vowel laxing rule. Presumably relevant to this point is the fact that the distribution of the feature tense (or equivalently ATR) is often sensitive to height features but not to the features back and round so that tense-lax vowels typically come in front-back pairs (i-u, ɨ-u, etc.). Perhaps [tense] is "bonded" to the height features and thus orthogonal to the features back and round so that even if the latter are multiply linked this will have no effect on the distribution of [tense].[7]

The logic of the appeal to underspecification is thus that at the point where the OCP is defined --the underlying level-- the high vowels are not specified for height and hence escape multiple linking. When specifications for height are supplied to the high vowels by the default rule the domain of the OCP has been passed and so no ATB effects are observed in the high-vowel laxing process. The validity of this explanation thus depends on the assumptions that the OCP does not in general hold for default features (for which there is a bit of independent evidence from tone) and that plus is the default value for high in Javanese (for which we unfortunately have no independent evidence at this time).

The alternative explanation appealing to tier conflation postulates that CiCiC and CuCuC roots are multiply linked at the underlying level of representation just like the roots with identical mid and low vowels. However, at a certain point in the derivation the consonant and vowel tiers are folded together to yield a singly linked representation for identical vowels separated by a consonant.

```
         i
        /|
(30)    CVCVC   ->   CVCVC
        | | |        |||||
        p i h        pilih
```

If high-vowel laxing is applied after the conflation operation while mid-vowel laxing (and the other rules with ATB effects) is applied before this operation then the contrasting behavior of the high and nonhigh vowels is explained. There is some suggestive evidence that the laxing of high vowels and mid vowels take place at different points in the grammar anyway independent of the question of multiple linking. Recall from (27) that high vowels in the final syllable of a stem such as tulis and etuŋ are tense in the phonetically open syllable formed by the addition of vowel-initial suffixes: nu.li.sɔ ŋe.tu.ŋi. Mid vowels, on the other hand, are lax in this environment even though they appear in a phonetically open syllable.

| | | | | |
|---|---|---|---|---|
| (31) | aŋɛl | 'difficult' | ŋaŋɛl-i | 'make difficult' |
| | anɔm | 'young' | ŋanɔm-i | 'act younger than one is' |

This contrast suggests that mid-vowel laxing is defined on the stem before the addition of the imperative and locative affixes while high-vowel laxing takes place in a shallower level of the grammar after suffixation and resyllabification take place. The operation of tier conflation could then be situated between these two points.[8]

There is another situation in Javanese where high vowels systematically fail to display ATB effects. This arises in the causative and locative forms of the verb marked, respectively, by the suffixes -ʔake (with the allomorph -ake after a consonant) and -ni (with the allomorph -i after a consonant). Before these suffixes mid vowels lax even though in an apparent open syllable (32a). As expected, the mid vowels exhibit ATB effects (32b). Surprisingly, high vowels lower to mid before these same two suffixes (32c).

| | | | | | |
|---|---|---|---|---|---|
| (32) | a. | jəro | 'deep' | njərɔ-ʔake | 'make deep' |
| | | | | njərɔ-ni | 'make deeper' |
| | | gawe | 'make' | ŋgawɛ-ʔake | 'make for him' |
| | b. | bodo | 'stupid' | mbɔdɔ-ʔake | |
| | | dede | 'sun oneself' | ndɛdɛ-ʔake | |
| | | le.nde | 'to learn' | lɛ.ndɛ-ni | |
| | c. | mlaku | 'to walk' | ŋlakɔ-ʔake | |
| | | pati | 'dead' | matɛ-ʔake | |
| | | bali | 'return' | mbalɛ-ni | |
| | | ləbu | 'enter' | ŋələbɔ-ni | |



On the assumption that the occurrence of two phonological changes of laxing and lowering in the same arbitrary morphological context is not accidental we might try construing the relationship between them as follows. Suppose the grammar stipulates a rule laxing vowels before these two suffixes.

(33) V -> [-tense] / ___ ʔake, ni

If, as we argued earlier, [+high] is assigned by default and if the assignment of the tense feature depends on having a specification for vowel height then the high vowels will have to lower to mid in order to be able to accept the [-tense] specification assigned by the morpholexical rule (33). In effect, this amounts to postulating a "redundancy" rule [-tense] -> [-high] in the deepest level of the grammar where (33) presumably applies. Recall that on the underspecification approach to the problem of high vowels, stems with two identical high vowels are not multiply linked since they contain no specification for the height features. Consequently we predict that when the redundancy rule assigns [-high] in these contexts no ATB effect should be detected. This is a correct prediction. In stems with two identical high vowels only the one immediately preceding the causative and locative suffixes lowers (and laxes).

| | | | |
|---|---|---|---|
| (34) | risi | 'uncomfortable' | risɛ-ʔake |
| | tuku | 'buy' | nukɔ-ʔake |

Under the tier conflation approach to the problem of high vowels it will be necessary to split apart the laxing and lowering processes. The laxing of mid vowels in the causative and locative would have to precede conflation while the laxing and lowering of high vowels would have to follow conflation. Since this analysis is more complex we conclude that the causative and locative provide a small amount of support for the underspecification approach.

Problem II - The Imperative

Recall that the imperative suffix /-a/ turns to ɔ word finally by (4a) but induces no change on a root vowel a: underlying /maŋan+a/ is realized as maŋan-ɔ. We explained this by limiting the scope of the OCP to the morpheme so that no amalgamation of a root vowel with a suffixal vowel will take place since they belong to different morphemes. McCarthy (1985) has suggested that the limitation of the OCP's scope to the morpheme may not have to be stipulated if one makes the further assumption that each morpheme constitutes a separate autosegmental tier. On this assumption the a's of the root and the suffix in /maŋan+a/ will not violate the OCP since they occupy separate tiers.

```
          a
         /|
(35)   CVCVC V
             |
             a

       (maŋan-ɔ)
```

The statement that the rounding of the imperative suffix has no effect on a root vowel is not completely accurate, however. An identical rounding does take place when the root itself ends in a.

(36) tәkɔ 'to come' nәkɔ-ɔ 'come!'
bisɔ 'can' bisɔ-ɔ 'if one could'

(Cf. taka-ku 'my arrival', bisa-ni 'can be done'

Evidently the OCP extends beyond the morpheme to collapse together two adjacent identical elements, as in (37).

```
        ә a a        ә  a        ә  ɔ
        | | |        | /|        | /|
(37)    CVCV+V  ->  CVCVV   ->  CVCVV
                                (tәkɔ-ɔ)
```

The amalgamation of suffixal and root a in /tәka+a/ and the blockage of amalgamation in /maŋan+a/ can be achieved in two ways. First, we might simply stipulate that extension of the OCP across morpheme boundaries requires strict adjacency on both the segmental and the skeletal tiers. Amalgamation will then be blocked in /maŋan+a/ because of the intervening C-slot on the skeletal tier. Alternatively, we might try to derive this contrast by adopting McCarthy's (1985) idea that each morpheme is a separate tier and that when conflation folds together morpheme tiers to bring together the suffixal and stem vowels of /tәka+a/ it also folds the consonant and vowel tiers together.

```
(38)      ә a
          t|k|          tәkaa      tәk a      tәk ɔ
          |||           |||||      |||/|      |||/|
   a.     CVCV V   ->   CVCVV  ->  CVCVV  ->  CVCVV
               |
               a

            a
           / \
          m|ŋ|n         maŋana     maŋanɔ
          |||||         ||||||     ||||||
   b.     CVCVC V  ->   CVCVCV ->  CVCVCV
                |
                a
```



In the first step of (38) the consonant and vowel tiers (or planes) as well as the morpheme tiers are folded together to yield adjacent a's on the segmental tier in (38a) but not in (38b). The OCP will thus amalgamate the adjacent identical vowels in (38a) but will not affect representation (38b) since there is no OCP violation. The rule rounding word-final a will then apply to the vowel of both the final and the penultimate syllable in (38a) but to just the final syllable in (38b). The success of the second analysis thus depends on combining together conflation of the morphemes with conflation of the consonant and vowel tiers. It makes the interesting prediction that in a CaCa stem the stem-final vowel should amalgamate with the suffixal vowel but the stem-initial vowel should be split off by the intervening consonant (39a). We thus predict macɔ-ɔ for the imperative of 'read'. But in fact rounding appears on all three vowels of the word. The correct form is mɔcɔ-ɔ.

```
(39)        a
           / \
          m|c|        macaa      mac a      mac ɔ
          ||||        |||||      |||/|      |||/|
   a.     CVCV V  ->  CVCVV  ->  CVCVV  ->  CVCVV
               |
               a
```

b. mɔcɔ 'to read' mɔcɔ-ɔ 'read!' (cf. maca-ni loc.

Thus, evidently the multiple linking of the root vowel in CaCa stems is still preserved at the point where the stem-final vowel amalgamates with the imperative suffix to produce a triply-linked a.

```
(40)      a a          a          ɔ
         /| |        //|        //|
         CVCV+V  ->  CVCVV  ->  CVCVV
```

## Conclusion

To briefly conclude, in this paper we have examined three phonological rules in Javanese which evidence across-the-board effects on the low and mid vowels. We have argued that these effects can be explained if it is assumed that vowels are projected on a separate tier governed by the OCP, which will enforce a multiply-linked representation for adjacent identical vowels. We also observed that the high vowels systematically fail to display ATB effects and quite tentatively suggested an explanation invoking underspecification theory.

An obviously important question to ask is why Javanese projects its consonants and vowels on separate tiers. It is after all not like Semitic where root consonants carry the basic lexical meaning of a word while the vowels (as well as the CV pattern of a root)implement various tense-aspect markings or are otherwise stipulated by the word-formation rules of the language.

Furthermore, Javanese is unlike English (and perhaps most other languages), which does not in any obvious way display ATB effects. (For example, application of the vowel shift rule in <u>divine</u> and <u>serene</u> has no effect on the first syllable.) We must thus suppose that the decision to separate the consonants and vowels of a root morpheme is a parameter that can be set for individual grammars. In Semitic the positive setting for this parameter is more obvious since it is thoroughly integrated with the morphology of the language. In Javanese it is manifested primarily in the ways in which the phonological rules operate. There are, however, some additional features of Javanese noted by Uhlenbeck (1950) which independently suggest that consonants and vowels are on separate tiers.[9] In a systematic survey of Javanese roots Uhlenbeck uncovered some remarkable patterns in the distribution of both consonants and vowels. For example, of the 6,354 roots of the shape CVCVC (which, as in Arabic, is the most frequent canonical pattern) he found that 2,248 or over one-third have identical vowels. Given that there are six vowel phonemes we expect $CV_iCV_iC$ roots to constitute just one-sixth of the total population. Furthermore, study of Uhlenbeck's data reveals that in a frequency ranking of the 6 x 6 = 36 possible combinations, $CV_iCV_iC$ roots occupy the first five positions and six of the first eight. Thus, the tendency to maintain like vowels in the root that we saw operating in the phonology also manifests itself in the frequency distribution of the underlying patterns themselves. Perhaps more significantly, there are patterns in the distribution of the consonants that are strongly reminiscent of the generalizations established by Greenberg (1960) for Semitic. In particular, there is a remarkable tendency for the first two consonants of a root to be either identical or to be drawn from different points of articulation. For example, examine the following table exerpted from Uhlenbeck's more complete table in his (1950) study.

(41)

| $C_1$ | $C_2$ | | |
|---|---|---|---|
| p | p 41 | b 1 | m 9 |
| t | t 46 | d 3 | n 19 |
| k | k 46 | g 7 | ŋ 8 |
| b | b 45 | p 6 | m 0 |
| d | d 17 | t 1 | n 7 |
| g | g 43 | k 1 | ŋ 0 |

When the first consonant of a root is <u>p</u> there are 41 roots in which the second consonant is also <u>p</u> but only 1 where the second consonant is a <u>b</u> and 9 where it is <u>m</u>. And when the first consonant is <u>b</u> there are 45 roots that have <u>b</u> as the second consonant but only 6 with <u>p</u> as the second consonant and none with <u>m</u>. There is thus a strong tendency to avoid successive consonants drawn from the same point



of articulation unless they are identical. This is precisely the kind of result reported by Greenberg (1960) to hold for the root in Semitic. As John McCarthy (1985a) has recently observed for Semitic, Greenberg's generalizations can be subsumed under the OCP if we assume that consonants are partitioned into dimensions that correspond to natural phonetic segmentations. In particular, if there is a separate point of articulation tier, the OCP will prohibit successive occurrences of the same point of articulation and require a multiple-linking. In order for this result to hold for the Javanese data of (41) we would have to assume that the features of voice and nasality link to the skeletal tier through the point of articulation tier. In this way successive <u>p</u>'s can be derived but p-b and p-m, etc. blocked.[10]

| | | |
|---|---|---|
| | [-voiced, -nasal] | nasal & voice tier |
| (42) | [+labial] | point of artic. tier |
| | C C | skeletal tier |

Although the patterns uncovered by Uhlenbeck have to be more systematically studied, the approach we have suggested here certainly seems promising. The avoidance of successive consonants drawn from the same point of articulation is of course a common phonotactic constraint. For example, <u>tl</u>, <u>dl</u>, <u>pw</u>, <u>bw</u> are barred from the permissible English initial clusters even though they exhibit a rising sonority profile. The remarkable thing about Javanese is that a similar constraint appears to hold for root morphemes even though the constituent consonants are separable by a vowel. But if, as we have argued for independent reasons, consonants and vowels are represented on separate tiers then the Javanese data of (41) can be subsumed under the same generalization. We thus conclude that the division of consonants and vowels into separate morphemes in Semitic is a further development made possible by the original decision to project consonants and vowels on separate tiers rather than a necessary condition for such a projection. In a similar fashion Semitic has adapted the skeletal tier itself to specialized morphological purposes. But clearly the distinction between the segmental and skeletal tiers does not depend on this special adaptation.

We started this paper by observing how enriched representations permit the phonological rule component to be simplified and expressed the concern that this move has not simply shifted complexity and arbitrariness from the rule system to the representational system. Perhaps this point was wrongly put. There will of course always be indeterminacy since any proposal to extend the model engenders a new set of questions. The important point is to continue the attempt to develop principles that can explain why phonological systems exhibit the properties they do. For example, in her careful analysis of Javanese phonology Dudas was perfectly aware of the ATB effects we have discussed. She remarks

> One could posit for the grammar of Javanese some principle which says that, any time a grammatical process, morphological or phonological, alters a relevant segment of a stem-final syllable, an identical segment in the preceding syllable will undergo the same change. (Dudas 1975:107)

However, such a principle is ad hoc in the theoretical framework of Dudas' description where the phonological component of the grammar is essentially just a list of ordered rules. I hope to have shown in this paper that these across-the-board effects follow in a natural way from the representational system we have devised. It is in this sense that we can modestly but justifiably assert that real progress has been made in the study of phonology during the past ten years.

## FOOTNOTES

*My primary source of data for this study has been Dudas (1975). I have also relied on material from Horne (1961, 1964), Sumukti (1971), and Uhlenbeck (1950). I wish to express my thanks to Mr. Bambang Srigandono for verifying some of the data for me.

[1]The OCP does not apply to elements of the skeletal tier since we conceive of them as being empty slots devoid of phonological content (despite the anachronistic CV labeling).

[2]In general in the native vocabulary syllables preceding the penult have nuclei drawn from the central set [a,ə] (Dudas 1975: 60, 103). Thus, /danawa/ 'giant' is realized as danɔwɔ. Also the peripheral vowels are barred from a closed penultimate syllable. We shall assume that these constraints override or cancel the effects of the a → ɔ change and explain why the rounding in atmɔ 'soul' (cf. atma-ne 'this soul') is not extended to the initial syllable.

[3]The statement in (12) is a violation of the inalterability condition of Hayes (1984) and Steriade & Schein (1984) since only one branch of a multiply-linked representation VCV # satisfies the

a

structural description of the rule. Other cases in which the structural change implemented on one branch of a multiply-linked representation are carried over to the other branch have been reported in the literature (cf. for example, Archangeli's (1985) analysis of vowel lowering in the Gashowu dialect of Yokuts; but see Steriade 1986 for an alternative interpretation of the data).



[4]I have been unable to locate any affixes with an ɛ or ɔ in a closed syllable in order to determine if a tautomorphemic condition would also be needed for the rules of (17). In any case in all known applications of these rules the trigger and the focus of the rule belong to the same root morpheme.

[5]If our analysis is correct then the mid-vowel laxing process with its reference to a closed syllable is a serious violation of the inalterability condition of Hayes (1984) and Steriade & Schein (1984). It is possible that "true" geminates and "long-distance" geminates respect partially different principles.

[6]Dudas also cites jaranjɛren and joranjaran as possible and slightly preferred realizations of a CaCaC base. Evidently there is some hesitation in combining both the a → o and the a → e vowel changes. Crucially, none of the sources I have consulted cite CaCaCCaCeC or CoCoCCaCaC. That is, the a → e change, if it occurs, must affect both vowels of a CaCaC base and only the first vowel of such a base may be affected by the a → o change.

[7]Thus the vowels might have the three-dimensional representation below where the specification for tense intersects the skeletal tier only through the height feature and the features for back and round are on a separate dimension.

```
        V
        |‾‾‾‾‾‾‾‾‾‾
    [ high]      [ back, round]
        |
    [tense]
```

If segments are partitioned in this fashion then it is possible that the OCP is defined on just certain dimensions, in which case like specifications for the features back and round in CiCiC or CuCuC roots may not matter.

[8]This difference between mid and high-vowel laxing is of course also compatible with the first analysis relying on underspecification theory.

[9]Thanks to John McCarthy for this reference.

[10]The data in (41) indicate that the OCP extends across all of the oral points of articulation and consequently suggest that none of these features are assigned by default rules the way in which tone and possibly vowel height is. Another important question is whether multiply-linked consonants display ATB effects. The rule replacing voiceless initial consonants by the corresponding nasal in verbs appears not to: tutup, nutup 'close'; tɔtɔl, nɔtɔl 'bulge'.

It is unclear whether this alternation is the result of a feature changing rule or a contraction process. Also possibly of relevance is a left-right asymmetry. The three rules producing ATB effects in Javanese all involve a change on the root-final syllable while in the case of the nasal replacement it is a left-hand element that is changing. It is conceivable that the notion of "head" must be invoked in the construction of multiply-linked structures. Perhaps ATB effects only show up when the head position is changed.

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