# Reduplication in Javanese

Paul Hirschbühler

# Reduplication in Javanese

Paul Hirschbühler

0. This essay is a contribution to the study of the interaction of reduplication with the application of phonological rules, with special attention to reduplication in Javanese. Two theories of reduplication are currently defended by different linguists. I will refer to them as the ordering theory (e.g. Schachter and Fromkin (1968), Carrier (1975), Aronoff (1976)) and the twin theory (Wilbur (1973) and Dudas (1975)). As we will see, the ordering theory is the more restricted one, and its predictions are also more in line with what we know about reduplication at this point. It is thus explanatorily a more adequate theory than the twin theory. Javanese displays an interesting type of reduplication, reduplication with vowel change, whose account in the framework of the ordering theory leads to an ordering problem. It is thus crucial for this theory that we be able to find an analysis in this framework that solves the problem in a satisfactory way, or that we propose an alternative theory that retains the advantages of the ordering theory and allows us to account for the Javanese case. We discuss both possibilities.

In the first section, I present the kind of facts that have led to the adoption of competing theories to account for the interaction of reduplication with the application of phonological rules. Section two discusses those theories and a more restrictive and traditional variant of the twin theory. I propose that the twin theory be definitely abandoned. Section three introduces most of the rules that we will need later on, and describes their effect in the case of full reduplication. Section four discusses reduplication with vowel change and examines which analyses can account for it.

## 1. Reduplication and phonological rules.

1.0. The question of the interaction between reduplication and phonological

rules has become a topic of controversy because of the existence of two kinds of facts, displaying respectively, according to Wilbur (1973) <u>over-application</u> or <u>failure of application</u> of phonological rules. The following examples, the first from Javanese, the second and third from Madurese and Akan respectively, illustrate each situation.

1.1 Overapplication of rules.

There exists in Javanese a rule by which a lax stop becomes tense in several environments, for example when followed by the suffix <u>-ake</u>; we thus find pairs of the following type:

(1)a /godog/ boil /godog + i/ [gɔdɔgi]
/godog + ake/ [gɔdɔkake]

Reduplication copies the stem, and the final consonant is the same in each stemlet:

(2)a gɔdɔg-gɔdɔge
b gɔdɔk-gɔdɔkake

i.e., the final consonant in the first stemlet behaves as if it were immediately followed by the suffix.

1.2 Failure of application.

Our two examples come from Wilbur (1973) and illustrate two typical situations.

1.2.1 Madurese.

There exists in Madurese an internal sandhi rule of nasal assimilation which assimilates a nasal consonant to the point of articulation of the following consonant (Stevens, 1968, p. 38). In reduplicated forms, the rule fails to apply (Stevens, id., p. 71).[1]

(3)a kunkun 'order' (p. 50)
b baŋbaŋ 'wing' (p. 71)

1.2.2 Akan.

Back consonants, like <u>k</u>, are palatalized in syllable initial position before non-low front vowels:

(4) kyɛ 'divide' /kɛ/ [tɕ̟ɛ]

There also exists a monosyllable reduplication rule which copies $C_1$ (and possibly $C_2$) plus $V_1$, which is made [+high].

(5) sa [sa?] 'cure' sesa [sIsa?]

In reduplicated forms, palatalization occurs only if the unreduplicated form has a vowel which triggers palatalization:

(6)a ky$\varepsilon$ /k$\varepsilon$/ [t$\varsigma\varepsilon$] 'divide' kyeky$\varepsilon$ [t$\varsigma$It$\varsigma\varepsilon$(?)]
b ka /ka/ [ka?] 'bite' keka [kIka?]

In (6)b, palatalization has failed to apply.

2. Theories in competition.

2.1 The twin theory.

Reduplication being a morphological process, Wilbur (1973) and Dudas (1975) adopt the position that it must precede the application of phonological rules. According to Wilbur, facts like those described in section 1 must then be explained under the assumption that there exists an identity constraint - not an absolute constraint, but a tendency - which would be part of the grammar of some languages, and which would not necessarily constrain all the phonological rules of those languages (Wilbur, p. 58). The relevant rules, when applied in reduplicated forms, apply to pairs or twin segments, i.e. to the original segment and to its copy, even when only one of those segments is in the appropriate environment; others apply to paired segments only if both of them are in the appropriate environment; if only one of them is in this environment, the rule doesn't apply. Each mode of application is encoded in the formulation of the rules themselves; paired segments are mentioned in the structural description of the rules. Some mechanism is moreover necessary to identify paired segments. Rules for overapplication and failure can be written in the following manner (my (7)a is a variant of Wilbur's formulation: for details, see Wilbur (1973, p. 72-74)).

(7)a Overapplication

X (and X') $\longrightarrow$ Y if X / A ___ B

(7)b Failure of application

X (and X') $\longrightarrow$ Y if X (and X') / A __ B

Since the relevant rules mention paired or twin segments, I refer to this theory as the twin theory.

2.2 The transparency theory.

One way to describe the observations made in 1, if one adopts the theory that reduplication must occur before the application of phonological rules, is to say that reduplicated strings are "transparent" with respect to each other. This idea can easily be incorporated in the standard formalism in the case of overapplication. Assuming that R represents a reduplicated string and that R can be identified, overapplication may be incorporated in a rule of the following type:

(8) $A \longrightarrow B \; / \; \_\_\_\_ \; R_0 \; C$

Here C, the environment of the rule, is on the right of the reduplicated strings. A reduplicated form will be analyzed once by the long and once by the short expansion of the relevant rules. If the segments are identified as satisfying the environment of the rule, they will be changed simultaneously (Chomsky and Halle, 1968, p. 343-344). To be able to account for failure of application we need only one additional convention on how to apply such rules. They apply to a reduplicated form only if both their short and their long expansion are met. If only one of the expansions is met, the rule doesn't apply. We will call this the double expansion convention. As we will see, the transparency theory as described here makes some interesting predictions.

2.3 The ordering theory.

Once one relaxes the requirement that all morphological processes necessarily take place before all phonological processes, reduplication may be ordered before, among, or after phonological rules. Such a possibility gives the means to account for most of the facts found in reduplicated forms. A phonological rule applying before reduplication and affecting a segment in the to-be-reduplicated string will have its effects copied by reduplication, but such a rule won't affect any segment in those cases where the environment for its application is created by reduplication. Aronoff (1976, p. 75) adopts the position that reduplication rules may occur after all cyclic phonological rules but before word-level rules and never among phonological rules. Carrier (1975, p. 13-14), however, has shown that some facts from Tagalog can be explained only if, in those cases, reduplication is preceded by some and followed by other phonological rules. As we will see, the same situation exists in Javanese.

2.4 Adequacy of the competing theories.

2.4.1. Predictions.

2.4.1.1 A look at the predictions made by the twin theory and the ordering theory shows that the ordering theory is a much more restrictive theory and that, moreover, its predictions agree better with the facts as we know them. The transparency theory as described in 2.2 has some of the interesting features of the ordering theory and some of the drawbacks of the twin theory. We will present in section 4 a version of the transparency theory that will no longer have the negative features of the twin theory.

2.4.1.2 The ordering theory divides rules into two groups, with one of them perhaps empty: the rules which precede and those rules which follow reduplication. The apparently special behavior of some rules in reduplicated forms is a function of their ordering with respect to reduplication. The rules which precede reduplication can either appear to overapply or fail to apply according to whether their structural description is met before or after reduplication is done. It is thus expected that a single rule will display apparently contradictory behavior in case the appropriate kinds

of input strings exist. On the contrary, the twin theory has no means to predict which rules will display overapplication or failure behavior. This case can be illustrated by the Akan example seen in 1.2.2: Palatalization applies normally in reduplicated forms when the environment of the rule is met twice, and fails to apply when the environment is created by the reduplication process. Only the ordering theory captures what is relevant in those examples, i.e. the rule applies when the environment is met before reduplication. Notice that the twin theory, but not the transparency theory, could as easily describe a situation where palatalization in forms like [sIsa?] would overapply rather than fail to apply. Such types of overapplication don't seem to exist, as predicted by the ordering theory (see Aronoff, 1976, p. 77-78).

2.4.1.3. Ordering and marking are different in another respect, too. In an ordering system, given three ordered rules A, B, and C, we don't expect to find the following apparent behavior in reduplicated strings: A overapplies or fails to apply, B applies in a single fashion, and C overapplies or fails to apply, when the target of each rule is in the (to-be) reduplicated string and the determinant of each rule lies outside the (to-be) reduplicated string. More generally, when we have an ordered set of rules, the ordering theory predicts that we will never find a rule which apparently applies in a twin fashion and has to be ordered after a rule which applies in a single fashion, when there are input strings where this rule could overapply, if it was ordered differently with respect to reduplication. Nothing in the twin theory and in the transparency theory as described in 2.2 rules out the existence of such situations.

2.4.1.4. Finally, with all its power, there is one case of interaction between reduplication and the application of phonological rules in Tagalog that the twin theory cannot account for, i.e. the interaction between Vowel Syncope and Duplication 2 in Tagalog (Carrier, 1975, p. 13-14): Duplication 2 normally copies the first two syllables of a stem (most stems are bisyllabic). Vowel Syncope is formalized by Carrier as in (9):

$$(9)\quad [+\,\text{syl}] \longrightarrow \emptyset \;/\; \underset{[-\text{long}]}{\_\_\_\_}\; C + VC$$

When a stem is reduced to one syllable by rule (9), the suffix is copied by Duplication 2. Ordering Vowel Syncope before Duplication 2, together with the correct formulation of this last rule (see Carrier, p. 21) gives the desired form:

(10)

| | /sunud+in/ | /sunud+in/ | |
|---|---|---|---|
| V-Syn | sun d+in | not applied | |
| $Dup_2$ | [sundinsundin] | [sunudsunudin] | 'follow on top of one another' |

The transparency theory as described in 2.2.1. is also unable to account for such cases.[3]

## 3. A Sketch of Javanese phonology and full reduplication.[4]

Most of the phonological rules of Javanese are relevant for the study of full reduplication and full reduplication with vowel change, and will briefly be described here. The formulation of the rules is essentially similar to what is found in Dudas (1975) and Hirschbühler (1976), and I refer the reader to those works for details and discussion. Full reduplication in Javanese copies verbal and nominal stems, which can be identified with the root except in so-called causative and locative forms when the root is vowel final. The consonant ʔ in the so-called causative forms and the consonant n in the so-called locative forms are added to the vowel final root, with concomitant lowering of this vowel to mid low to form an appropriate stem before the suffix is added [5]. Other aspects of reduplication will be mentioned where necessary. This section will be divided in two. We will first give the rules affecting the shape of the stem, and then rules affecting both the shape of suffixes and the stem will be examined. For each rule reduplicated forms will be given showing the change resulting from application of the rule. The rules are given in the order in which they apply (see Dudas (1975) and Hirschbühler (1976) for arguments).

### 3.1. Stem alternations.

(11) a/ɔ final[6]

a ⟶ ɔ / ___#

| | | | | |
|---|---|---|---|---|
| /basa/ | bɔsɔ | 'language' | bɔsa-bɔsɔ | 'languages' |
| /basa+mu/ | basamu | 'your language' | basa-basamu | 'your languages' |

but

| | | | | |
|---|---|---|---|---|
| /manaŋ/ | 'to eat | /manaŋ+a/ | manaŋɔ | 'why don't you eat?' |

(Sumukti, p. 81)

(12) a/ɔ local

a ⟶ ɔ / _____ +ɔ

/adja+a/ [ɔdjɔɔ] if it were not so (Horne, 1974, XXV)

but

/salah+a/ [salaɔ] to make a mistake (Dudas, communication)

(13) a/ɔ harmony[7]

a ⟶ ɔ / ___ $C_0$ɔ]$_{stem}$

See examples in (11) and (12)

(14) Mid vowel laxing

$$V \longrightarrow [-\text{tense}] \;/\; \underline{\quad} \; C]_{stem}$$
$$[-hi]$$

/kodoʔ/ 'frog' kɔdɔ kɔdɔʔ-kɔdɔʔ
/kodoʔ+e/ 'his frog' kɔdɔʔe kɔdɔʔ-kɔdɔʔe

(15) Mid harmony[8]

$$\begin{bmatrix} V \\ -hi \\ -low \\ \alpha back \end{bmatrix} \rightarrow [-tense] \;/\; \_\_\_\_\; C_o^i \begin{bmatrix} V \\ -hi \\ -low \\ \alpha back \end{bmatrix} C]_{stem}$$

/conto/ 'example' cɔntɔni 'to set an example' (Sumukti, p. 101)
/rene/ 'come here' rɛnɛʔake 'bring it here' (idem)

See also the example for the preceding rule.

(16) Tense dissimilation

$$\begin{matrix} V \\ [-hi] \end{matrix} \longrightarrow [-tense] \;/\; \_\_\_\_\; C_o^i \begin{matrix} V \\ [+hi] \end{matrix} ]_{stem}$$

/kopi/ kɔpi vs. kɔpine 'his coffee'
/meri/ mɛri 'envious' 'envy' mɛrine 'his envy'

but:

/di+kondur+i/ dikonduri 'bring him home' (Horne, 1961, p. 469)

(17) Close laxing

$$\begin{matrix} V \\ [+hi] \end{matrix} \quad [-tense] \;/\; \_\_\_\_\; C. \quad \text{(We use the dot for syllable break)}$$

/murid/ murɨt 'a student' murɨt-murɨt 'students'
/murid+e/ muride 'the student' murid-muride 'the students'
/murid+ku/ murɨtku 'my student' murɨt-murɨtku 'my students'

In fact, the specification [+hi] can be left out, since the mid vowels in the same environment have already been turned into lax vowels by rule (14).

(18) Mid before schwa laxing

$$\begin{bmatrix} V \\ -hi \\ -low \end{bmatrix} \longrightarrow [-tense] \;/\; \_\_\_\_\; C_o^i \; C]_{stem}$$

/bosɔn/ bɔsɔn 'bored'
/esəm/ ɛsəm 'a smile'

but

/gawe+nən/ gawenən make[it] (Horne, 1961, p. 343)

(19) H-deletion

$H \longrightarrow \emptyset \ / \ V \_\_ V$

| | | | |
|---|---|---|---|
| /bədah/ | 'broken' | bədah-bədah<br>bəda-bədae | (Dudas, p. 208) |
| /dajoh/ | 'guest' | dajɔh-dajɔh<br>dajɔ-dajɔe | (Dudas, p. 209) |
| /salah/ | 'mistaken' | salaɔ | (Dudas, communication) |
| /sareh/ | 'patient' | sarɛɔ 'be patient' | (Sumukti, p. 92) |
| /kokoh/ | 'rice mixed into soup' | kɔkɔ(w)e 'the rice...' | (Dudas, p. 113) |

As can be seen from these examples, H-deletion must occur after the rules that affect vowels, and especially a/ɔ Local, Mid Vowel Laxing, Mid Harmony. I haven't found relevant examples to determine its ordering with respect to Tense Dissimilation and Mid before schwa Laxing. I will assume the same general ordering. The following example can also be accounted for by ordering a/ɔ Harmony before H-deletion.

(20) /adoh/ 'far' saqadɔ-adɔe (Sumukti, p. 22)

One may have the impression that the a of the stem is not turned into ɔ simply because the following ɔ is not word final, but the following example shows that this will not work. It motivated the introduction of the stem boundary in rule (13).

(21) /adja+a/ ɔdjɔɔ 'if it were not so' (Horne, 1974, p. XXV)

(22) Consonant Tensing

$$C \longrightarrow [+\text{tense}] \ / \ \_\_\_\_ \ \left\{ \begin{array}{l} C \\ \# \\ \text{-ipun} \\ \text{-ake} \end{array} \right\}$$

For examples, see rule (17).

(23) Degemination

$$C_i \ C_i \longrightarrow 1 \ \emptyset$$
$$1 \quad 2$$

This rule applies across all boundaries (see Uhlenbeck, 1949, p. 227).

| | | |
|---|---|---|
| /siŋ ŋaran/ | siŋaran | 'the one who writes' (Horne, 1961, p. 89) |
| /ayam+mu/ | ayamu | (Uhlenbeck, 1949, p. 226) |
| /raum+mu/ | raumu | (Dudas, personal communication) |
| /ŋgoren-ŋgoren/ | ŋgorɛŋ-gorɛŋ | (Uhlenbeck, 1954, p. 374, fn. 7) |

The third example shows that Close Laxing applies before Degemination. The last example shows that Degemination is ordered after reduplication.

Discussions and details about ordering can be found in Dudas (1975) and Hirschbuhler (1976). Here it will be enough to say that all vowel rules must be ordered after H-deletion. The examples also show that all phonological rules except Degemination must be ordered before reduplication. Degemination is not a word-level rule and follows the application of such rules. It is thus not surprising that is follows reduplication.

3.2 Vowel contraction.

I will examine vowel contraction between an affix and the stem only with respect to the suffixes -an and -ṇ. The same argument could be based on the prefixes kə- and maybe ka- too, but the facts there are unclear to me. For more details, see Hirschbuhler (1976) and Uhlenbeck (1955).

The suffix -an is used to make nouns, verbs, and adjectives. The suffix -ən, occuring with the prefix kə-, is used with adjectives and makes derived forms meaning too Adjective; we will refer to it as the excessive degree marker.

Consider the following pairs, from Sumukti, p. 97-98:

| | | | | | |
|---|---|---|---|---|---|
| (24)a | bali | 'to return' | balɛn | 'returned object' |
| b | tibɔ | 'to fall' | kətiban | 'hit by falling object' |
| c | səru | 'loud' | kəsərɔn | 'too loud' |
| d | gəde | 'big' | gədɛn | 'on a large scale' |
| e | jəro | 'deep' | kəjərɔn | 'too deep' |

From such examples, one may posit a rule like (25):

(25) Vowel Contraction[9]

$$V + \underset{[-\text{tense}]}{V} \longrightarrow \underset{[-\text{high}]}{V} \quad \emptyset\ \emptyset$$

Ordering this rule before Mid Laxing or Close Laxing would account for why the resulting vowel is lax, [the [-tense] specification could then be omitted], assuming a restructuration rule reanalyzing the consonant of the suffix as part of the stem. This could be supported by the fact that in reduplicated forms, the nasal consonant of the suffix appears on each stemlet.

(26) uni 'sound' unɛn-unɛn 'noise, saying' (Sumukti, p. 98)

Reduplication could then be formulated as in (27):

(27) $X\ [_{\text{stem}}\ Z\ ]\ W \longrightarrow 1\ 2 + 2\ 3$
$\quad\quad 1 \quad\quad 2 \quad 3$

How the interaction between vowel contraction and reduplication can be accounted for in the

twin theory or the transparency theory is unclear to me. Reduplication would have to reduplicate the suffix in addition to the stem only when vowel contraction is going to apply later on, i.e. we would need a derivational constraint.

This ends our discussion of full reduplication in Javanese. For a discussion of the behavior of the nasal prefix in Javanese, especially in reduplicated forms, I refer the reader to Dudas (1975) and Hirschbuhler (1976). We now have all the elements necessary for a discussion of reduplication with vowel change.

4. Reduplication with vowel change.

4.0 Reduplication vs. Reduplication with vowel change.

In Uhlenbeck (1954, p. 572), the semantic correlate of the opposition between reduplication/absence of reduplication for verbs is described as: "possessing iterative, c.q. intensive, c.q. conative value/neutral as regards this value". The semantic correlate of the vowel change in reduplicated forms is that it "charges the sentence with affective overtones like astonishment, disgust, irritation, on the part of the speaker." It seems natural then to assume that reduplication with vowel change results from two separate processes, i.e. we should account for the reduplication by the rule of full-reduplication discussed in the preceding section, and have independent rules for the vowel changes. If this view is correct, reduplication in those forms with reduplication with vowel change should occur at the same point as reduplication in forms without vowel change, i.e. after the application of most phonological rules.

4.1 The facts.

4.1.0 Each description I know of has some variants that aren't found in any of the others. The problem we will be confronted with exists however for each description. We will base our discussion on Dudas's description because it is the more complete: she not only discusses unaffixed forms like all the others, but she also systematically discusses affixed forms.

Reduplication with vowel change may in the first stage be described by the following three statements, adapted from Dudas (p. 243):

> Vowel Change I: the last vowel of the first member of the doubled form is replaced by a (if it was an a it stays a).
>
> Vowel Change II: if the penultimate vowel of the first member of the doubled form is a, replace it by o.
>
> Vowel Change III: if the last vowel (or the last two vowels) of the second member of the doubled form is/are a, replace it (them) by /e/.

4.1.1 We will first consider cases where the last vowel of the to-be reduplicated form is different from a. Since the number of vowel combinations is large, we will limit ourselves to a few interesting examples. For more data, see Dudas, chapter VII, and Uhlenbeck (1949, p. 221). The examples are taken from Dudas, p. 231.

| | | | | |
|---|---|---|---|---|
| (28)a | /adus/ | adus | 'take a bath' | odas-adus |
| b | /bali/ | bali | 'return' | bola-bali |
| c | /dede/ | dede | 'sun oneself' | deda-dede |
| d | /ilo?/ | ilɔ? | 'suitable' | ila?-ilɔ? |

The vowel inserted in the last syllable of the first stemlet is a, whether the stem ends in a consonant or in a vowel. This suggests that the insertion of a follows the application of the a/ɔ Final rule, if doubled forms which are quadrisyllabic undergo phonological rules in the way genuine quadrisyllabic words do. According to Uhlenbeck (1949, p. 39), and this is confirmed by the data found in Horne's dictionary (1974), four syllable words behave as two independent bisyllabic words, undergoing phonological rules separately. Most of the examples are borrowings from Sanskrit:

| | | | | |
|---|---|---|---|---|
| (29) | a. | dwipan/tərɔ | (Skt) | 'Indonesian archipelago' |
| | b. | djalan/tərɔ | (Skt) | 'aqueduc' |
| | c. | dewɔ/daru | (Skt) | 'a certain mythological tree with magical properties' Notice the variant dewan/daru |
| | d. | rədjɔ/kɔyɔ | | 'livestock' (Sumukti, p. 101) |
| | e. | rədjɔ/kayane | | 'his livestock' (idem) |

The ordering suggested is evidently what is expected from what we have seen in the previous section, where a/ɔ Final was ordered before reduplication. We will see additional evidence that a/ɔ final occurs before Vowel Change.

4.1.2 Consider now the following examples:

| | | | | | |
|---|---|---|---|---|---|
| (30)a | /ngoda/ | ngodɔ | 'tease' | ngoda-ngodɔ | (Sumukti, p. 105) |
| b | /amba/ | ɔmbɔ | 'large' | omba-ɔmbɔ | (Dudas, p. 256) |
| c | /keri/ | kɛri | 'is left' | kera-kɛri | (Sumukti, p. 105) |
| d | /tjlorot/ | tjlɔrət | 'to dart' | tjlorat-tjlɔrət | (Sumukti, p. 105) |
| e | /bosən/ | bɔsən | 'tired of' | bosan-bɔsən | (Dudas, p. 231) |

Examples (30)a and b show that the last vowel of each stemlet at the moment Vowel Change occurred must have been ɔ and not a if the formulation of Vowel Change I and III are correct. This simply confirms that a/ɔ Final precedes Vowel Change.

Examples (30)b-e exemplify one of the problems that reduplication with vowel change create for the ordering hypothesis. From the ordering of phonological rules given in section 3.1., we would expect the first vowel of the first stemlet of those examples to be lax, i.e., we would expect:

(30)b' ɔmba-ɔmbɔ
c' kɛra-kɛri
d' tjlɔrat-tjlɔrɔt
e' bɔsan-bɔsan

Instead, we get a tense vowel, which is identical to the underlying vowel, except in (30)b, where it seems that Vowel Change II has occurred, as if a/ɔ Harmony hadn't applied before Vowel Change II. That is, it seems that a/ɔ Harmony, Tense Dissimilation, Mid Harmony, and Mid before schwa Laxing haven't applied. This would contradict the ordering we arrived at in section 3.1., where they applied before reduplication, i.e., before the vowel changes. We will discuss possible solutions later on.

4.1.3. Let us now examine cases involving Vowel Change III.

| | | | | |
|---|---|---|---|---|
| (31)a | edan | 'crazy' | edan-ɛdɛn | (Dudas, p. 234) |
| b | udan | 'vain' | udan-udɛn | (idem) |
| c | tjobɔ | 'try' | tjoba-tjobɔ | (Dudas, p. 257) |
| c' | njoba?ake | so called causative form of tjobɔ. | njoba?-njobɛ?ake | |
| d | rewaŋ | 'servant' | rewaŋ-rɛwɛŋ | |

Examples (31)a-b-c' could be accounted for if Vowel Change III replaced a by /e/, and if Mid Vowel Laxing turned this /e/ into [ɛ]. Example (31)d could be accounted for in the same way with additional application of Mid Vowel Harmony. We would thus apply after Vowel Change III two phonological rules which in section 3.1. we claimed applied before reduplication. We thus have the same problem as we saw in 4.1.2.

Let us now take a few cases with two a's. Several forms exist and they are given according to their relative frequency (see Dudas, p. 237), the first one being the most frequent.

| | | | | |
|---|---|---|---|---|
| (32)a | salah | 'mistaken' | solah-salah | (VC II) |
| b | | | salah-sɛlɛh | (VC III) |
| c | | | solah-sɛlɛh | (VC II + VC III) |
| (33)a | njalahake | | njolah-njalahake | (VC II) |
| b | | | njalah-njɛlɛhake | (VC III) |
| (34)a | ŋrasa?ake | causative of 'taste' | rosa?-ŋrasa?ake | (VC II) |
| b | | | rasa?-ŋrɛsɛ?ake | (VC III) |

There are three variants when there is no suffix, and only two when there is one. We won't discuss this; for some observations, see Dudas, p. 260. Since it is impossible to tell whether VC I has applied in the above examples, we will concentrate only on VC II and VC III. In examples with two a's, VC II is the most frequent change, followed by VC III, and finally a combination of both. As in the cases where there was only one a, it seems that VC III is followed by application of Mid Laxing and Mid Harmony, if the vowels inserted by the vowel change rule are /e/'s.

Let us summarize the situation.

1) We have seen in section 3.1. that all the phonological rules discussed there, except Degemination, had to apply before reduplication.

2) Reduplication with vowel change seems to require application of a/ɔ Final before Vowel Change III, but application of a/ɔ Harmony, Tense Dissimilation, Mid before schwa Laxing, Mid Vowel Laxing, and Mid Vowel Harmony after the Vowel Change rules.

Let us finally examine cases involving H-deletion.

| | | | | |
|---|---|---|---|---|
| (35)a | -wɛnɛh | 'give' | mona-mɛnɛi | (Horne, 1961, p. 314) |
| b | | | diwonah-wɛnɛhake | |
| (36) | adɔh | 'far' | ŋoda-ŋadɔi | (Dudas, p. 263, fn.3) |

As can be seen, H is deleted from both members, which means that in the ordering theory, H-deletion must have occurred before reduplication. Consequently, all the rules mentioned in point 2) above must have applied before reduplication too, since we have seen in 3.1 that they applied before H-deletion. If this is so we generate ungrammatical forms as in (30)b'-e', and when Vowel Change III has applied, as in (31) and (32), we end up with inserted [e] instead of [ɛ]. We will try to solve those difficulties in the rest of this paper.

4.2 The analyses.

4.2.1 The twin theory.

The facts described in 4.1. can be accounted for without problem in the twin theory, except that it will still be necessary for a/ɔ Final to apply before Vowel Change I and III to account for examples like (30)a and (31)c, i.e. it would still be necessary to have one phonological rule apply before a morphological rule, if we decide to keep the formulation of Vowel Change I and III given above. It would also be necessary to eliminate the rules affecting penultimate vowels of stems from the set of twin rules. In the case of reduplication without vowel change, the penultimate vowel of each stemlet can be changed independently in an identical manner without any need of a twin rule. We have however seen enough reasons to reject the twin theory in section 3, and I won't try to resurrect it for the case under discussion.

4.2.2 Inadequacy of a cyclic analysis.

The ordering problems encountered in section 4.1. is reminiscent of ordering problems that have led to cyclic analyses. Such a move would however be inappropriate here. First of all, we would have to accept that the phonological rule which reduplicates the stem creates cycles for the phonology to work on. Even if one decides to ignore the problems that this would create for the theory of the cycle, such a move wouldn't help at all,

since it will allow reapplication of two rules which clearly don't reapply, a/ɔ Final and Consonant Tensing. In this theory, one would eliminate the problem raised by expected but ungrammatical forms like (30)b'-e' by adding a rule making tense a non low vowel followed by $C_0^i$ a. But reapplication of a rule like Consonant Tensing (see above) would give forms like *gilik-gilige or *murit-muride instead of gilig-gilige and murid-muride (see Dudas, p. 207) because the last consonant of the first stemlet is followed by another consonant. Tensing could also occur if one considers that the stemlets are separated by a word boundary. At this point I haven't found any relevant example in the data given for reduplication with vowel change. Dudas's detailed description of reduplication with vowel change as well as her fn. 8 p. 264, where, when mentioning the locative suffix, which doesn't trigger Consonant Tensing, she doesn't mention any difference with respect to Consonant Tensing between reduplication and reduplication with vowel change, leaves no doubt that there is no difference with respect to this rule between the two kinds of reduplicated forms. Notice that if there was such a difference it would mean that the new cycles would be created by the Vowel Change rules rather than by reduplication. Also, the assumption that reduplication with vowel change or reduplication creates new cycles leads us to expect application of a/ɔ Final in the first stemlet of examples like (28)b-c and (30)a-c. I thus conclude that an analysis involving creation of new cycles is to be rejected.

4.2.3. A reformulation of the Vowel Change rules:

Let us keep the conclusion arrived at in section 3.1.: all phonological rules except Degemination apply before reduplication. We then have to find a solution to account for the fact that the first vowel of the first stemlet in examples like (30)a-e is tense and for the fact that the vowel which appears at the place of a as the result of Vowel Change III is [ɛ] and not [ɐ], as well as for the fact that when the inserted vowel is preceded by /e/, this /e/ appears as [ɛ], as if Mid Vowel Harmony had applied, as can be seen from example (31)b.

4.2.3.1. Let us take first the problem created by examples like (30)a-e. Two solutions come to mind, each one worthy of consideration.

4.2.3.1.1. First, as mentioned in 4.2.2., we may posit the existence of a tensing rule like (37), which would apply after the Vowel Change rules, or more precisely, after Vowel Change I:

$$(37)\quad V \longrightarrow [+\text{tense}] \;/\; \_\_\_\; C_0^i\ a\ ]_{stem}$$

This would simply make tense again those vowels made lax by the application of other phonological rules. It would also account for the [o] in the first stemlet of examples like (30) by tensing an [ɔ] derived from /a/ by application of a/ɔ Harmony before reduplication. Notice that this rule would not apply between a root and the suffix -an in examples like (38):

| | | | | | |
|---|---|---|---|---|---|
| (38)a | gɔsɔʔ | 'to rub' | gɔsɔʔan | 'the rubbing' | (Sumukti, p. 55) |
| b | gandɛn | 'to link' | gandɛnan | 'link with each other' | (Sumukti, p. 65) |

This is not a real problem since other rules too, like a/ɔ Harmony, Tense Dissimilation, and Mid before Schwa Laxing don't apply either from suffix to stem. This is why "Stem" is part of the structural description of rules (13), (14), (15), (16) and (37).

| | | | | | |
|---|---|---|---|---|---|
| (39)a | maŋan | 'to eat' | maŋanɔ | 'why don't you eat?' |
| b | adaŋ | 'to steam' | adaŋɔ | 'why don't you steam [rice]?' (Sumukti, p. 81) |
| (40) | bodjo | 'spouse' | bodjoku | 'my spouse' (Sumukti, p. 52) |
| (41)a | gawe | 'make' | gawenən | 'make [it]!' (Horne, 1961, p. 34) |
| b | ombe | 'to drink' | ombenən | 'drink it!' (Sumukti, p. 81) |

4.2.3.1.2. A different analysis is however possible, and it would be based on the assumption that Vowel Change always involves the insertion of a pair of vowels, not a single vowel. In the first stemlet, a pair of vowels is substituted for another set of pairs: o...a replaces the pairs defined by a... [-Low], i.e., 9 pairs. o...a also replaces a...a when Vowel Change III is not applied (and does it optionally if Vowel Change III is applied). In the other cases, where it is not obvious at all that a pair of vowels is inserted, the first vowel of the pair would be the tense variant of the penultimate vowel present in the first stemlet just before the Vowel Change rule applies and the second would be a. In cases like those in (30), the first vowel of the inserted pair would replace a lax vowel, while in cases like (28)c-d, it would be identical to the original vowel. Except for the cases where o...a is inserted, this is just a variant of the preceding analysis.

Vowel change in the first stemlet can then be written as follows:

(42) Stemlet 1 rule (optional)

$$C_o \begin{bmatrix} +syll \\ \langle +low \rangle_a \end{bmatrix} \quad C_o[+syll] \quad C_o \longrightarrow 1 \quad \begin{bmatrix} 2 \\ +tns \\ \langle -low \rangle \\ \langle +bk \rangle_b \end{bmatrix} \quad 3 \quad a \quad 5$$

1 2 3 4 5

Condition: If a, then b

A slight support for the pair insertion hypothesis can be found in the variety of vowel change described by Horne (1961, p. 314):

> "A complex doubling involves vowel changes in the first member, as follows:
>
> (1) The last vowel changes to a;
> (2) The next-to-the-last vowel changes to o, except that i, ə, and u in this position remain unchanged."

That is, [-high] vowels except [ə] are replaced by [o].

In Uhlenbeck (1949, p. 223) too there are additional cases where it is clear that a pair of vowels is inserted: when the stem has a pair of identical vowels, normally the second one in the first stemlet is replaced by [a], but there are also a few cases where a variant exists, with insertion of two as in the first stemlet:

(43)a latja-lutju vs lutja-lutju
b tjlala-tjlili vs tjlila-tjlili
c ayan-ɔyɔn vs oyan-ɔyɔn

Obviously, the facts described by Horne and Uhlenbeck don't show that the pair insertion hypothesis is what is needed for the data described by Dudas, but it gives some support to the idea.

4.2.3.2. Let us now examine the case of the second stemlet. There are three cases: a...a is replaced by ɛ...ɛ, e...a by ɛ...ɛ too, while $V_i$...a with $V_i$ different from a or e is replaced by $V_i$...ɛ, so that only the last vowel seems to have been changed. Since Mid Vowel Laxing and Mid Vowel Harmony apply before reduplication, they are no longer available to account for why the vowels which are different from the original ones are lax. If we want to maintain the ordering of phonological rules we arrived at, we thus have to claim that what is inserted in the second stemlet are ɛ's and not e's, i.e., we have to claim that synchronically it is an accident that Mid Vowel Laxing and Mid Vowel Harmony seem to have applied, though it may reflect an earlier stage of the language where those rules were involved in the derivation of such forms. There is some marginal data in Uhlenbeck (1949, p. 223) which is compatible with the idea that phonological rules were ordered after reduplication and vowel change at an earlier stage of the language. That is, besides the regular reduplicated forms with vowel change given first, one finds a few cases where [e]'s are introduced in the second stemlet:

(44)a ɔpɔ 'something' opa-apa vs ɔpɔ-epe
b dɔwɔ 'long' dowa-dɔwɔ vs dɔwɔ-dewe

For the meaning differences, see Uhlenbeck (1949, p. 223). Those examples can be accounted for by the following ordering:

(45) /# apa #/

1. Reduplication # apa # apa #
2. VC III # apa # epe #
3. a/ɔ Final # apɔ # epe #
4. a/ɔ Harmony # ɔpɔ # epe #

Given that very few forms of that type exist, we may consider them as lexicalized forms. The fact that such formations are no longer productive makes totally unnecessary a formulation of VC III making reference to e's rather than ɛ's. The vowel change affecting stems can be written as follows.

(46) Stemlet 2 rule (optional)

$$\left\langle C_0 \begin{bmatrix} +syll \\ -hi \\ -bk \end{bmatrix}_a \right\rangle \quad C_0 \begin{bmatrix} +syll \\ +low \end{bmatrix} \quad C_0 \left\langle 1 \rightarrow \begin{bmatrix} 2 \\ -tns \\ -low \\ +front \end{bmatrix}_b \right\rangle 3 \quad \begin{matrix} 4 \\ [-tns \\ -low] \end{matrix} \quad 5$$

1 2 3 4 5

Condition: If a, then b

If stemlet 1 rule applies and performs some change, then stemlet 2 rule doesn't apply in causative and locative forms (see ex. 33-34).

4.2.3.3. Let us summarize and give a conclusion to what we have seen in the last two sections. It is possible to account for the data of reduplication with vowel change and maintain that reduplication and vowel change occur after the application of most phonological rules in two ways (at least) as far as the first stemlet is concerned: have VC I and II as formulated on page , plus a late phonological rule like (37), or reformulate the vowel change rules so that it is always a pair of vowels which is inserted. As far as the second stemlet is concerned, the ordering we arrived at in section 3.1. forces us to insert ɛ's rather than e's, i.e. a phonological solution is unavailable to account for why the inserted vowels are lax in the second stemlet, unless one wants to let the relevant rules reapply. To make the account of the first and the second stemlet uniform, I suggest that we adopt the analysis by which vowel change generally inserts a pair of vowels. In such an analysis, the vowel change is a very surfacy phenomenon without much interest, but in the absence of a better theory than the ordering theory, I feel the analysis is reasonable. In the following section we will examine a version of the transparency theory that allows a more elegant account of the data, at the cost of the introduction of a new way to do reduplication.

4.2.4. The transparency theory and Vertical Reduplication

Let us assume, as suggested in section 2.2. that for some reason the reduplicated strings are transparent to each other, for the relevant rules. In this case it is possible to account for all the facts of reduplication with vowel change as described by Dudas by the following order of rules:

(47)
1. Fusion
2. Reduplication
3. a/ɔ Final transparent
4. Vowel Change (as formulated in 4.1.0)
5. Other transparent and non-transparent phonological rules.

The problem is to find a way to achieve transparency so that it will preserve the interesting features of the ordering theory presented in 2.4.1. One such way is to do linear reduplication in two stages: first, reduplicate vertically, and second, have a rule which linearizes the reduplicated strings. It is then possible to have some rules apply before reduplication, others between reduplication and linearization, and still other rules after linearization. For the data we have discussed, we need the following order of operations:

(48)
1. Fusion
2. Vertical Reduplication
3. a/ɔ Final

4. Vowel Changes (as formulated in 4.1.0)
5. Phonological rules which appear to overapply or fail to apply in full reduplication without vowel change.
6. Linearization
7. Degemination

Let us take now a few examples to show how this works. First of all, an example with Fusion and without Vowel Change.

(49) /#uni+an#

| | |
|---|---|
| Fusion | #unen# |
| Vert. Redup. | #{unen / unen}# |
| Mid Vowel Laxing | #{unɛn / unɛn}# |
| Linearization | # unɛn#unɛn# → [unɛnunɛn] |

I assume that for application of phonological rules, a schema like $X\left\{\begin{smallmatrix}A\\B\end{smallmatrix}\right\}Y$ must be interpreted as if we had X A Y and X B Y, rules applying independently to each substring.

Let us now examine some examples involving Vowel Change. I assume that the topmost of the vertically reduplicated strings is the one to which VC I and VC II apply, and that Linearization moves it in front of the other.

The two following examples show how we get cases like (30)a-e, with a tense vowel as the penultimate vowel of the first stemlet:

(50) /#keri#/

| | | |
|---|---|---|
| Vert. Redup. | #{keri / keri}# | |
| VC I | #{kera / keri}# | |
| Tense Dissimilation | #{kera / kɛri}# | (the environment is met only for the lower substring) |
| Linearization | #kera#kɛri# → [kera#kɛri] | |

(51) /#amba#/

| | | |
|---|---|---|
| Vert. Redup. | #{amba / amba}# | |
| a/ Final | #{ambɔ / ambɔ}# | (the environment is met in both substrings) |
| VC I+II | #{omba / ambɔ}# | |
| a/ Harmony | #{omba / ɔmbɔ}# | (the environment exists only in the lower substring) |
| Linearization | #omba#ɔmbɔ# → [ombaɔmbɔ] | |

The next example involves H-deletion:

(52) /#ŋ+adoh+i#/

| | | |
|---|---|---|
| Vert Redup. | #ŋ+{adoh / adoh}+i# | |
| VC I+II | #ŋ+{odah / adoh}+i# | |
| Mid Vowel Laxing | #ŋ+{odah / adɔh}+i# | (the environment is met in the second substring only) |
| H-Deletion | #ŋ+{oda / adɔ}+i# | (the environment is met in both substrings) |
| Linearization | #ŋoda#adɔ+i# → [ŋodaadɔi] [10] | |

Finally an example involving Vowel Change III:

(53) /#rewaŋ#/

| | | |
|---|---|---|
| Vert. Redup. | #{rewaŋ / rewaŋ}# | |
| VC III | #{rewaŋ / rewɛŋ}# | |
| Mid Vowel Laxing | #{rewaŋ / rewɛŋ}# | (The environment is met only in the lower substring) |
| Mid Vowel Harmony | #{rewaŋ / rɛwɛŋ}# | |

Linearization #rewaŋ#rəwɛŋ#

[rewaŋrəwɛŋ]

As we have seen, splitting reduplication between two different processes allows us to keep the formulation of the vowel change rules as given in 4.1.0., which is the first one which comes to mind given the facts, and eliminates all the difficulties we struggled with earlier. Moreover, this system retains all the positive aspects that the ordering theory had: the rules which apply before reduplication, or after reduplication but before Linearization are those which will appear to overapply (when no vowel change rule is applied) or fail to. The rules which are ordered after linearization apply in the usual manner. The theory which allows such results should be given some consideration. The problem at this point is whether there are other kinds of facts besides those of the type examined here for which Vertical Reduplication allows us to capture something which the other theories can't. At this moment I haven't been able to imagine what such other types of facts could be. Another question is whether it is possible to find another way to achieve transparency, i.e., another formalism that would give us all the good predictions made by the ordering theory and the Vertical Reduplication theory. I don't have an answer to this question either.

## 5. Conclusion.

Reduplication with vowel change in Javanese, although extremely simple to describe in words, presents some problems for what has been shown in this paper and in other works, like Carrier's and Aronoff's, to be the more adequate theory of the interaction between reduplication and the application of phonological rules, i.e. the ordering theory. An account in this framework seems to require a modification of the vowel change rules generally proposed by linguists who have worked on Javanese previously, rules which would incorporate facts that one may wish to account for in the phonology. There is however a formulation of the transparency theory, the vertical reduplication theory, which can be considered as a more powerful version of the ordering theory, which allows us to account without any difficulty for the facts of Javanese. Before a decision in favor of this more powerful theory should be made, it would be necessary to find other types of evidence that such an additional power is useful. If it is not, I suggest that we should adopt an analysis within the framework of the ordering theory, possibly the one I have developed in 4.2.3.1.2 and 4.2.3.1.3.

## Notes

[1] In fact, there is plenty of evidence that synchronically, those forms are not reduplicated forms, e.g., they can themselves be reduplicated (Stevens, 1968, p. 71). The same point can be made with total reduplication, however (Stevens, p. 34-5, 38, and fn. 5, p. 96). Stevens proposes an analysis which makes use of boundaries to block assimilation. Whatever the correct analysis, the examples discussed may at least be taken as illustrative of a potential case.

[2]Notice that while in the ordering theory overapplication necessarily follows from appropriate ordering, it is not the case that failure necessarily results from ordering. The presence of boundaries may prevent the application of some rules, as Stevens assumes for homorganic nasal assimilation and consonant gemination in Madurese. There are also cases of failure, as in the Luiseño examples discussed by Wilbur (1973, p. 18-24) and Aronoff (1976, p. 76-77) for which neither ordering nor the use of boundaries is useful. For a discussion, see the references given above.

[3]Wilbur overlooked an additional case described by Stevens (1968, p. 38) which provides more evidence in favor of the ordering theory: the interaction between End Reduplication and Vowel Nasalization in Madurese. Vowel Nasalization (p. 29, rule P8) occurs before End Reduplication, in order to account for cases like the following one:

| | | | | |
|---|---|---|---|---|
| (i) | R+main-an | → R+mãẽnãn | → ẽn+mãẽnãn | 'toys' (p. 34) |
| (ii) | R+niat | → jãt+nẽjãt | | 'intentions' (p. 36) |
| (iii) | i+R+tañ-i | → èR+tàñãẽ | eñãtàñãẽ | 'keep on being asked' (p. 34) |

The boundary '+' blocks the application of nasalization. This predicts that if we have an example like (iii) but with the stem beginning with a vowel, this vowel will not be nasalized. I haven't found in Stevens' book any example which would allow us to check this prediction, but if it is confirmed, the ordering 1)Vowel Nasalization 2)End Reduplication will give us those facts without any need for the boundary solution. This would then be an additional case where a rule apparently both overapplies and fails to apply, something unexpected in the twin theory.

[4]The surface vowel system of Javanese is as in (i) and may be derived from (ii) by several rules, most of which are discussed in section 3.

(i)

| | | +Front | -Front -Back | +Back |
|---|---|---|---|---|
| +High | +Tns | i | | u |
| | -Tns | ɨ | | ʉ |
| -High -Low | +Tns | e | | o |
| | -Tns | ɛ | ə | ɔ |
| +Low | -Tns | | a | |

(ii)

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

The surface consonant system is as follows, according to Sumukti (1971, p. 26)

| | | Labial | Dental | Alveolar | Palatal | Velar | Glotal |
|---|---|---|---|---|---|---|---|
| stops | Tense | p | t | ṭ | tj | k | ʔ |
| | Lax | b | d | ḍ | dj | g | |
| Fricative | Tns | | | s | | | h |
| Nasals | | m | n | | n | ŋ | |
| Liquids and glides | | w | l,r | | y | | |

Only the native and productive phones are given.

[5]We thus find alternations of the following type:

(i) tuku 'to buy' [tuku+n] ⟶ tukɔni 'to buy from someone'
(ii) djəro 'deep' n+[djəro+ʔ]+ake→ndjərɔʔake 'to make deeper'

The reason for saying that n and ? in "locative" and "causative" forms have a status different from the n that precedes some of the other suffixes when added to vowel final roots is that the first ones are copied by reduplication, while the second is not:

(iii) ndjərɔʔ-ndjərɔʔake
(iv) medja-medjane 'the tables'

For a discussion, see Dudas, chapter 4.

[6]Some data mentioned in Uhlenbeck (1949, p. 219) shows that a/ɔ Final and a/ɔ Harmony apply in the first stemlet of reduplicated forms with suffix in the less educated speech from Surakarta. So, the following variants are found:

sadɔwɔ-dawane vs sadawa-dawane

This would result from application of a/ɔ Final and a/ɔ Harmony after reduplication, in the way those rules apply in quadrisyllabic stems. See example (29)a, rɔdjɔkayane, section 4.1.1.

[7]$C_o^i$ is intended to represent the consonant clusters which don't block the rules affecting vowels, i.e. no consonant, any single consonant, consonant-liquid, nasal+homorganic consonant, nasal+homorganic consonant+liquid. In all types of cases except one, the preceding syllable is open. The exception is when a nasal is followed by a tense consonant. Then the nasal closes the syllable. So we get the following sorts of pairs, with the dot marking a syllable break:

tɔm.pɔ 'to get' vs tɔ.mbɔ 'medicine' (Sumukti, p. 12)

[8]The argument in favor of rules (14), (15), and (16) is mainly of a morpheme condition type, since there is generally no alternation in the presence of a suffix. Some additional support can however be found when one considers the locative and causative stems. When locative n or causative ʔ are added to vowel final roots, the final tense high and tense mid vowels are turned into the corresponding mid lax vowels. The laxing is expected if ʔ and n close the stems. Moreover, the lowering of the last vowel (or the fact that ʔ and n would close the stem) bleeds Tense Dissimilation:

klɛru vs. klerɔʔake (Dudas, p. 65-66)

Similarly, the laxing of the final vowel of the root feeds Mid Harmony:

| | | | | |
|---|---|---|---|---|
| conto | 'example' | cɔntɔni | 'to set an example' | (Sumukti, p. 101) |
| rene | 'come here' | rɛnɛʔake | 'to bring here' | (idem) |

[9]There is some limitation on fusion with -an, according to Uhlenbeck's description (1955). There is fusion only when the last vowel is a, i, u, but not when it is e, o. Even with high vowels there are cases where fusion doesn't occur (see his remarks p. 293). And when fusion doesn't occur the suffix is not copied:

/noko/ ----→ noko-nokowan (Uhlenbeck, 1949, p. 218)

w is inserted between a back vowel and a.

[10]The description of Vowel Change given by Horne is different from the others. For details, see Horne, 1961, p. 314.

References

Aronoff, M. 1976. Word formation in Generative Grammar. MIT Press.

Carrier, J. 1975. The interaction of Reduplication and Infixation with the Phonology in Tagalog. Unpublished paper. MIT.

Chomsky, N. and M. Halle. 1968. The Sound Pattern of English. New York: Harper & Row.

Dudas, K. 1976. The Phonology and Morphology of Modern Javanese. Ph.D. dissertation. University of Illinois.

Hirschbuhler, P. 1976. Javanese phonology and reduplication. A sketch. MS. University of Massachusetts.

Horne, E. C. 1961. Beginning Javanese. Yale University Press. New Haven.

Horne, E. C. 1976. Javanese-English Dictionary. New Haven: Yale University Press.

Schachter, P. and V. Fromkin. 1968. A Phonology of Akan, Akuapem, Asante, and Fante. Working Papers in Phonetics, 9. Los Angeles: University of California Press.

Stevens, A. M. Madurese Phonology and Morphology. American Oriental Series, vol. 52, American Oriental Society. New Haven, Connecticut.

Sumukti, R. H. 1971. Javanese Morphology and Morphophonemics. Ph.D, dissertation, Cornell University.

Uhlenbeck, E. M. 1949. De Structuur van het Javaanse Morpheem. Bandoen A. C. Nix.

_____. 1954. Verdubbelings procede's by het Javaanse Werkwoo Bijdragen tot de Taal-, Land-, en Volkenkunde, 110, p. 369-387.

_____. 1955. Over woordvorming in het Javaans, id., 111, p. 288-307.

Wilbur, R. 1973. The Phonology of Reduplication. Ph.D. dissertation, University of Illinois.