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Asymmetry and linearization in phonology[*]

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This paper investigates whether the *asymmetry hypothesis* proposed by Kayne (1994) is relevant to phonology. A broad interpretation of the asymmetry hypothesis is that *linear precedence* is derivable from and dependent on *asymmetrical* relations. Any connection between precedence in linear ordering and asymmetry in representations has important ramifications for phonological theory because the types of phonological representations that are considered is shaped by these constraints. Barring a brief discussion in Cinque (1996) there has been no investigation of what the asymmetry hypothesis can tell us about linear ordering in phonology or the nature of phonology in general. The main focus of this paper is to discus the relevance of the asymmetry hypothesis for the representation of linear order in phonology. Specifically, the issue of when *non-asymmetrical* precedence representations occur and how they are dealt with in the phonology in light of proposals made in Raimy (2000b) is investigated. Following from this discussion a comparison of how non-asymmetrical representations are handled in syntax and phonology is outlined. This path of investigation allows both similarities and differences between representations in syntax and phonology to be identified and this contributes to our better understanding of universal grammar.

1. Asymmetry in phonology

Traditional assumptions on the relationship of precedence in phonological representations indicate that it has the following characteristics.

Precedence is non-transitive. Precedence in phonological representations is neither necessarily *transitive* or *atransitive* because of the nature of adjacency in phonology. Long distance effects in phonology as evidenced by vowel harmony across consonants indicate that some processes require precedence to be *transitive*. This type of precedence requires that if A precedes B and B precedes C then A precedes C to be true. Processes that require strict adjacency between segments indicate that precedence in phonology may also be *atransitive* in that if A precedes B and B precedes C then A does not precede C must be true. Because precedence appears to be transitive in some cases and atransitive in others[1] it is properly characterized as *non-transitive* meaning that strict transitivity is not required.

Precedence is irreflexive in that if A precedes B then A is not B must be true. This characteristic is implicitly assumed since the idea of reflexivity of precedence has not been pursued in phonological representation. One possible interpretation of reflexivity of precedence in phonol-

[*] I would like to thank Milan Rezac, Cedric Boeckx and the participants of the Asymmetry Conference for discussing the ideas here with me. All mistakes, misstatements or misunderstandings are my responsibility alone.

[1] Whether a process requires a transitive interpretation of precedence or an atransitive interpretation appears to be specified as a parameter of a given process. See the discussion of this aspect of phonological processes in Odden (1994) for concrete examples of both long distance (i.e. transitive) and strictly local (i.e. atransitive) precedence requirements on phonological processes. If adjacency in phonology operates in a 'relativized' way along the lines suggested by Odden (1994), then precedence may be a purely *atransitive* relation and can be calculated on tiers of representation other than the timing (x-slot) tier which allows the presence of surface 'long distance' effects.

ogy is the representation of geminates as a single melody linked to two timing slots. In a sense, due to the multi-tiered representation of geminates a unit of melody does 'precede itself' when the timing tier is considered. This appearance of reflexiveness of precedence results from autosegmental units being allowed to be associated with more than a single unit on another tier. Within a single tier in an autosegmental representation, precedence can only be irreflexive.

Precedence is asymmetrical meaning that if A precedes B then B does not precede A must be true. Simply put, there is no language where [kæt] = [tæk]. This is core attribute of phonological representations that allows the relevance of Kayne's (1994) proposals to be seen in phonology. The asymmetry hypothesis holds in phonology because all precedence structures are ultimately asymmetrical.

The characteristics of precedence discussed above are presently understood as static and inviolable constraints on the well-formedness of a phonological representation. A phonological representation may start out as ill-formed due to the presence of a floating feature or if the position that morphemes are not linearly ordered in the input is assumed. These situations do not violate any of the proposed characteristics of precedence because both of them arise from two pieces of phonological representation not having any relation of precedence between them. Since there is no precedence relation, the conditions placed on precedence relationships can not be violated. We can thus conclude that all precedence relationships respect all of the constraints on phonological representations derived from these characteristics. This situation is similar to Kayne's (1994) interpretation of the LCA where all syntactic representations are required to be well-formed with respect to asymmetry. While this static view of asymmetrical properties of phonological representations is the prevailing model, it is not necessarily the only model of phonological representations.

2. Non-asymmetrical precedence structures in phonology

Raimy (2000b) argues that precedence relationships must be explicitly notated in all phonological representations. This point causes a change in the way phonological representations are presented as seen in (1). '→' indicates the relationship of *precedence* in the representations proposed by Raimy (2000b). Note that '#' and '%' represent the null set so they should be read as 'nothing precedes X' = # and 'X precedes nothing' = %. See Raimy (2000b) for a discussion for the need of both of these units to define the beginning and end of a word.

(1) a. kæt b. # → k → æ → t → %

The representations in (1) are actually equivalent in the information about the precedence structure of the word in question if the characteristics of precedence that are discussed in section 1 are assumed. The difference between (1a) and (1b) is only in whether the precedence information is explicitly presented. Given the strong constraints on precedence relations in the static view presented in section 1 there is no pressing reason to complicate our graphic presentation of phonological representations because the only way (1a) can be interpreted is as (1b).

One effect of the lack of explicit precedence notation in phonological representations is that the assumptions about the characteristics of precedence discussed in section 1 have not been questioned. The traditional phonological representation in (1a) limits us to only considering phonological representations that follow the constraints on precedence outlined in section 1 be-

cause if these assumptions are abandoned, the precedence structure in (1a) becomes very difficult to interpret. If explicit precedence notation is added back into phonological representations as in (1b), we can question whether the characteristics of precedence that have been assumed are correct or not.

Given explicit precedence notation we can consider phonological representations that violate the conditions on precedence in section 1. Raimy (2000ab) proposes that reduplication is best represented by precedence structures that are 'looping' in nature. Consider the representation in (2).

(2) # → k → æ → t → % 'cat-cat'

The representation in (2) violates the conditions of *asymmetry* and *irreflexivity* for precedence if we assume the *transitive* version of precedence. If precedence is a transitive relation, then in (2) every segment precedes itself and this violates the irreflexive characteristic of precedence. It also follows that the entire precedence structure is *symmetrical* because every segment precedes every other segment since /k/ precedes /æ/ and /æ/ precedes /k/ through transitivity, etc.

Within a model of phonology that allows representations like (2), non-surface[2] representations are not necessarily interpretable at the relevant interface. One aspect of phonology is to ensure that representations stored in memory are converted to representations that are interpretable at the phonetics interface. (2) is not interpretable at the phonetics interface because the overall precedence ordering in the representation is not *asymmetrical*. This is one point where phonology is indebted to Kayne (1994) which proposes the connection between asymmetry and linear order.

Analogous to the syntactic LCA (Kayne 1994), phonology contains a *linearization* process which ensures that representations have *asymmetrical* precedence structures and are thus interpretable at the phonetics interface. Linearization in phonology repeats segments within a 'loop' in order to eliminate asymmetrical precedence relations. Consider the representations in (3).

(3) a. # → k → æ → t → % b. # → k → æ → t → k → æ → t → %

Both (3a) and (3b) contain the same *types* of precedence relations. The term *type* here captures the fact that although (3a) and (3b) are different along some dimensions (number of segments and distinct environments that each segment appears in) they are also the same if we only refer to unique precedence relations. The specific types of unique precedence relations found in (3ab) are presented in (4).

(4) {# → k} {k → æ} {æ → t} {t → %} {t → k}

The difference between (3a) and (3b) is to be found in the *tokens* of precedence relations in each

[2] We can include input or underlying representations and any type of 'intermediate' (derivational level, sympathetic candidate (McCarthy 1997), etc.) representation in the phonology that is not actually sent to the phonetics interface. A bare output condition (Chomsky 1995) on phonological representations is that it must be a strictly linear representation that follows all of the restrictions on precedence in section 1. In other words, precedence structures that are not asymmetrical are not interpretable by the phonetics interface.

representation. The notion of tokens of precedence relations is directly tied to the number of segments used to represent the precedence information. (3a) and (3b) have different numbers of segments which results in a different number of tokens of precedence relations. Consider the lists of tokens of precedence relations in (5).

(5) a. tokens for (3a) [# → k] [k → æ] [æ → t] [t → %] [t → k]
b. tokens for (3b) [# → k] [k → æ] [æ → t] [t → k'] [k' → æ'] [æ' → t'] [t' → %]

By repeating segments, which creates new tokens of precedence relations, linearization allows all of the precedence information in (3a) to be contained in (3b) without containing any non-asymmetrical precedence relations. Crucial to understanding linearization in phonology is that copies (i.e. different tokens) of particular segments (same type) created by linearization do not have a relationship of *identity*[3] or any other type of dependency relation between them. The precedence structure in (5b) and the graph in (3b) does not contain any symmetrical precedence relations because each segment is a distinct entity. The fact that a /t/ precedes a /k/ and the /k/ precedes another /t/ does not instantiate a symmetrical precedence relation because the two /t/s (and two /k/s) in question are not the same entity. They are distinct segments and have distinct precedence environments which do not create a non-asymmetrical precedence structure.

Linearization in phonology creates and repeats distinct tokens of types of precedence relations in order to eliminate non-asymmetrical precedence structures. The fact that phonology chooses to repeat segments in order to remedy non-asymmetrical representations (as opposed to deleting segments) is an important point to note especially when the way that non-asymmetrical structures in syntax are remedied (discussed in section 4).

To summarize this section, four main points have been made. The first is that restrictions on possible precedence structures in phonology do not hold at all levels of representation. Phonological representations stored in memory or assembled in the morphology may violate some condition on what is interpretable at the phonetics interface. This leads to the second point which is that a linearization process in the phonology ensures that representations are interpretable with respect to precedence structures at the phonetics-phonology interface. Converting abstract memorized forms into representations that can be utilized by the phonetics module and consequently turned into motor control programs is one of the fundamental aspects of phonology. The behavior of the linearization process is the third main point of this section. Linearization eliminates non-asymmetric precedence structures through repetition of segments which preserves the overall organization of a precedence structure while not causing problems of interpretation for the phonetics module. The final point is that we can see concrete effects of symmetrical precedence structures and linearization in reduplicated forms. The repetition of segmental material that we recognize as reduplication is the result of the linearization of a non-asymmetric precedence structure which was created in the morphological component.[4]

[3] I use the term identity here in the sense of Wilbur's (1973) *identity constraint* which states that two segments can be in a relationship of identity which can cause phonological processes to apply (or not apply) in an exceptional manner to ensure the two segments stay identical. This relation creates a dependency between two segments that in effect causes them to be the 'same' segment thus creating symmetrical precedence relations.

[4] Not all reduplication must be created in the morphology component. Cases of 'inherent reduplication' (e.g. cases in Manam as argued for by Buckley 1999 or possibly cases of biliteral roots in Semitic as argued for by Gafos 1998) can be accounted for by simply allowing memorized phonological forms to contain loops.

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3. Linearization as an economy based process

One of the main points of the previous section is that there is a linearization process in the phonology which remedies non-asymmetrical precedence structures through repetition. This section investigates the characteristics of the linearization process in further detail and argues that linearization is an economy based process. Two main principles of economy that are relevant for linearization are presented in (6).

(6) a. SHORTEST PATH- produce the precedence graph with the least number of tokens of precedence relations from the input
b. COMPLETENESS- produce a precedence graph that uses as many of the types of precedence relations from the input as possible

The interaction between the principles in (6) creates the optimization characteristic of linearization in that structures that are created by linearization employ only as many tokens of precedence relations that are needed to use all the types of precedence relations in the input.

Linearization has characteristics in common with the *containment model* of Prince and Smolensky (1993). Possible linearizations are strictly constrained by the input precedence structure because only precedence relationships that are present in the input structure can be present in the output structure. No novel precedence types are ever added or created by the linearization process itself. Another basic well-formedness condition on the output of linearization is that every precedence structure will have a beginning ([# → X]) and an end ([Y → %]). If a precedence structure does not have a beginning or an end, it is not interpretable at the phonetics-phonology interface.

Given this initial sketch of the properties of the linearization process, consider what occurs when a completely asymmetrical linear precedence structure is linearized as presented in (7).

(7) *input*: a. # → k → æ → t → %
outputs: b. # → k → æ → t → %
c. **# → t → æ → k → %
d. **# → k → æ
e. **# → d → a → g → %
etc.

The input in (7a) will be linearized as (7b) and both the COMPLETENESS (in the output there is at least one token of each type of precedence relation from the input) and SHORTESTPATH (there is only a single token of each type of precedence relation from the input present in the output) are maximally satisfied. Other possible linearizations that could be considered by linguists are not entertained by the linearization process because they contain precedence relationships that are not present in the input structure. (7c) is the mirror structure of the input and actually contains none of the precedence relations from the input. Because of this it can not be produced by the linearization process as a legitimate linearization. Structures that are not legitimate linearizations of the input structure are marked by double asterisks (**). (7d) is also illegitimate specifically because it does not have an 'end' (there is no [t → %] which is the only legitimate ending according to the input) in the output precedence graph. (7e) and other analogous structures (e.g. 'plane', 'transcendentalism', 'cats', etc.) are also illegitimate because they contain segments that

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are not present in the input structure which automatically causes there to be precedence relations present in the output that do not occur in the input.

Precedence structures that are not asymmetric will have non-trivial linearizations because these types of structures present situations where SHORTESTPATH and COMPLETENESS may be in conflict. Due to this conflict, there will be more than a single possible way to linearize the input. Consider the linearization possibilities for a looping structure given in (8). Note that illegitimate linearizations are excluded from the discussion here since there are actually multiple possible linearizations that compete for the best satisfaction of both principles of economy.

(8) *input*: a. # → k → æ → t → %

output: b. *# → k → æ → t → %
c. # → k → æ → t → k → æ → t → %
d. *# → k → æ → t → k → æ → t → k → æ → t → %
etc.

The multiple possible linearizations presented as outputs in (8b-d) highlight the conflict in the economy principles. (8b) is the smallest possible output precedence structure that can be created by the linearization process. (8b) has a beginning and an end but the principle of COMPLETENESS is not satisfied because there is no token of the [t → k] precedence relation (the 'loop back') in the output. The omission of this particular precedence relation is why (8b) does not show reduplication. (8c) is the most economic output that linearization can produce. This representation is not the smallest possible precedence structure because it has seven ([# → k] [k → æ] [æ → t] [t → k'] [k' → æ'] [æ' → t'] and [t' → %]) tokens of precedence relations while (8b) only has four but it is the smallest representation that satisfies COMPLETENESS. There is at least one token of each type of precedence relation from (8a) in (8b). At this point, we can see that the economy principle of COMPLETENESS overrides SHORTESTPATH when there is a conflict between them. (8d) and all other possible output structures that use the [t → k] precedence link more than once equally satisfy COMPLETENESS but are larger precedence structures than (8c). Thus, these gratuitously large precedence structures are not the most economical possible linearization.

Indonesian provides an excellent case study which further illuminates the economy principles of linearization. Consider the data in (9) (taken from Uhrbach 1987, McCarthy and Prince 1995).

(9)	a.	potoŋ	mə-motoŋ-motoŋ	'to cut (intensive/repetitive)'
		tulis	mə-nulis-nulis	'to write (intensive/repetitive)'
		duduk	mən-duduk-duduk	'to occupy ('sit' intensive/repetitive)'
		isi	məŋ-isi-isi	'to fill with various things'
	b.	pukul	pukul-məm-ukul	'to hit (reciprocal)'
		tari	tari-mən-ari	'to dance (reciprocal)'
		hormat	hormat-məŋ-hormat-i	'to respect (reciprocal)'
		ambil	ambil-məŋ-ambil	'(give and) take'

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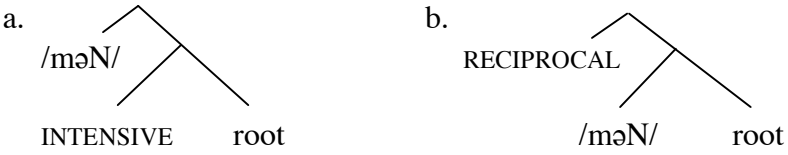
The relevant aspects of the data in (9) are as follows.[5] Total reduplication is present as the result of both 'intensive/repetitive' (9a) and 'reciprocal' morphology (9b). The prefix /məN/ is not reduplicated as part of the total reduplication in either (9a) or (9b) The position of the prefix /məN/ alternates between prefixing to the base and reduplicant in (9a) and being interposed between the base and reduplicant in (9b). How to account for the interposing pattern of reduplication in (9b) is the important question in this data.

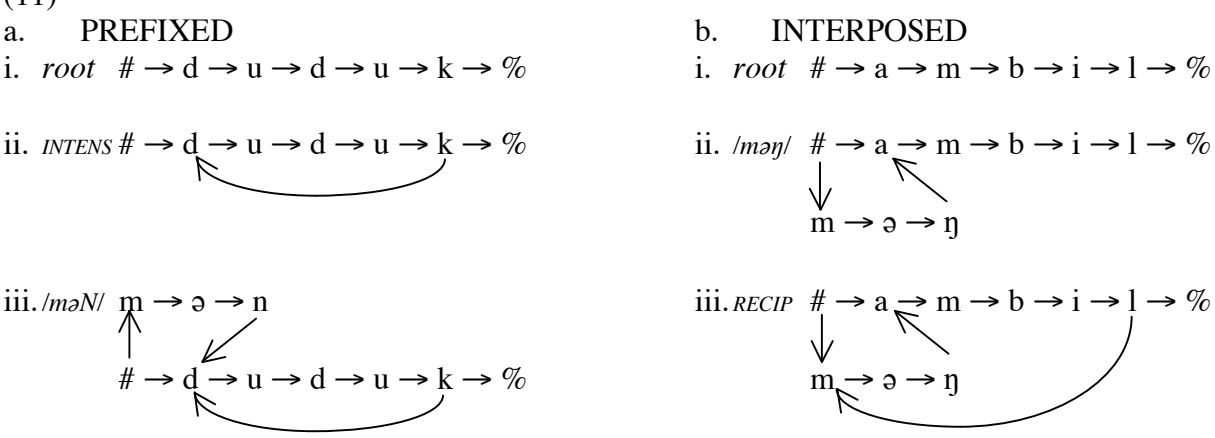
The difference in the placement of /məN/ in (9) and an explanation of how /məN/ becomes interposed between base and reduplicant is derivable from the difference in morphological structure of (9a) and (9b) and the principles of economy. The morphological structure of the forms in (9) is basically a question of which morpheme has the widest scope. The morphological structure for the prefixing pattern in (9a) is found in (10a) where /məN/ has the widest scope, including both the 'intensive/repetitive' morpheme and the root within it. The interposing pattern in (9b) has the morphological structure in (10b) where the 'reciprocal' morpheme has scope over both /m´N/ and the root.

(10)



Given the morphological structures in (10) and the assumption of cyclic spell-out of the morphosyntactic features we arrive at the derivations of the phonological representations (precedence graphs) for (9a) and (9b) in (11). (See Raimy 2000b for a full discussion of the concatenation of morphemes given the precedence structures under discussion.)

(11)



Both INTENSIVE and RECIPROCAL morphology trigger total reduplication which adds a precedence link from the last segment of the phonological string to the first segment. This creates a loop from the *end* to the *beginning* of the form. Depending on whether /məN/ has already been

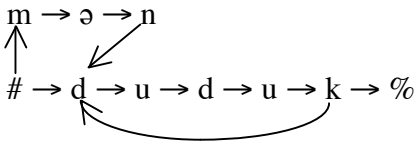
[5] The interaction of reduplication and nasal substitution seen in some of the forms in (9) will be ignored for the purposes of this paper. See Raimy (2000b:99-112) for an analysis of this aspect of the Indonesian data.

spelled-out, /məN/ may be contained within the loop or not. As (11) shows, fundamentally different precedence structures are created for forms with RECIPROCAL and INTENSIVE morphology in Indonesian even though they are constructed from the same pieces. The different precedence structures result from the different order in which the same pieces are put together.

In (11a), the intensive morpheme is spelled-out when only the root has been spelled-out. This produces the precedence structure in (11aii) where /məN/ is concatenated to a representation that already contains a loop. Consequently, in (11aiii) /məN/ is not contained within the loop.

(11b) shows a different order of spell-out/concatenation of morphemes. In this form, /məN/ is spelled-out first and concatenated directly to the root as shown in (11bii). After this, the reciprocal morpheme is spelled-out which adds a precedence relation from the last segment of the representation to the first segment. Since /məN/ has been concatenated to the root, /m/ is now the first segment thus causing /məN/ to be included inside the loop as show in (11biii). This is a different precedence structure from (11aiii) and we should expect different surface linearizations to occur for these two representations.

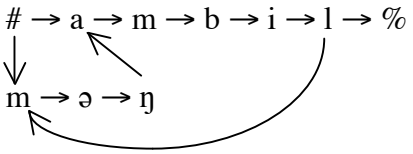
Linearization of the structure in (11aiii) (the prefixed /məN/ pattern) follows directly from the previous discussion of interaction of the economy principles. (12) presents the occurring and some possible alternative linearizations.

(12) a. 

b. mən-duduk-duduk
c. *duduk-duduk
d. *mən-duduk
e. *duduk
f. *mən-duduk-duduk-duduk

(12b) is the occurring surface form and it is the smallest precedence structure possible (14 precedence relations) that uses both the prefix /məN/ and the 'loop'. COMPLETENESS is maximally but not completely satisfied by this output because there is no [# → d] precedence relation in the output. There is no way that both the /məN/ affix and this precedence link can be used given the structure in (11aiii). Linearization must make a choice between using the [# → m] link or the [# → d] link. Choosing to use the [# → d] link produces (12c) a representation in which SHORTEST PATH is minimally violated but there are more violations of COMPLETENESS than (12b). Other possible linearizations, as in (12d-e), also produce smaller precedence structures than (12b) but utilize less of the precedence structure thus violating COMPLETENESS more than (12b). This rules them out from being the most economical linearization. (12f) satisfies COMPLETENESS to the same level as (12b) but is a larger precedence structure. This fact makes (12f) less economical with respect to SHORTESTPATH.

The precedence graph for (11biii) (the interposed /məN/ pattern) presents a more complicated interaction between the economy principles in linearization. Although the interaction is more complicated, the surface form for (11biii) is generated by the present principles of economy.

(13) a. 

b. ambil-məŋ-ambil
c. *məŋ-ambil-məŋ-ambil
d. *ambil
e. *məŋ-ambil

Given the precedence structure in (13a), (13b) is the smallest precedence structure in which COMPLETENESS is maximally satisfied. As discussed in the linearization of (11aiii), there can only be one 'word initial' segment so there is a choice in whether to use the [# → a] or [# →m] precedence link. There is no way to use both of these links given the *containment* nature of the linearization process. (13b) is produced by following the [# → a] link as a 'short cut' to using the loop back link. Because /məN/ is within the looping back link, the short cut through [# → a] is not detrimental to the overall satisfaction of COMPLETENESS because there will always be at least one unused precedence link.

(13c) shows what occurs when the [# → m] is utilized by the linearization process. This path causes /m´N/ to be present in the output twice leading to a larger precedence structure than (13b) with no gain in COMPLETENESS. Because both (13b) and (13c) leave one precedence link unused this makes both linearizations equal with respect to satisfying the COMPLETENESS economy principle. Since COMPLETENESS does not distinguish between the two linearizations, SHORTESTPATH determines that (13b) is the more economic linearization since it is smaller than (13c).

Other possible linearizations such as (13d-e) do not maximally satisfy COMPLETENESS and are thus ruled out. Linearizations that are larger than (13c) (**məŋ-ambil-məŋ-ambil-məŋ-ambil*, **ambil-məŋ-ambil-məŋ-ambil*, etc.) do not improve satisfaction of COMPLETENESS so the only result produced by these forms is more violation of SHORTESTPATH.

We can now see that the curious pattern of interfixing the /məN/ prefix in Indonesian is derived from the general language universal principles of linearization and morphological scope/spell-out in the morphology. This investigation into the principles of linearization indicate that it is an optimization process that occurs in the phonology. Linearization is driven by two principles of economy,[6] SHORTEST PATH and COMPLETENESS and COMPLETENESS overrides SHORTEST PATH when these economy principles are in conflict.

4. Linearization in syntax and phonology: Why is phonology different?

Both syntax and phonology have the characteristic that asymmetrical representations are required at the relevant interface. Syntax and phonology also share the characteristic that non-asymmetrical representations can be built or occur during a derivation. Section 2 of this paper discusses how the phonology contains non-asymmetrical looping precedence structures that were built within the morphology component. Syntax builds non-asymmetrical structures when movement occurs (the copy theory of movement, Chomsky 1993). To see this fact about syntax,

[6] A preference to use morphologically added material over underlying material may be an additional aspect of COMPLETENESS or an additional independent economy principle. See Raimy (2000b) for discussion.

consider the example in (14) (taken from Nunes 1999).

(14) a. $[_{TP}$ John^{i} $[_{T'}$ was + T $[_{VP}$ kissed John$^{i}]]]$
b. *John was kissed John
c. John was kissed

Copy and movement of 'John' from the VP in (14a) creates symmetrical and reflexive c-command relations according to Nunes (1999:225) because this movement causes 'John' to c-command 'kissed' but 'kissed' c-commands the lower copy of 'John'. This is a case of symmetrical c-command which violates the LCA. In addition to this, a reflexive c-command relation ship is also created because 'John' in subject position c-commands 'John' in object position. Nunes (1999) argues that the general response to chains that create symmetrical and reflexive c-command structures in violation of the LCA (Kayne 1994) is to delete part of the chain at PF.[7]

At this point we have reached a paradox if asymmetry and linearization is to be a cross-modular factor in UG. Specifically, syntax deletes elements in order to change symmetrical representations into asymmetrical ones and phonology repeats elements to achieve a similar conversion. One possible response to this paradox is to simply dismiss it as another basic difference between the syntactic and phonological modules. A deeper explanation of this paradox can be formulated if we consider how the notion of *identity* operates over representations in each module.

Syntax requires a relationship of identity in order to allow chains to be formed. Chains instantiate symmetrical c-command relations because the elements of a chain are identical from the perspective of the syntax. This situation causes the moved category to c-command itself and for intervening categories to c-command and be c-commanded by the moved category. Consider the example in (15) which illustrates this point.

(15) a. John^{i} wants John^{j} to go
b. *John^{i} wants John^{i} to go

The difference in grammaticality between (15a) and (15b) can be explained by considering whether the second 'John' in each sentence in (15) refers to the same person as the subject or not. (15a) is only acceptable when the two 'Johns' refer to different individuals and thus do not form a chain. Since these two instances of 'John' are not *identical*, no symmetrical or reflexive c-command relations exist in this sentence. (15b) is ungrammatical because the two instances of 'John' are identical forming a chain which creates a symmetrical c-command relation which violates the LCA.

An explanation of the paradox of syntax deleting parts of a representation to achieve asymmetry and phonology repeating parts to obtain the same goal can be developed based on the role that *identity* plays within each grammatical module. Simply, phonology behaves differently from syntax because there is no dependency between copies of segments. This lack of depend-

[7] Nunes (1999:232-237) discusses cases where some intermediate traces are not deleted. A brief summary of Nunes' position is that these traces are not deleted because a morphological process has merged the trace with another constituent into a phonological word (following a suggestion in Chomsky 1995:337). This process eliminates the trace from the LCA thus allowing it to not be deleted.

ency means that there is no sense of identity between *tokens of segments* produced by linearization.[8] The claim here is that phonology does not require a function of *token identity* that relates two distinct segments (prosodic units, features, etc.) and requires them to be (or evaluates whether they are) identical along some dimension. This type of *token identity* is the core of the correspondence model (McCarthy and Prince 1995) of reduplication which formalizes Wilbur's (1973) Identity Constraint. The main liability of this type of model of reduplication is that since *identity* is an arbitrary relation that can hold between any two segments whether they have any similarity of features at all it produces a too powerful model of phonology which causes problems for acquisition. See Idsardi and Raimy (to appear) for discussion of this theme.

The model of reduplication argued for in Raimy (2000ab) accounts for identity effects in reduplication without resorting to *token identity* by claiming that identity effects in reduplication (overapplication and underapplication, including backcopying) only occur when a rule applies to a phonological representation that contains a 'loop'. The loop is crucial to this explanation because it presents a situation where a segment can appear in two distinct environments at the same time. When these multi-environments diverge along some dimension, identity effects are produced because after linearization has occurred, each copy of a segment may appear in a distinct environment.

To show how these multi-environments adequately capture identity effects in reduplication consider the behavior of nasal spread in Malay (Kenstowicz 1981) presented in (16a).

(16) a. aŋẽn 'wind' ãŋẽn-ãŋẽn 'unconfirmed news'

b. # → a → ŋ → e → n → % ⇒ # → ã → ŋ → ẽ → n → % *nasal spread*

c. # → ã → ŋ → ẽ → n → ã → ŋ → ẽ → n → % *linearization*

McCarthy and Prince (1995) identify this pattern of rule application in reduplication as one that shows backcopying. Backcopying occurs in this pattern because the word initial vowel in the reduplicated form becomes nasalized even though it is never preceded by a nasal segment. In other words, there does not appear to be any way to cause the nasalization of the word initial vowel without resorting to some interpretation of *identity* between this vowel and the corresponding word internal vowel which occurs in a nasalizing environment.

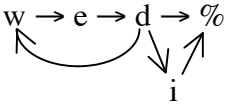
Raimy (2000a) argues that the backcopying identity effect results from the nasal spread rule in Malay applying to the pre-linearization representation in (16b). The representation in (16b)

[8] This kind of identity is distinct from *type identity* which may be required in phonology to evaluate certain types of processes as discussed by Reiss (this volume). The main difference between *type* vs. *token* identity is that *type identity* only evaluates whether two segments are the same with respect to a certain feature or set of features (i.e. Is this segment [coronal]?). *Token identity* requires an evaluation which determines whether two segments are copies of each other or share some other type of dependence between them (*correspondence* in McCarthy and Prince 1995 terms). Under this evaluation, *token identity* would allow two completely different segments to be *identical* (correspond in this example) without sharing a single feature. This situation is instantiated by some emergence of the unmarked analyses of reduplication where miscopying is preferred to faithful copying because a reduction of markedness is achieved (Alderete et al 1999). *Type identity* does not allow this type of *identicalness* because what is being evaluated is whether two segments both have a feature or set of features (or possibly more complex conditions as argued by Reiss). So, if two segments do not share any feature in common, they can not be considered to be identical along any dimension.

presents a case of a multi-environment situation since /a/ is 'at the beginning of the word' and 'following /n/' at the same time. Symmetrical precedence structures create multi-environments which leads to opaque identity effects after linearization. The surface form in (16c) is derived, according to Raimy (2000a), by allowing the nasal spread rule to apply to the prelinearized representation in (16b) even though only one part of the multi-environment triggers nasalization. Linearization then places one copy of the now nasalized vowel in word initial position, (16c), and the backcopying effect is accounted for without resorting to any kind of *identity constraint* or *transderivational device*. Identity effects in reduplication are cases of opacity in the Raimy (2000ab) model.

Non-identity effects will occur in reduplicated forms when a rule applies after linearization has already converted a loop into a repeated region of segments. Consider the example of coda devoicing in Washo (Jacobson 1964 as cited in Kager 1999:231). Syllable boundaries are marked with '.' in (17a) and with parentheses in (17cd).

(17) a. /RED+wed-i/ wet.we.di 'it's quacking'

b. # → w → e → d → %


c. # (w → e → d) → (w → e) → (d → i) → % *linearization*

d. # (w → e → t) → (w → e) → (d → i) → % *coda devoicing*

All that needs to be done in order to account for this pattern of rule and reduplication interaction is to allow linearization to occur before coda devoicing applies. This ordering produces the representation in (17c) for coda devoicing to operate on. Since there are now two distinct copies of the /d/ in (17c), coda devoicing can operate on them independently. Application of this rule causes devoicing of the first /d/ because it occurs in a coda while the second /d/ is unaffected because it occurs in an onset. The two copies of underlying /d/ diverge in quality in (17d) as a result of coda devoicing because there is no *identity* between copies of segments in phonology.

The importance of non-asymmetrical relations in both syntax and phonology can now be recognized and a fundamental difference between syntax and phonology has been identified from this point. The syntactic component eliminates non-asymmetrical relations among elements by deleting copies of the offending elements at PF. Phonology eliminates non-asymmetrical relations by copying and repeating elements during linearization. This difference between syntax and phonology can be derived from whether the grammatical module in question requires a function of *identity*. Syntax requires *identity* in order for chains to be formed while phonology does not require any dependency of this sort. Consequently, a transderivational identity function is not required or justified by the necessity of accounting for reduplication. All identity effects in reduplication can be achieved through derivational ordering of processes and this results in a less powerful model of phonology.

5.0 Conclusion

This short paper has investigated the relevance of the *asymmetry hypothesis* proposed in

Kayne (1994) to phonology. From this point of inquiry we have identified some characteristics of *linearization* that appear to be part of universal grammar. These characteristics are that linearization ensures that representations at interfaces have strict asymmetrical linear ordering and that linearization operates under principles of economy. Given these universal aspects of linearization we have also identified module specific characteristics of linearization. Linearization will either delete or repeat parts of non-asymmetrical representations depending on whether the module has a function of identity. Syntax requires a function of identity so chains can be created and interpreted correctly and this causes deletion to be the remedy for symmetrical representations. Phonology does not require a function of identity (contrary to McCarthy and Prince 1995) so repetition of segments in non-asymmetrical representations occurs. Finally, although linearization in both syntax and phonology operates under principles of economy, there is likely to be distinct principles that are relevant for each module. Because of the difference in representations in syntax and phonology (hierarchical trees of categories based on c-command vs. strings or precedence graphs of segments) it is unlikely that linearization in each module operates under the same principles.

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