PARTS 5-6—MATRIX MECHANICS

THE SIMPLE VOWELS AND THE SIMPLE CONSONANTS

All phonemes, or more exactly, their nodes are initially **created** by the **mergers** in various combinations of the three primal phoneme nodes h, n and m. The mergers are generated within the framework of the 3 x 3 matrix and they take place at **three** levels. The **first level** produces the basic vowels and basic (voiceless) consonants, while at the **second level** the nodes of these newly emerged phonemes once more merge with the primal phonemes and with one another. The second level yields the complex vowels (rounded, closed) and complex consonants (all voiced and all remaining voiceless ones). The **third** level includes additional recombinations of complex phonemes that offer alternate articulations of complex phonemes. This section describes the **first** level generation.

The primal phonemes /h/, /n/ and /m/, are self-standing and are not merged combinations of other phonemes. They are the parents of all phonemes, of the highest rank in the phonemic

The **tools and processes** of phoneme production mechanism are the following elements: primal nodes, primal presettings, and locking, switching and merger action of nodes within the 3x3 matrix.

5.1 First level mergers: simple vowels and simple consonants

First level phonemes include: the simple vowels /i/, /a/, and /u/, the voiceless stops /t/ and /k/, as well as /ɲ/, /ŋ/ and /ɣ/, plus /j/, /w/, /l/ and /r/, (the latter four in this system being defined as semivowels), all of which derive from various mergers of the primal phonemic nodes h, n and m. These actions are explained in matricial mechanics described below.

Example of first level processes: (see fig. 1)

1. The initial setup at minimal energy level is a balanced framework.

2. Starting with either dorsal or ventral presettings, there is the option of whether the **h** or **n** or **m** node will act as the central **stable anchor node**. In fig. 1 the m node is stable and it is located in the mid-central cell of the 3 x3 matrix.

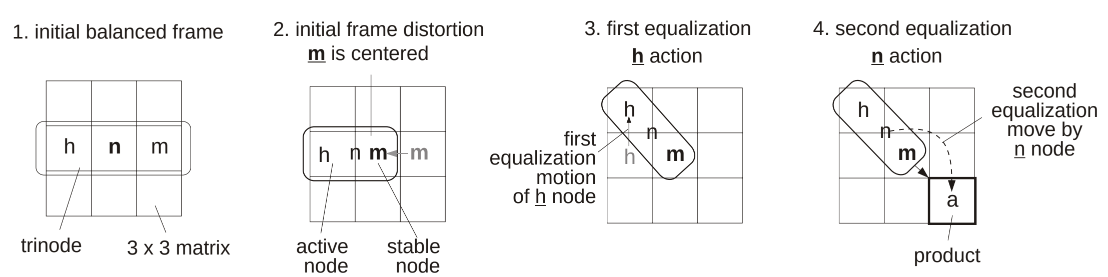
3. This rearrangement creates an imbalance of forces and the frame distortion generates equalization movement by the other two nodes. The h node makes the **first** move to equalize the distortion.

4. The **second** move, performed by the n node completes the equalization. This is an either dorsally or ventrally directed target motion which produces the articulation frame of a first level simple vowel, which in this case is /a/. Observing this process provides a solid basis for perceiving all further ones.

Generation of the various simple consonants and semivowels is initiated by different functional roles executed by the primal phonemes. Simple consonants are produced with the h node as stabilizing anchor and m as the active node. The converse holds for simple vowels. When m+n or h+n form the stable+active node combinations then the resulting articulations are those of the semivowels /j/, /w/, /l/ and r/. Table 5.2 on page 2 gives a summary of first level phoneme production.

1

Example of matricial phoneme generating process



5.2 GENERAL CHART OF FIRST LEVEL MERGERS

key:
ŋ - English /ng/
ɲ - French /gn/
ɣ - Arabic /gh/

Simple vowels and consonants

Ventral primary setting

parent nodes			products	
nodes stable	nodes active	axes*	vowel presetting	consonant presetting
m	h	oblique ×	i a u ə	t k ɲ ŋ
		true +	n**	ə

Dorsal primary setting

parent nodes			products	
nodes stable	nodes active	axes*	consonant presetting	vowel presetting
h	m	oblique ×	t k ɲ ŋ	i a u gh
		true +	ə	n

Semivowels j / w and l / r

Ventral primary setting

parent nodes			products	
nodes stable	nodes active	axes*	vowel presetting	consonant presetting
h	n	both axes	w	j
n	h	both axes	w	j

parent nodes			products	
nodes stable	nodes active	axes*	vowel presetting	consonant presetting
m	n	both axes	j	ɣ
n	m	both axes	w	ɣ

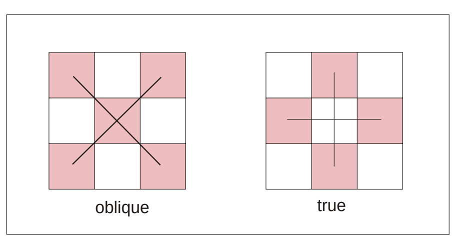
Dorsal primary setting

parent nodes			products	
nodes stable	nodes active	axes*	consonant presetting	vowel presetting
h	n	both axes	w	j
n	h	both axes	w	j

parent nodes			products	
nodes stable	nodes active	axes*	consonant presetting	vowel presetting
m	n	both axes	ɣ	j
n	m	both axes	l	r

*** The movement axes in the matrix**

There are two distinct directions of nodal motions in the matrix along two sets of axes: **true**, or horizontal and vertical, and **oblique**, or diagonal in either direction. Placement of active nodes falls into two types, along **oblique** (or diagonal) and **true** (or horizontal and vertical) axes. This is an anatomically determined faculty. When set in either configuration nodal movement is efficient only along oblique or true directions. Contrasting axial configurations produce different phonemes in some cases, but not in others.



**** Note:** occupation of a cell by a single phoneme indicates that the phoneme is produced in every cell of the particular axial configuration.

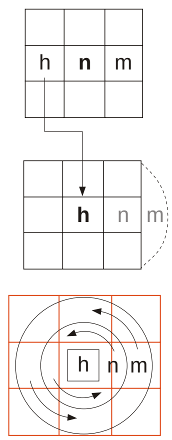
Note on Table of First Level Mergers

It is notable that at this initial level of mergers phonemes such the vowels /i/, /a/, /u/, as wells as the neutral vowel and /ɣ/ are sounds that also occur in modified forms in animal vocalization. The nodes of simple phonemes also show up in mastication, although lack of phonation prevents their vocalization. The nodes /t/ and /k/ are the anterior and posterior gates of the oral mastication chamber. The /j/ and /w/ nodes appear when food passes the velum and /m/ occurs preceding deglutition. The simple vowel nodes /i/, /a/, /u/ are present in the mastication chamber. The /m/ node generates the universal expression of taste appreciation. This situation explains the readiness with which vocalization or speech can be entered by animals and humans while feeding.

5.3 The actions of the primal nodes in the articulative matrix

Basic to the processes discussed here is a behavior illustated in fig. 2. When one node is assigned primacy, and is therefore the stable anchor of the frame, then the remaining nodes appear in movement paths within the envelope surrounding the anchor and the nodes can move in along those paths.

2 **The actions of the primal nodes in the articulative matrix**



Primal trinode at equilibrium, with medial stabilizer anchoring (n).

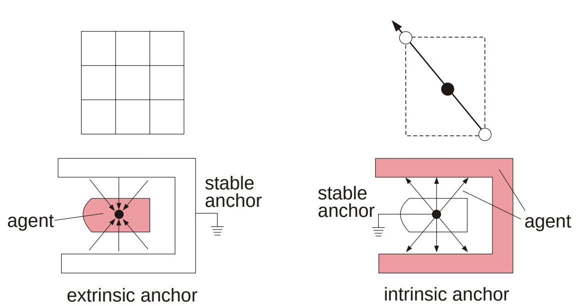
The node (h) becomes stabilizing anchor and moves to center of its superimposes its frame.

With this frame in place node behaviors change: the other two nodes move along paths around the anchor node, moving into the various matricial cells.

The **action** of the trinodes in phoneme production can be illustrated in **two** ways: in a **matricial** and in a **geometric** format.

The difference between the two modes lies in the fact that there is a sequential **alternation** in ongoing activity by the **intrinsic** and **extrinsic** forces of the tongue. Controlled action must be executed by an **agent** and an **antagonist** interaction and it is these opposing roles that take part in alternation. Specifically, in the **matricial** aspect the prime agent, or anchor is the **lingual node** and its **intrinsic** muscular frame. In the **geometric** aspect the prime agent is the **extrinsic** lingual muscular frame. Thus, in observing the actions of the two modes of phoneme generation it is important (a) to work in the speech mode and framework, rather than in the respiratory or other framework, and (b) to distinguish intrinsically and extrinsically initiated behaviors, figs. 3 and 4.

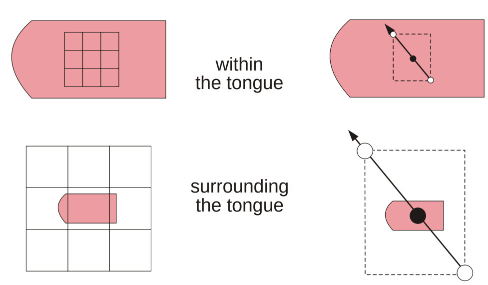
3 **matricial aspect** **geometric aspect**



In the matricial aspect the stable anchor is the extrinsic frame and the active agent is central node.

In the geometric aspect the stable anchor is the central node, and the active agent is the extrinsic frame.

4 **matricial aspect** **geometric aspect**



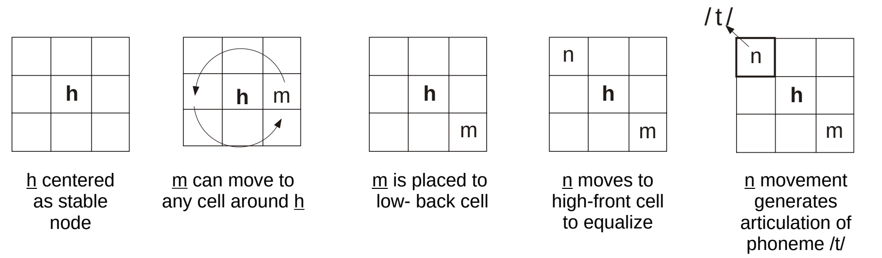
Both the matricial and geometric frames can be projected to appear either within the tongue or surrounding it, that is, at different sizes. This is due to notions explained in the section *Phase Relations*.

5.4 Matricial format:

Fig. 5 exemplifies consonantal generation with the h node serving as the central anchor. When this node moves centrally the other nodes adjust their positions to equalize the frame distortion, moving into various cells around the center. In this case the m node relocates to the low-back cell and responding to this the n node takes the symmetrically opposite high-front position. This last action creates an articulating framework of /t/.

5

Production of simple phoneme in the 3 x 3 matrix



Note: observation of both matricial and geometric node movement behaviors needs to take place in the speech mode. The chosen anchor node is to be centered. Upper and lower teeth should not be in contact.

Analyzing phoneme generation is **clearest** in the **matricial** format since it entails locating and moving nodes in a cellular matrix, where location within or movement across cells is easily perceived. First moving the anchor node to various cells solidifies the matricial structure; other nodes can be then located and moved to chosen cells. Note that the cells are enclosed within borders which can be crossed only when a certain amount of additional energy is applied—this process is related to syllabification.

5.5 Geometric format:

Note: observation of behavior needs to occur in the speech mode and the extrinsic forces are agents of movement.

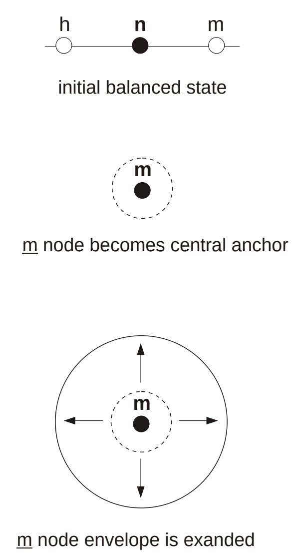
In the initial balanced frame the trinode is centered on n.

When articulation anchored by the **m** node is initiated, the m becomes the central node, and the force **envelope** of the m node appears. The envelope is constricted, of smaller size and of tenser configuration when compared to the initial balanced one. Being masked by the increased frame tension, the remaining nodes become less apparent to discernment, fig. 6.

As in simple vowel and consonant frame expansion, mentioned in Part 4 (Basic mechanics), 4.4, the m centered frame can undergo an expansion. Causing a distortion as it appears, the m frame executes an expansion in order to equalize intrinsic and extrinsic forces. Here we see functional alternation: the intrinsic centripetal (centralizing) m action is followed by an extrinsic centrifugal (expanding) one.

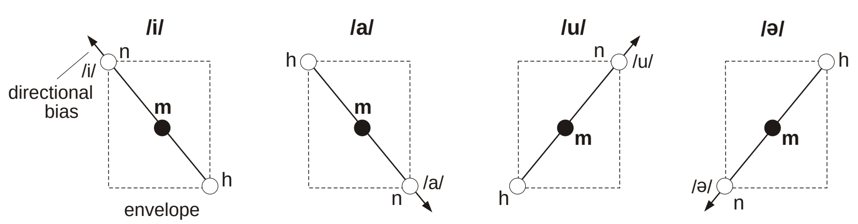
In the expansion there is a targeting **bias** towards a particular direction. There are four such directions, although the modal one is forward and up, targeting a /i/. Manipulating the forces or tilting the head forward or backward changes the targeting directions toward those of the phonemes /a/, /u/ and /ə/, fig. 7.

6



7

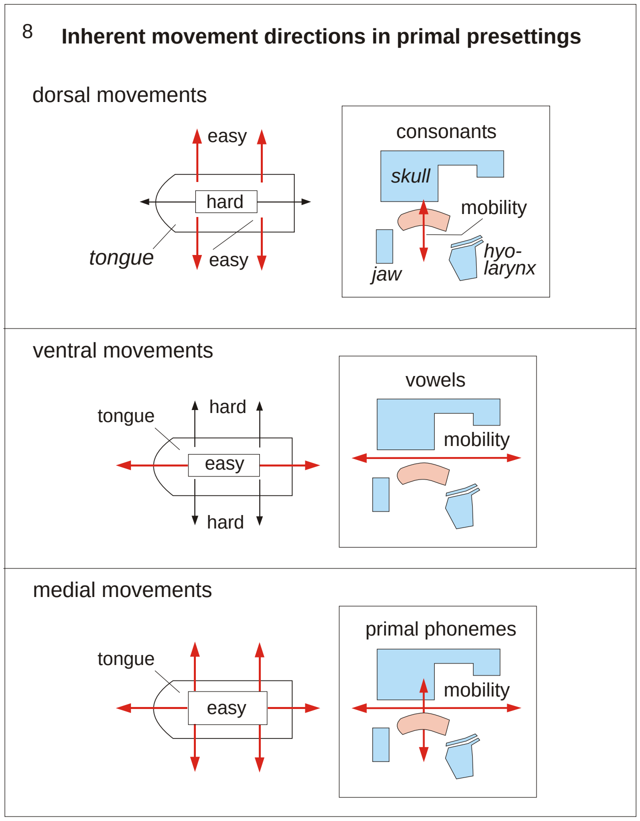
Frame expansion



5.6 The inherent directional determinants of node movement directions: the two versions of the 3 x 3 matrix

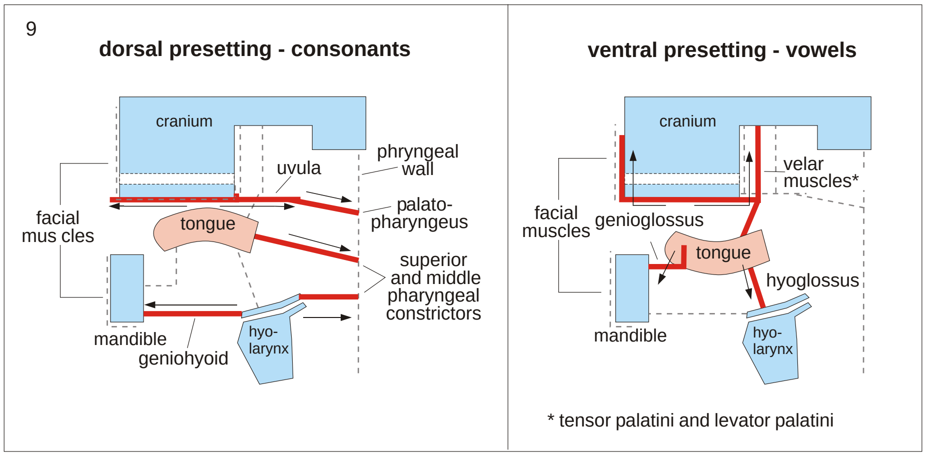
Deriving from their anatomic characteristics, in each of the three presettings there is definite bias for a certain direction of movement.

In **ventral** presetting and in the vowel matrix the tongue and movements between the vocalic nodes is more efficient in the **horizontal** direction and more difficult vertically. In contrast in the **dorsal** presetting and in the consonantal matrix **vertical** movement is more efficient than the horizontal one. Thus, an inherent directional movement determinant is present in the presettings, fig. 8. The reason behind this is given below.



5.7 Anatomic design of directional determination

The **anatomic** basis for this phenomenon is shown in fig 9. In the dorsal setting the horizontal (axial) forces dominate, i.e., are the prime movers. In the ventral setting the verticals dominate. In the medial setting the horizontal and vertical components are of equal strength. In the **dorsal setting** it is difficult for a node to move along tense **horizontal** frame paths while vertical motion is easier since the vertical frame components are relatively relaxed. In the **ventral presetting** the bias for nodal movements is **vertical**. Ventral (depressive) positioning of the tongue is in part assisted by its own weight, requiring less energy to be maintained, hence the greater mobility of the vowels.



Note: the involvement of the facial muscles in speech production arises from evolutionary development. Briefly, as it has been established in comparative vertebrate anatomy, the organs of speech, both bones and musculature are (a) originally gills-derived (**branchiomeric**) structures, as well as (b) extensions of certain somatic muscles located under the gills (**hypobranchials**). These two subsystems have evolved to be thoroughly integrated and so the mandible and the facial muscles, including most apparently the lips (orbicularis orbis) directly interact with movements of the oral speech muscles.

Consideration of the evolutionary sources of the speech mechanism is important in better understanding it. For example, fish gills are a row of valves. But then the speech tract is also a row of valves, starting at the lips, through the tongue, velum, epiglottis, larynx, pharyngeal constrictors, esophageal sphincter, to the diaphragm.

The **branchiomerics** include: the visceral bones, including the jaw and the hyoid, and the visceral muscles: temporalis, masseter, pterygoids, laryngeal muscles, mylohyoid, digastric anterior and posterior bellies, tensor palatini, levator palatini, stylohyoid, stylopharyngeus, uvulae, palatoglossus, pharyngeal cons**a**trictors, palatopharyngeus, salpingopharyngeus; also the facial muscles—which extend frontally from the top of the skull (frontalis) to the upper chest (platysma), and the aural parts: tensor timpani, stapedius.

The **hypobranchials** include: the tongue, genioglossus, geniohyoid, hyoglossus, sternohyoid, thyrohyoid, sternothyroid, omohyoid, trapezius, sternocleidomastoid.

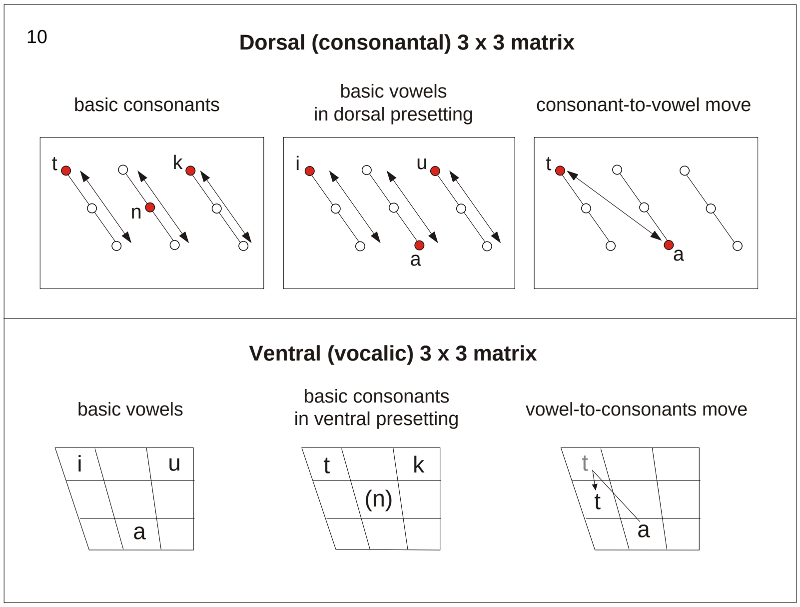
5.8 Nodal movement in syllabification in primary settings

This difference in inherent bias of movement directions between the primal presettings means that in **phonemic ground** actions if (a) the dorsal (consonantal) presetting is the prime agent, then vertical movement is efficient and therefore **consonant articulation**, built from the dorsal setting will efficiently transfer **downward** to reach and return from a **vowel** node below it; (b) on the other hand, still due to inherent directional determination, a consonant node will move **horizontally** with **difficulty** to reach another consonantal node—cf. limitations in consonant adjacency. The **converse** behavior holds for the **vowel** presetting, although ability for **vertical** motion for vowels is significantly assisted by mandibular movement.

The choice of whether a consonantal or a vocalic matrix appears in a syllable is **determined** by the initiating phoneme of a syllable. Thus a CV or CVC syllable will set up a consonantal matrix, and the converse is true for a VC or VCV syllable. For this reason when a vowel is generated in a **consonantal** syllable, its vocalic framework is secondarily superimposed on the consonantal presetting, which remains embedded.

The **converse** holds true for a consonant superimposed in a VC or VCV syllable.

5.9 The two versions of matrix diagrams



In view of inherent directional bias, the **consonantal matrix** is best represented as three obliquely vertical **lines** or columns, along which consonants move. The consonantal matrix generates its own **distinct** vocalic matrix, in which vowel nodes created in a consonantally initiated syllable are also approached to and exited from through vertical paths. That is, vowel production is accessible within the dorsal/consonantal presetting—which forms its own set of vowel positions within its frame and these vowel nodes move along the lines dictated by the consonantal setting, fig. 10.

Note: The longitudinal axis of the tongue posteriorly curves downward, and this fact is reflected by the **tilt** in the vertical lines.

The **vowel matrix** is best represented as a table of 3 x 3 **cells**, where inter-vowel horizontal or vertical movements are available since vowels are significantly associated varying tongue heights, while consonants are to a much lesser degree. Cells, rather than points appear in the vocalic matrix because **vowel nodes** are **mobile** within a cell, i.e., in relatively greater space than do consonants. The tongue axis **slant** exists in the vowel matrix as well, but since the **tilt** varies with the tilt of the head, it is less complicated to depict the vowel matrix without a tilt.

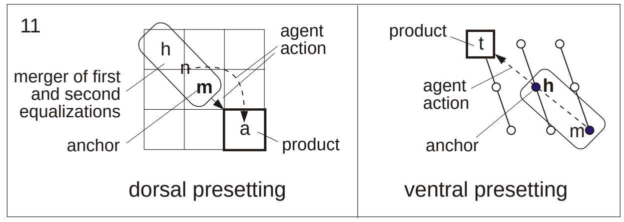
In the vowel matrix, transfer of a vowel node to a consonant node appears to be horizontal (at the nodal level, but not so in full articulation). The reason is that once an articulated product is generated inside an obliquely reached cell, the forces are such that due to the relative plasticity of the vowel matrix the matrix itself becomes rotated and therefore the position of the generated consonant approximately aligns with the initial vowel. It is difficult to present this in a diagram.

PART 6—MATRICIAL GENERATION: SIMPLE PHONEMES
THE FIRST LEVEL MERGERS:

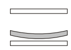
The following pages provide the detailed diagrams of the mergers classified in the **General Chart of First Level Mergers** on page 2. The mergers are grouped according to source parents, dorsal or ventral presettings and matricial axes. Key to diagrams in fig. 11.

Also see Part 8.1 where the phoneme production function performed by the nodes is described in more detail.

key to diagrams



VENTRAL PRESETTING

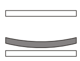


m + h class

simple vowels and simple consonants plus n and ə

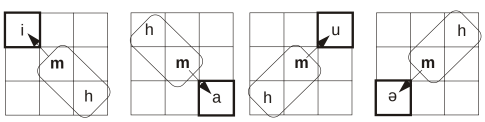
m anchor node
m=stable + h =active
articulator agent = n

primary (vowel) setting

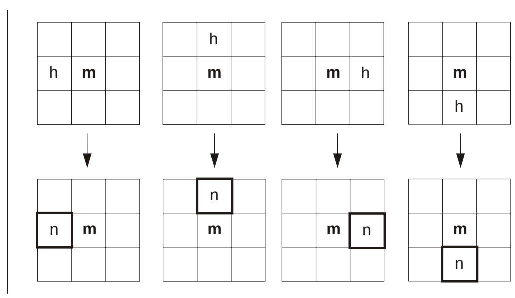


products: i a u ɘ n

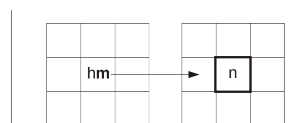
oblique axes



true axes



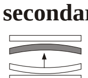
centered merger



The basic vowels /i/, /a/, and /u/ as well as the neutral vowel (ə) are generated in this configuration.

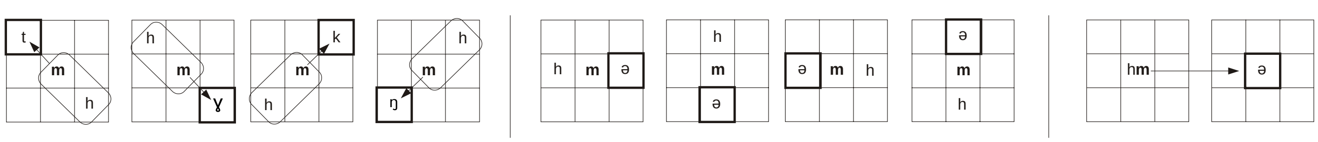
Note: n appears to be generated in the cell occupied by h.

secondary (consonant) setting



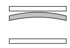
products: t ɣ k ŋ ɘ

oblique axes | true axes | centered merger



The stops /t/ and /k/ as well as /ɣ/ and /ŋ/ appear at this basic level because they originate in mastication. /t/ and /k/ are the front and back bounding gates of mastication space, /ŋ/ and /ɣ/ appear in the start of swallowing. The neutral vowel /ə/is centered between h and m, and is the vocalic (spatial) aspect of /n/.

DORSAL PRESETTING

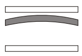


h + m class

simple vowels and simple consonants

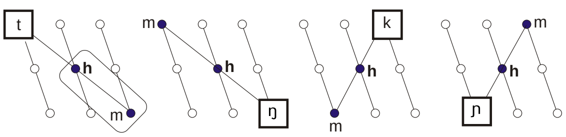
h anchor node
h=stable + m=active
articulator agent = n

primary (consonant) setting

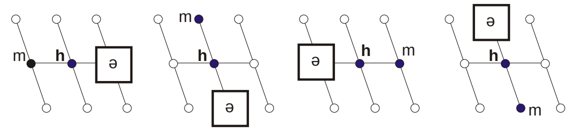


Products: t ŋ k ɲ ɘ

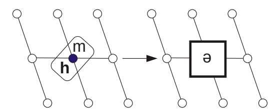
oblique axes



true axes



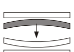
centered merger



Mirrors the secondary consonantal setting of the Vocalic Presetting, except that the /ng/s change places and /gh/ substitutes for /nj/.

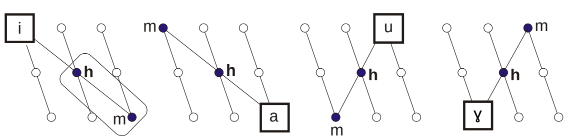
This set is the same in both Vocalic and Consonantal Presettings. The merger product in all cases is /shewa/.

secondary (vowel) setting

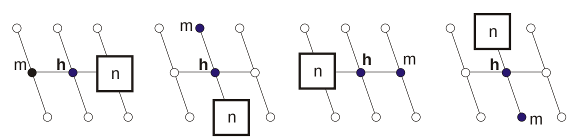


Products: i a u ɣ n

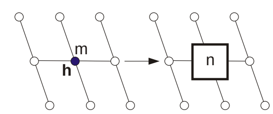
oblique axes



true axes



centered merger



Identical with Ventral presetting/vowel setting/oblique axes configuration except the /ɘ/ v s / ɣ / contrast.

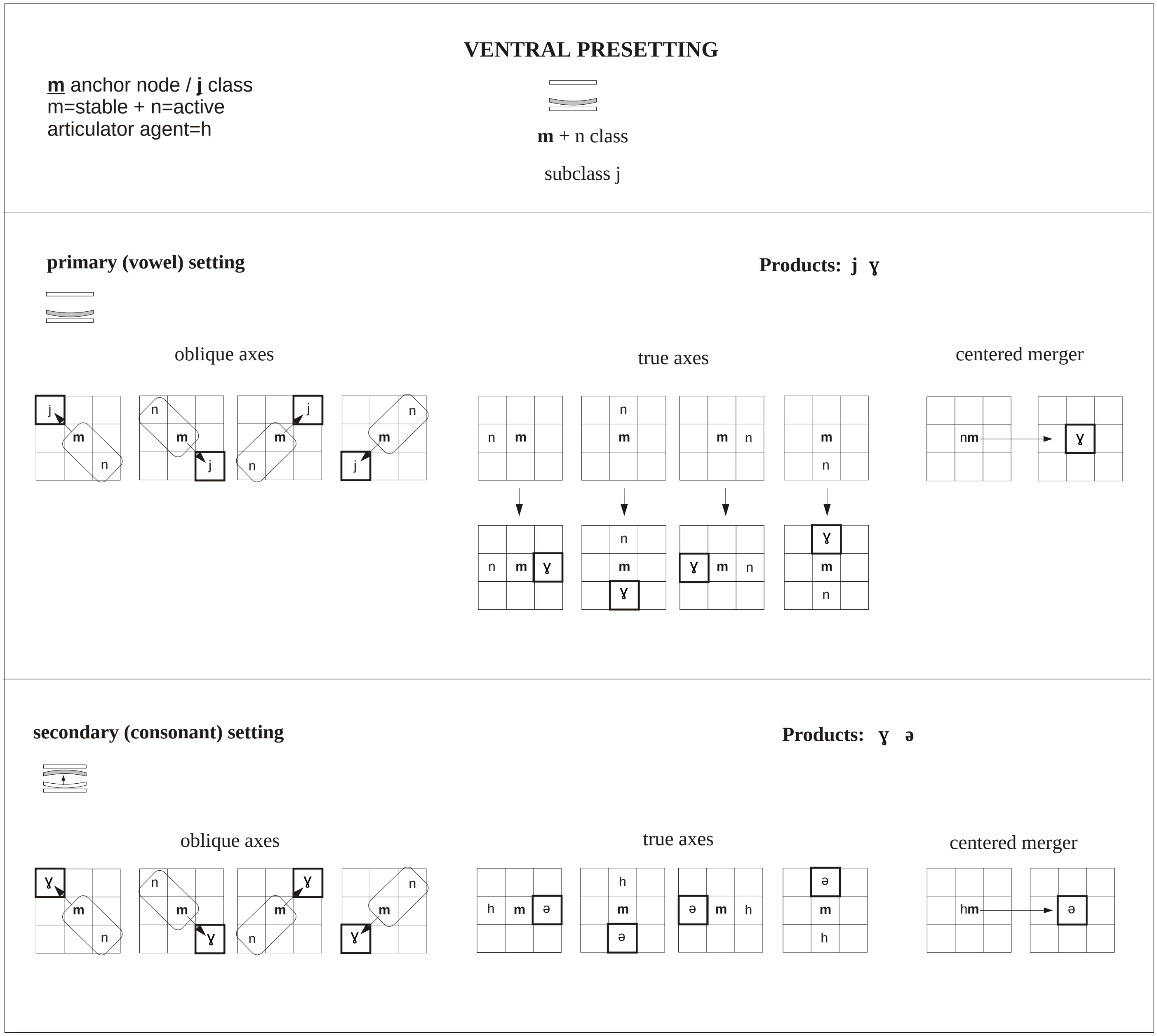
Note: the oblique axes produce , respectively, consonants and vowels. But / ɣ / normally considered a consonant, occurs in the vowel group. It is thus genetically a semivowel more than a consonant.

With an facial expression of animal aggression and teeth bared the /ɣ / phoneme emerges as a growl. / ɣ / and the basic vowels /i/, /a/ and /u/ among some other phonemes are all found in animal voice articulations.

It seems curious that gh appears at this basic articulation level. /ɣ/is not a phoneme common to many languages, but it appears as a laryngeal sound articulated in the frame of smiling.

The true axes yield /ə/ in the consonantal setting, whereas they produce /n/ in the vowels setting.

The same contrast occurs in the true axes.



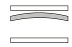
The consonants j and w are products of m+n mergers. They appear at this fundamental level because they are functional agents of mastication, respiration and vocalization. Acting as valves the j node closes the velar tract while the w node closes the linguo-pharyngeal passage.

Comparison of the configurations reveal various symmetries.

Note: the gh producing actions in the vowel setting are true-axial, but are oblique-axial in the consonantal setting.

DORSAL PRESETTING

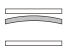
<u>**n**</u> anchor node / **j** class
m=stable + n=active
articulator agent=h



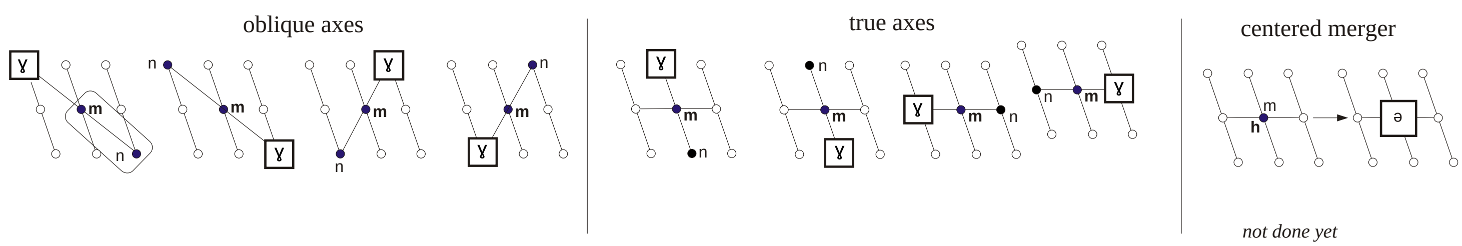
m + n class

subclass j

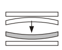
primary (consonant) setting



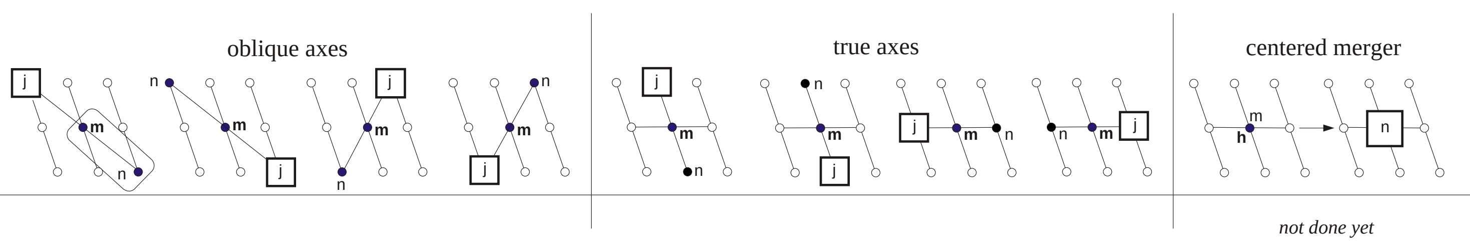
Products: ɣ ə



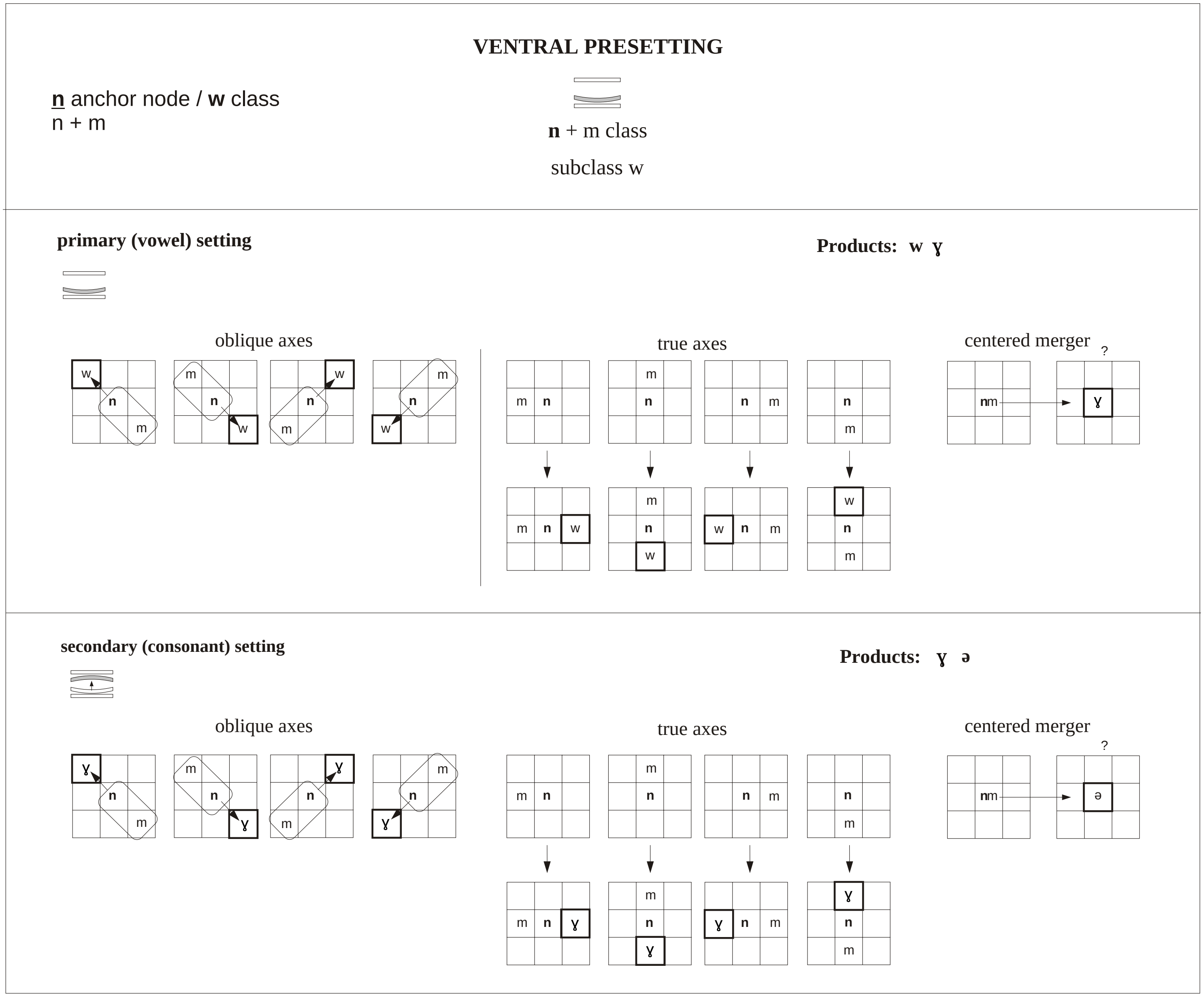
secondary (vowel) setting



Products: j n



Note: /j/ appears only in either primary or secondary vowel settings, indicating that it is closer related to vowels than to consonants. In the consonant setting /j/ degrades to the more primitive /ɣ/.



Note: paralleling /j/, the phoneme /w/ is more vocalic than consonantal; it occurs only in the vowel presetting class. In the consonantal frame it degrades to the more primitive /**ɣ**/.

DORSAL PRESETTING

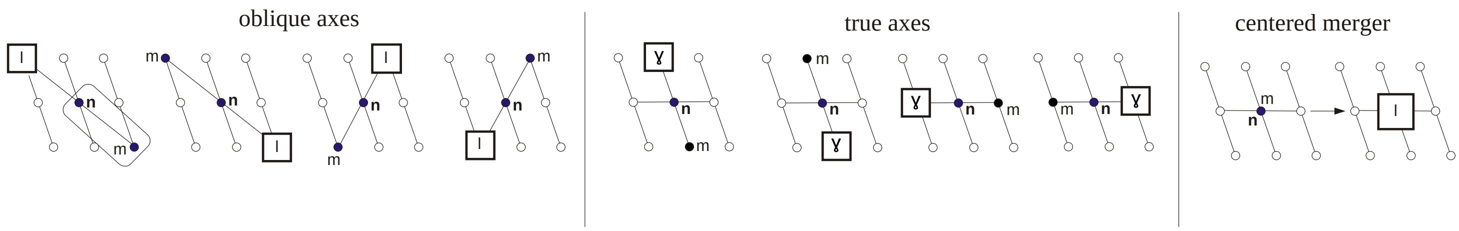
n anchor node / **l** and **r** class
n + m

n + m class

subclass l and r

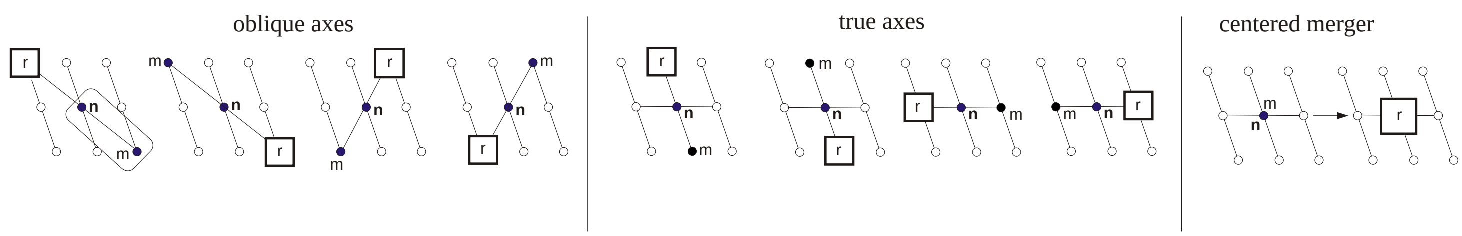
primary (consonant) setting

Products: l ɣ



secondary (vowel) setting

Product: r



A symmetry exists between /l /and /r/ as they contrasting in appearing, respectively, in the consonantal and the vocalic setting.

The phonemes /l/ and /r/ are related as shown by their shared node configurations: both are n based articulations and both are dorsally preset, anbd differ only in primary consonantal versus primary vowel settings.
The association between /l/, /r/ and /w/, all three being n-based articulations, is evident in their substitution of /w/ or /l/ for /r/ often found in children's and certain adults' speech and substitution of /w/ for the lateral (”lazy”) /l/ by some persons.

There is also the mutual exclusion of /r/ and /l/ in Chinese and Japanese, and confusion between /l/ and /n/ in Cantonese. Korean features an ambiguous case, where /l/ and /r/ alternately occur depending on context.

Lastly, there is a relationship in the substitution of uvular /r/ for trilled /r/.
The phoneme /r/ is more vocalic than /l/ since it occurs in the vocalic presetting; it allows for greater air flow than does /l/.

6.1 Nodal actions in producing the simple vowels

The sequence of nodal movements in generating the basic vowels /i/, /a/ and /u/ are illustrated in fig. 855. The ventral primary presetting of vowels is not shown; rather the series begins with the superimposition of a secondary presetting specific to the vowel. This function accords the tract height associated with them. It may be noted that /u/ is medially preset. This may come from the fact that although /u/ is perceived as a high back vowel, the anterior tongue is low, hence /u/ has both high and low placement qualities.

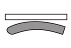
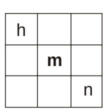
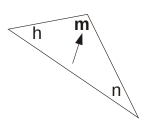
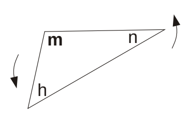
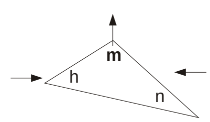
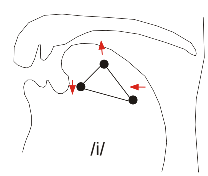
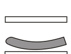
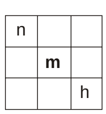
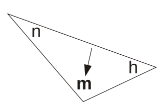
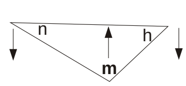
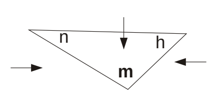
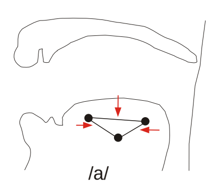
The following steps continue with changes in the matricial line-up of the trinodes and end with full articulation.

The series proceeds through an alternation of extrinsic and intrinsic frame active agencies. Each step introduces a distortion of varying amount since each one superimposes a change, and therefore, each subsequent step also serves to equalize.

Steps:
1. Secondary presetting
2. matricial line-up
3. n-action
4. /i/ product
5. phonation
6. resulting tongue shaping

After the n-agency occurs in step 2, it is the stabilizing node m that changes location and it is the other two nodes that alter positions in order to equalize the trinode frame. This transformability of the anchoring frame allows m to **glide** and so to enable generating the positional variants of the vowel or to approach consonant nodes in vocalic syllables.

(The mechanics positional moves by the nodes are covered in section *Phase Relations*).

step	1 secondary presetting	2 primal phoneme matricial line = equalization	3 pre-articulatory n-action = equalization	4 /i/ node generated = equalization	5 phonation =equalization	6 tongue shape
agency	extrinsic	intrinsic	extrinsic	intrinsic	extrinsic	
vowel **i**						
a						
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