On the Notion of Full Interpretation in Phonology*

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1. Introduction

Seuren (2004) delivers a harsh criticism on Chomsky’s (1995, 2003) Minimalist Program (hereafter, MP) on the general assumption that the “random generator” view of language in the MP fails to satisfy the criteria for sound scientific work: (i) respect for data, (ii) unambiguous formulations, and (iii) falsifiability. This paper works out a version of the random generator view of phonology, in which subsystems of phonology are formulated under the non-monotonic logic of scientific theorization to satisfy the criterion of falsifiability.

The three criteria are not independent from each other. The first and the third of the three criteria, respect for the data and falsifiability, are essentially the two sides of the same coin: if a given theorization does not respect the content of the linguistic data, then it is not falsified by data, and vice versa. The second criterion is a decisive factor for the third.

The main lines of argumentation in this paper converge on elucidations of the notion of Full Interpretation in phonological system that internalizes the random generator. The framework of phonology that I submit is a revised version of phonological theory that I laid out in Takahashi (2004a, b).

This paper will proceed as follows. The second section describes a general outline of the architecture of phonology, which is founded on monotonically organized framework in tandem with sets of non-monotonic sub-systems. The third section reviews the theory of Feature Geometry and presents a uniform treatment of segmental continuancy and temporal attributes. The fourth section formalizes the Sonority Sequencing Generalization in Feature Geometric terms. The fifth section elaborates upon a possibility of unifying the sub-modules of Full Interpretation.

2. A General Outline of Minimalist Phonology

The framework of Minimalist Phonology that I submit internalizes a gadget that virtually generate outputs in a random fashion, whose operations on linguistic structures are severely restricted: the gadget consists of two kinds of operations, the main operation Merge and the auxiliary operation Erase. The syllable structures of words are formed by the main operation

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Merge according to the principles of Strength Hierarchy and Syllable Template as are proposed in Kiparsky (1979). The two operations are evoked to apply when the outputs from phonology violate the principle of Full Interpretation, which I assume involves three sub-systems:

(1) Full Interpretation in Phonology
   a. Feature Geometry
   b. Sonority Sequencing Generalization
   c. Obligatory Contour Principle

The purposes of the three sub-modules are assumed to be mutually independent:

(2) Feature Geometry (FG)
   The content of the segmental melody accords with the hierarchical organization of the phonological features.

(3) Sonority Sequencing Generalization (SSG)
   The sonority scale of the segmental melody is so organized as to successively rise and fall.

(4) Obligatory Contour Principle (OCP)
   Adjacent identical melodies are prohibited.

The principles in (2)–(4) internalize parameters that capture variations among individual languages, to which I will refer in the later sections. There is a possibility that the three sub-modules of Full Interpretation would be collapsed into one: the effects of FG and those of OCP are derivable from SSG. The last section will discuss this possibility.

Let us take an example from English: nasalization of vowels, as is instantiated in can and stone. At the lexical level, the nasality of the vowels is fully predictable, so that the vowels are lexically [Ωnasal]. The operation Merge will apply to form the syllabic structures of the words according to the SSG, where the vowels and nasals are in the codas. Unless the vowels are assigned their feature value with respect to [nasal], the representation would violate the FG, which stipulates that the vowels are assigned values of the feature [nasal]. If the vowels are assigned [−vowel], this violates the SSG:

(5) Complexes of Feature Values of the Vowels and the Neighboring Nasals
    [−nasal, +vocalic, −consonantal], [+nasal, −vocalic, +consonantal]

The SSG assesses the partial representation in (5) to be non-sequential with respect to sonority. If the operation Merge applies to form a linked structure in the syllable codas, then it will obtain approval from the SSG:

(6) Complex of Feature Values Derived by Merge
    [+nasal, +vocalic, −consonantal], [+nasal, −vocalic, +consonantal]
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The SSG gives the representation in (6) license to be an output from phonology. It is crucial to note that the representation in (6) is more felicitous than (5) with respect to the criterion of successive rise or fall of sonority. In order to formally capture what the SSG regulates, I would like to introduce an inspection procedure:

(7) A Modus Operandi for the SSG

An improved representation is given license to be an output from phonology.

The modus operandi in (7) contributes to a solution to the bottomless problem of naturalness of descriptions in phonology, as formulated in Postal's Naturalness Condition and Kiparsky's Alternation Condition. The net effect of (7) is to minimize the number of the stages of derivation.

The system of phonology that I submit here is founded on two substantially heterogeneous structural designs: monotonous and non-monotonous. The former refers to purely formal considerations in theory construction, while the latter makes crucial access to linguistic substance. The principle of Underspecification belongs to the former, because it does not depend on the nature of linguistic substance: e.g., Underspecification makes access to what is predicted by the Trisyllabic Shortening Rule and goes on to stipulate that the feature specification [−long] in the antepenultimate syllable is not encoded in the lexical representation. The FG is in the realm of the latter, because it is constructed upon language-specific traits, specifically those aspects of language that stipulate articulatory inevitabilities. However, the FG internalizes a monotonous stipulation to the effect that the association lines in the representation do not cross. In this sense, theories on language in general are of bipartite architecture of monotonous and non-monotonous structures of logic: non-monotonous systems describing the logic in linguistic substance are agglutinated by monotonous systems that are reflections of processes of human understanding.

In the sections that follow, I would like to analyze the logical architectures that build up sub-modules of Full Interpretation, that is, the theory of Feature Geometry, the Sonority Sequencing Generalization, and the Obligatory Contour Principle.

3. Temporal Aspects in the Feature Geometry

In this section, I would like to attempt to derive the attribute of continuancy from modified representation of timing elements. Takahashi (2004a, b) presented a revised mode of representing temporal relations among features:
(8) Underlying Representation of /t/

\[
\text{ROOT} \\
\quad \text{[-continuant]} \quad \text{Laryngeal Supralaryngeal} \\
\quad \quad \text{[-voice]} \quad \text{Place} \\
\quad \quad \quad \text{Coronal} \\
\quad \quad \quad \quad \text{P R P} \\
\quad \quad \quad \quad \quad \text{[+anterior]}
\]

The elements \( P \) and \( R \) stand for \textit{Point in Time} and \textit{Region in Time}, respectively. The left hand side of \( P \) refers to the onset phase of articulation and the right one, the offset phase of articulation. Linkages are introduced later in the derivation that associate the terminal features and the \( P \)s. A default rule assigns the association lines as shown in (9):

(9) Temporally Fully Linked Structure

\[
\text{ROOT} \\
\quad \text{[-continuant]} \quad \text{Laryngeal Supralaryngeal} \\
\quad \quad \text{[-voice]} \quad \text{Place} \\
\quad \quad \quad \text{Coronal} \\
\quad \quad \quad \quad \text{P R P} \\
\quad \quad \quad \quad \quad \text{[+anterior]}
\]

The default rule is given in (10):

(10) If \([-\text{continuant}]\), then the terminal feature is linked to the onset and offset \( P \)s.

The mode of representation in (8) markedly differs from that in Sagey (1986): The temporal elements are situated not at the top of the feature geometric representation, but at the position above the terminal and the non-terminal nodes. Therefore the processes of autosegmental operation are restricted to the terminal elements.

A new proposal in this paper is to derive segmental continuancy from the default concerning the alignment of temporal elements:

(10) Deriving Continuancy from Temporal Elements

a. Non-Continuant Segments: \([P R]\)
b. Continuant Segments: \([R]\)
c. \( Q \rightarrow P/P R \)
The assumptions in (10) virtually do away with the feature [continuant].

Two significant consequences are in order: (i) the assimilation of place of articulation and (ii) the consonantal epenthesis.

The specifications of the assimilation of place of articulation in language are two-fold with respect to segmental continuantness: (i) Type A, in which continuant consonants are assimilated in place of articulation to the following non-continuant consonants and (ii) Type B, where assimilation of place of articulation occurs only if the continuantness of the trigger consonant is identical to that of the target consonant. Sanskrit belongs to the former, while English belongs to the latter.

(11) Assimilation of Place of Articulation in English
a. tenni[ʃ] [ʃ]oes
b. a tenni[s] player, *a tenni[ʃ] player
c. a tenni[s] court, *a tenni[x] court

(12) Assimilation of Place of Articulation in Sanskrit¹
a. tatas ca → tata[ʃ] ca “and then”²
b. divas putras → diva[ʃ] putras “Heaven’s son”
c. nala kāmam → nala[x] kāmam “at Nala’s will”

It is remarkable that English exhibits progressive and regressive assimilation of manner of articulation under certain specifiable environments:

(13) Progressive and Regressive Assimilation in English
a. giv[ʃ]en me ...
b. ... and th[ʃ]en

The assimilation found in the English cases in (13) is severely restricted: (i) the trigger is virtually restricted to nasality and (ii) the specification of the place of articulation of the trigger differs from that of the target only with respect to the feature [distributed].

The difference in the assimilatory patterns between English and Sanskrit is attributable to what are represented at the level of lexical representation:

² The symbol “c” in (12a) stands for a palatal stop, which in a traditional phonetic notation corresponds to [tʃ]. The data implies that in Sanskrit the segment [tʃ] is interpreted to be [−anterior], which means that the segment is a complex segment in the language, in the sense of Sagey (1986), contrasted with “contour segments,” which is phonologically “[+anterior] [−anterior].”
(14) Lexical Representations of /s/ in English and Sanskrit

a. English /s/
   PLACE
   CORONAL
   \ R

b. Sanskrit /s/
   PLACE
   R

Let us examine cases from English: tenni[j] [i]oes and *a tenni[Φ] player. The partial representations crucial to our argument are cited in (15):

(15) Assimilation of Place of Articulation in English

   a. tennis shoes
      PLACE   PLACE
      CORONAL CORONAL
      \ R \ R
      \[-anterior\]

   b. a tennis player
      PLACE   PLACE
      CORONAL LABIAL
      \ R \ P \ R
      \[-round\]

It is crucial to note that the feature specification \[-round\] cannot be spread onto the temporal element “R” on the left, because the feature is governed by the sequence of elements “P R,” which is incongruent with the temporal specification “R.” By the Shared Features Convention (henceforth, SFC), the merged structure in (15a) is coalesced and we have (16):

(16) Coalesced by the SFC

      PLACE   PLACE
      CORONAL
      \ R
      \[-anterior\]

The distinction between (11a) and (11b, c) is attributed to the matching of temporal elements that dominate the features that are targets of merger. The process of merger is evoked to
satisfy the feature geometric stipulation in the principle of Full Interpretation.

Let us go on to our examination of the cases in (13). The principle of Underspecification stipulates that the feature values [+distributed], [−round] and [+nasal] are encoded at the lexical level. Therefore, the system of default includes the following:

(17) Default Rules
   a. [+consonantal, +vocalic] → [−nasal]
   b. Coronal → [−distributed]
   c. Labial → [+round]

The underlying representations of the relevant parts in (13) are shown below:

(18) Underlying Representations
   a. ... give me ...
   SUPRA
      PLACE
      LABIAL
      R
      [−round] ...
   SUPRA
      PLACE
      LABIAL
      P R
      [−round]
   b. ... and then ...
   SUPRA
      SOFT
      P R
      [+nasal]
   SUPRA
      PLACE
      CORONAL
      P R
      [+distributed]

In our approach, the problem with the cases in (18) is identified as the locus of violation of the principle of Full Interpretation. I assume that /v/ and /m/ (and /n/ and /ð/) are similar enough to incur a violation against the Obligatory Contour Principle, which triggers Erase to wipe away the feature specification [−round] (and [+distributed]). As for the case in (18a), an instance of [−round] is erased and the feature [+nasal] is shared by the two segmental nodes. In the case in (18b), the segments /n/ and /ð/ govern the specification [+anterior], which I interpret is enough to incur a violation of the OCP. One of the two instances of [+anterior] is erased and the two segmental structures are merged.

Let us proceed to the Sanskrit cases. I adopted a crucial assumption on the underlying representation of /s/, which is repeated here as (19):
(19) Sanskrit /s/
   \hspace{1em} \text{PLACE} \\
   \hspace{2em} \text{R}

The assimilation of place of articulation is accounted for straightforwardly: Sanskrit /s/ has no underlying Place node, so that it must be assigned one to satisfy the principle of Full Interpretation. The derived representation of the italicized part of divas putras is quoted in (20) for confirmation:

(20) divas putras
    a. Underlying Representation
       \hspace{1em} \text{SUPRA} \\
       \hspace{2em} \text{PLACE} \\
       \hspace{3em} \text{LABIAL} \\
       \hspace{4em} \text{R} \\
       \hspace{5em} \text{P} \\
       \hspace{6em} \text{R} \\
       \hspace{7em} \text{[−round]}
    b. Derived Representation
       \hspace{1em} \text{SUPRA} \\
       \hspace{2em} \text{PLACE} \\
       \hspace{3em} \text{LABIAL} \\
       \hspace{4em} \text{R} \\
       \hspace{5em} \text{P} \\
       \hspace{6em} \text{R} \\
       \hspace{7em} \text{[−round]}

I assume crucially that a newly created non-terminal node functions to cancel a configuration of temporal elements that are incongruent with each other. Note that in the English case in (15b) no new non-terminal node is created. The assumption on the cancellation of the incongruent temporal elements could be translated into some effect of strict cyclicity, but I will leave open the question for future research. A significant corollary of the present approach is that we may have to do without the manner of articulation feature [continuant]. We may ask whether or not the representation in (20b) can be interpreted by the sensorimotor articulatory organs, which is a problem appropriately interpreted from the viewpoint of Articulatory Phonology by Browman and Goldstein (1986).

4. Sonority Sequencing Generalization in Feature Geometric Terms

Kiparsky (1979) presents a segmental generalization over sequentiality of sonority with syllables, dubbed Strength Hierarchy, which interacts with his Universal Syllable Template to generate syllable structures of language. Selkirk (1982: 344) delineates a feature-based
theory that partially includes reference to feature specification in the syllable template:

(21) Syllable Template by Selkirk (1982)

\[
\text{+syll (} +\text{son) (} \text{) \text{+cons (} -\text{son) }
\]

\[\text{-syll (} +\text{son) (} \text{)}\]

The syllable template in (21) has direct access to language-specific collocation restrictions, e.g., (22):

(22) If there is a second consonant in the onset, the first must be an obstruent.

Selkirk (1982: 246)

Remarkably, Selkirk’s feature-based theory does not directly capture the notion of segmental strength. This section describes a theory of the syllable based on the geometry of features, which constitutes a sub-component of the principle of Full Interpretation.

The theory of the syllable based on feature geometry that I present here (henceforth, SFG) is governed by a linguistic monotonic logic of Underspecification. Therefore the theory has access to information encoded in the lexicon.

Let us begin with the case of partial devoicing of sonorants in English onsets: \(t[r]ial\). The voicedness of the sonorant \(/r/\) is totally predictable, so that the feature value is unspecified in the lexicon: [+voice] is assigned by default, and [−voice] comes from the neighboring segment /t/, which is [−voice]. The voicelessness of the obstruent /t/ is assigned by default: [−sonorant] \(\rightarrow\) [−voice]. The instance of /t/ in the syllable onset behaves rather differently from that in the syllable coda: the latter does not affect the voicedness of the following sonorant as in the night [r]ate.

The phonetic contrast observed in the voicing of /r/ in nitrate and in night rate can be captured by prosodically constrained autosegmental spreading:

(23) Spread \(\alpha\)

a. Spread any terminal node rightward within a phonological word.

b. Otherwise, spread any terminal node leftward.

It is crucial to assume (i) that the word nitrate is morphologically and prosodically a word and (ii) that the sequence night rate consists of two phonological words. Thus, an instance of rightward spreading is licensed by (23a) to apply to nitrate: the feature specification [−voice] is spread onto to /r/. The feature specification [−voice] in /t/ in night rate cannot be spread onto /r/ because the two segments, /t/ and /r/, are in separate words. The net effect could be achieved by assuming that the autosegmental operation cannot be applied rightward across word boundaries.
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The notion of direction of autosegmental spreading has been abandoned in Takahashi (2004b), where autosegmental spreading has been translated into merger of segmental feature-geometric structures of phonological segments. Two varieties of non-directional formulation of explanation are available: (i) Exemplar Based Approach and (ii) Sonority Sequencing Approach. The first approach conceives of “linguistic representations as consisting in or being directly shaped by speakers’ memories of specific tokens of linguistic items.” The second is built upon principles of sonority sequencing that have access to the geometry of phonological features. The present paper delineates the second approach and leaves open the possibility of the first approach.

The sonority sequencing scale of the second approach consists of the following scheme:

(24) Principles of Sonority Sequencing
a. Features are ranked according to their strength.
b. The ranking of doubly linked structures of features \([\alpha F]\) and \([-\alpha F]\) is evaluated to be lower than \([\alpha F]\) and higher than \([-\alpha F]\).

The principle in (24a) stipulates the ranking of features: e.g., any \([+\text{sonorant}]\) segment will be ranked higher than \([-\text{sonorant}]\) segments. The principle in (24b) evaluates the ranking of doubly linked contour segments, which are randomly generated by merger of segmental structures. I would like to introduce a stipulation on the effect of merger:

(24) Merger
a. The inputs to the process of merger are (i) a terminal node and (ii) a non-terminal node.
b. The process creates a new temporal element in the phonological representation.
c. The temporal elements must alternate with each other.

The stipulation in (24c) rejects contiguous \(P\)s and \(R\)s.

Let us go back to our examples, nitrate and night rate. The lexical representations of the two segments /t/ and /r/ are specified as follows:

(26) Lexical Representation of /t/ and /r/

```
ROOT
\([-\text{son}]\) LARYN
[voice]
```

```
ROOT
LARYN [+]son]
[voice]
```

By the default “\([\alpha\text{son}] \rightarrow [\alpha\text{voice}]\)” the temporal elements and the feature values are assigned:

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5 Cited from a web page on a symposium on “Exemplar-based models in Linguistics,” whose url is as follows:
http://wsho.uchicago.edu/symposium.html.
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(27) Intermediate Representation

```
    ROOT
       /\               /\              \\
      [-son] LARYN    LARYN [-son]    \\
       \   \               \   \        \\
      P    R               R            \\
       /\                   \          \\
      [-voice]             [ +voice ]   \\
```

The targets of merger are identified as follows:

(28) Targets of Merger

```
    ROOT
       /\               /\              \\
      [-son] LARYN    LARYN [-son]    \\
       \   \               \   \        \\
      P    R               R            \\
       /\                   \          \\
      [-voice]             [ +voice ]   \\
```

The targets are merged by a temporal element $P$, where any insertion of $R$ cannot be accepted, due to the sub-principle in (24c):

(29) Merged Structure

```
    ROOT
       /\               /\              \\
      [-son] LARYN    LARYN [-son]    \\
       \   \               \   \        \\
      P    R               R            \\
       /\                   \          \\
      [-voice]             [ +voice ]   \\
```

The default in (10c) licenses the linkage of the introduced $P$ with the LARYN node on the left.

The ROOT node on the right dominates a partial structure “[-voice][+voice],” which stands for a partial devoicing of the sonorant /r/. As for the representation of night rate, the merger is directly prohibited by (30):

(30) Linking Constraint

The terminal feature in the word-final segment cannot be the target of merger.

Alternatively, the constraint in (30) can be reformulated as a visibility condition on merger:

(31) Visibility Condition on Merge

The terminal features in syllable coda are not visible.
The second possible alternative is an opacity condition on Merge:

(32)  Opacity Condition on Merge

Merge does not have access to the terminal features in syllable codas.

The three possible formulations of restriction on Merge should be evaluated in the light of the whole architecture of the theoretical framework that we adopt.

The present section has presented an argument for a formalism to capture the Sonority Sequencing Generalization in Feature Geometric terms and has opened possibilities to virtually constrain the applicability of the central computational unit in phonology, i.e., Merge.

5. On Deriving the Effect of Obligatory Contour Principle

This section submits a minimalist scheme of deriving the effect of OCP from the assumptions on the architecture of phonology based upon the enterprise in MP. The net effect of OCP is to prohibit adjacent identical elements.

Realization of adjacent identical elements is a special case of phonological structure, which violates the principle of Sonority Sequencing Generalization. SSG stipulates that the sonority scale is so organized as to successively rise and fall. Let us examine a case from English: a night train. In its natural pronunciation, the adjacent /t/s violate both OCP and SSG. They violate OCP because they are totally identical except for the position in the syllabic constituents, as in onset, nuclei, and coda. They violate SSG because the sonority scale does not successively change.

Let us observe how the two adjacent /t/s are avoided. If the two /t/s include specifications [Coronal, −voice] governed by PRP, they violate OCP and SSG. The auxiliary operation Erase is evoked, and it erases the specification [−voice] in the word-final coda. I would like to assume a stipulation on Erase:

(33)  Opacity Condition on Erase

Erase does not have access to the terminal features in syllable rhymes.

The operation Merge is evoked to link the non-terminal node Laryngeal in the word-final coda and the terminal feature [−voice] in the word-initial onset. A P is inserted that links the non-terminal and terminal nodes. A sequence of temporal elements PR is assigned by default under the non-terminal node Laryngeal on the left, and a P is inserted by default under the non-terminal node Laryngeal on the right. Thus, the operation Erase helps account for the cases of OCP violation.

We may resort to the auxiliary function of Erase to explain the phonological dichotomy of strengthening and weakening of segments, with which I will be engaged in Takahashi (2005).

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Two typical weakening processes in English, that is, Fricative Voicing in Old English and Flapping in American English, and a strengthening process of vowels in Japanese, i.e., Vowel Devoicing in Japanese, are accounted for as processes in which certain feature values are erased, which feed a processes of insertion of feature specifications.

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