Gary S. Tong (2006)

APPENDIX to The mechanics of speech ontogeny

Appendix A.

Demonstration of frame and content affinities

The cyclic **affinity** of CV pairs, such as /t/d/ with /i/ of with /a/ is demonstrated:

a. If within the speech mode, the closed jaws are held neutral, and an isolated lingual t stop map is continuously maintained, then the entire tongue tends to become transversely narrowed, either dorso-ventrally or laterally or both, and as compensatory air tract channels, open the t map changes into that of /i/. When the /t/ anchor is released, in order to optimize the respiratory state, the /i/ anchor replaces it.

b. Similarly, if while maintaining a t map, the tongue is retracted, once again an i vowel space arises.

c. When the tongue is narrowed or retracted, the t envelope (and hence the entire frame) becomes distorted and the necessary glottoregulative compensation adjusts the framework by **exchanging** the present anchor, with the least expenditure of energy, with the **symmetrical** anchor within in the trisegmental structure. Moving to any other anchor requires more energy.

d. Holding the t with the jaw lowered will similarly produce a shift to /a/.

e. With k the i and a associations are symmetrically opposite. The k with closed jaw gives a, and with open jaw yields i.

f. The voiced versions, d and g, employed in the above experiment generate more centralized variations the neutral vowel ə.

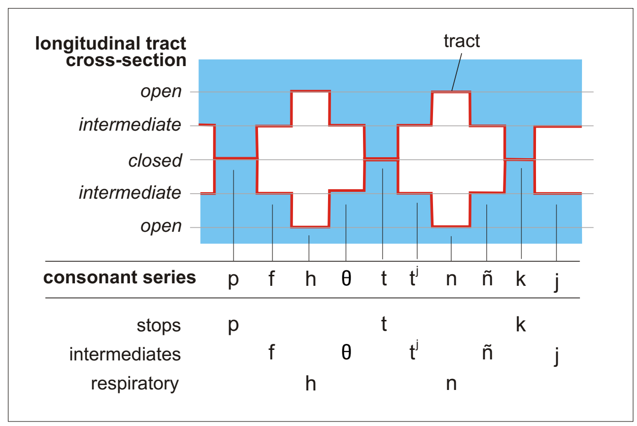
Both the tongue and the jaw actions distort the tract and through glottoregulative optimizing adjustment the closest alternate articulatory-phonatory frame is generated. Thus, jaw-tongue settings and glottoregulation together determine what particular consonants and vowels will be syllabically associated.

Appendix B.

Demonstration: the presence of metaperistaltic (peristalsis-based) pattern in speech

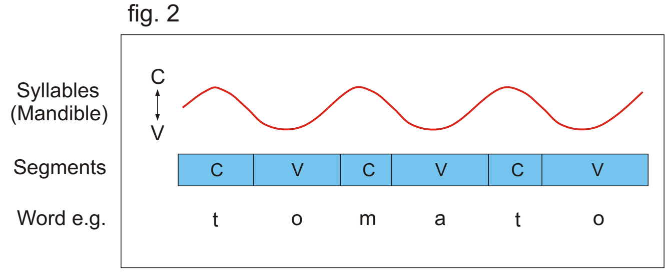
Relax all of the speech framework. Isolate the lingual anchors and keep phonation minimal. Then, slowly and carefully going through the articulation of the sequence of consonants in diagram XR, in either direction, observe the degree of tract closure to respiratory flow produced by each phoneme. The cross section of the air tract varies with the phoneme type: stops block the flow, intermediates (fricative, palatalized, semivowel) partly impede it, and the respiratory consonants /h/ and /n/ open the tract. Interestingly, both tract cross section and dorsal target points of the phoneme series line up in an order that appears as a quasi-peristaltic pattern. fig. 1. See *The essentials of speech mechanics/Metaperistalsis* and */Appendix / Peristalsis.*

fig. 1



McNeilage and Davis have recognized such peristaltic structuring in the relationship between mandibular close-open alternation and segmental consonant-vowel alternation in the syllable pattern of words: fig. 2.

fig. 2



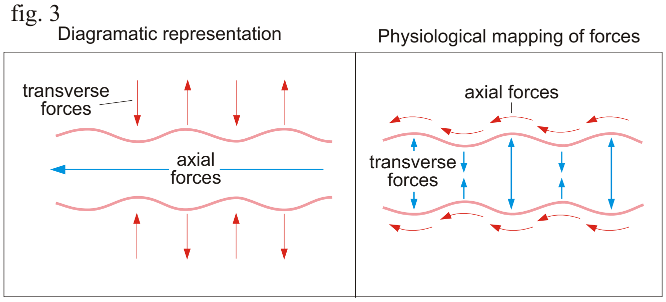
After slide in P. F. MacNeilage and B. Davis: *The Hand & the Mouth in the Evolution of Language*

Appendix C.

Serial-parallel functions

Peristaltic behavior can be interpreted as an action controlled by two simultaneous wave functions, one **longitudinal,** the other, **transverse.** These components can be seen as geometrically **serial** and **parallel** behaviors, which constrict or expand tract segments according to particular patterns. fig.3.

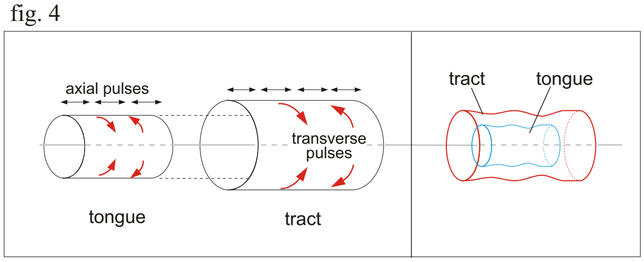
fig. 3



Stabilization of the peristaltic action is essential in the UV, because an ongoing basic balanced state, especially in respiration must remain constant. **Regulation** is achieved by a balancing of antagonist forces. When one distorts the tract another compensates to bring the action to optimal efficiency during a particular behavior. **Articulation** and **phonation** each have agonist and antagonist components within their own respective subframeworks and are also mutually compensating agents of each other. Speech production, therefore contains four simultaneous monadically coactive agonist-antagonist behaviors.

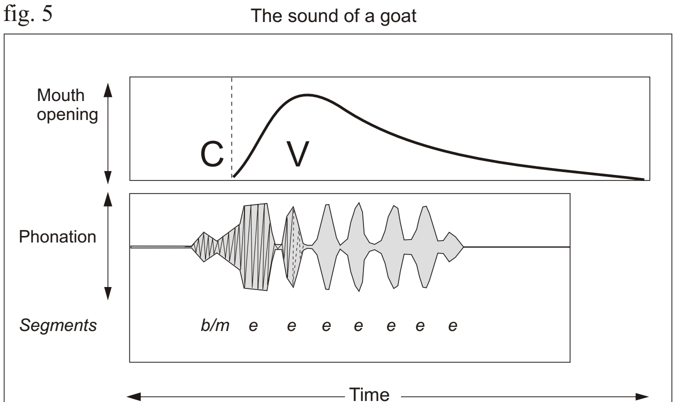
The **oro-pharyngeal** part of the upper visceral tract is a **metaperistaltic** device consisting of two concentric coaxial structures, the tongue and the tract. Each has an axial and a transverse regulatory function and working together can create a number of complex wave patterns such as appea in respiration, feeding, speech, etc. The velar apparatus is another coactive region. fig. 4.

fig. 4



Three such simultaneous wave activities of metaperistalsis are illustrated in the record of a sound emitted by a goat, in a slide presentation by MacNeilage and Davis. The diagram from slide collection *The Hand & the Mouth in the Evolution of Language* depicts the simultaneity of mandibular opening and syllable formation, to illustrate the role of the jaw. All three functions are peristaltic-based alternating pulses in different phases. The mandible opening-closing comprises one pulse, the several syllabic segments arise from laryngeal valve pulsation, and the phonation component, a far more rapid pulse, is created by oscillating glottis. fig. 5.

fig. 5 The sound of a goat



After slide in P. F. MacNeilage and B. Davis:
The Hand & the Mouth in the Evolution of Language.
The line of "Segments" has been added to original slide.

The sound of the goat approximates a "p/b/m/w/-e-e-e-e...", (although the initial consonant is ambiguous and is not well-defined in terms of human standards). This points to a similarity to the the association of jaw opening with /p/ and /m/ in human speech: the goat's jaw opening frame, like that of cattle or sheep, starts with a sound of mixed /m/ and /p/b/w/ qualities. In these sounds the tract does not isolate /p/ and /w/ but shapes itself to produce both simultaneously. When our nose is stuffed during a cold the tract generates a mixed /n/ + /d/ phoneme. The cat vocalization, /miau/, starts with /m/, as well, and continues with the basic vowel series //i/, /a/ and /u/.

Appendix D. Anatomic symmetries in the upper visceral system

The consonantal t-n-k and vocalic a-e-i trisegments employ symmetrical transfers of force between anchors, and so form the symmetries of syllable (frame-content) generation. These patterns are reflected in various anatomic symmetries within the upper visceral system. The following are some examples.

1. Horizontal mandibular axis symmetry

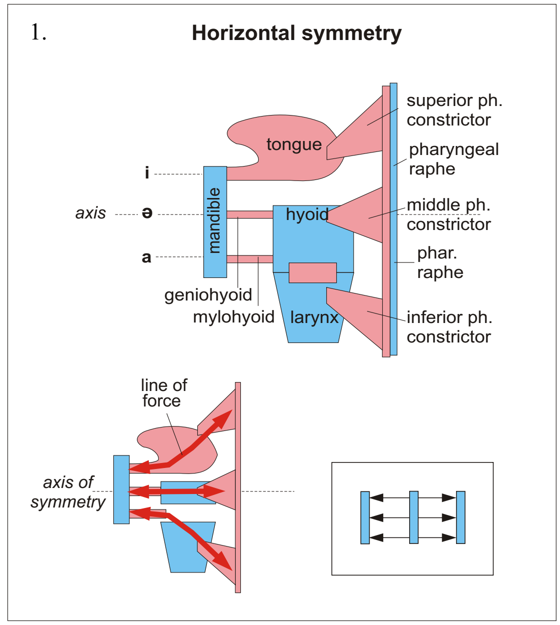
In this configuration the vertically aligned tongue, the hyoid bone and the larynx are centered between with their anterior and posterior muscles connecting the mandible and the pharyngeal raphe. The three tiers, or bridges between the two end regions, namely those of the tongue, hyoid and hyolarynx are also associated with the basic vowel anchors, a, e, and i. These forces are part of the outer manifold of the tongue anchor envelop and are coactive with it as agents of alternate articuation.

The three levels together may be seen as a modified segmental unit of organization. The modifications are no doubt due to the evolution of the UV from pharyngeal and gill structures. Resemblence to segmental structuring may be vestigial or secondarily developed. fig. 1

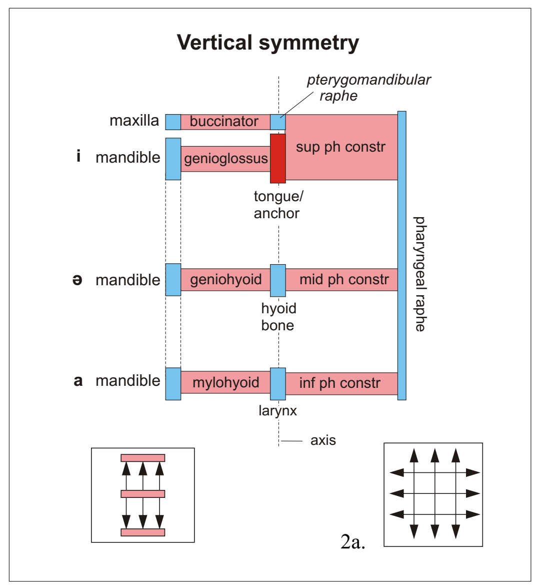
2. Vertical mandibulo-pharyngeal symmetry

This is configuration is a different aspect of the above pattern. Here the vertical line passing through the pterygomandibular raphe, tongue, hyoid and larynx, with their anterior and posterior horizontally running musculature is the axis of symmetry between the maxilla and the mandible. fig. 2.

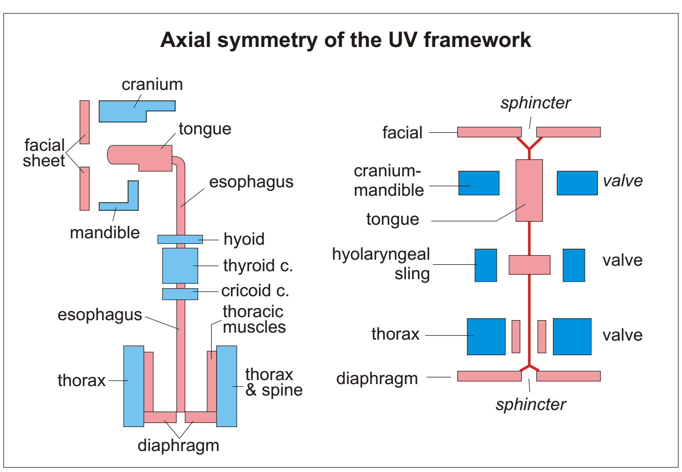
2a. The configuration of forces in the two symmetries above can be composed in 3x3 matrix. fig. 2a.



2.



2b.

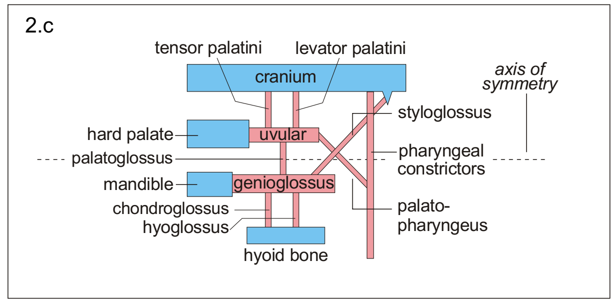


2b. Axial symmetry of the UV tract

The entire length of the UV tract is symmetrical. Two sheets with sphincters are at the ends; further in, two bone structures enclose the tongue and the thoracic muscles; centrally the hyoid and the cricoid enclose the thyroid cartilage and the glottal mechanism. It is more correct to compare not the facial, but the entire head covering to the diaphragm. Then we see two aponeuroses (the galea aponeurotica and the central tendon, each surrounded by radiating musculature.

2c. Tongue-velum symmetry

The mechanical symmetries of the AMS may be related to anatomic symmetries of the UV. Evolutionary restructuring usually mask these. One example can be shown in a diagram. When the genioglossus muscle is straightened, so that it posteriorly extends from the jaw, it and the velum appear as structural duplicates, mirroring each other .fig. 2.b



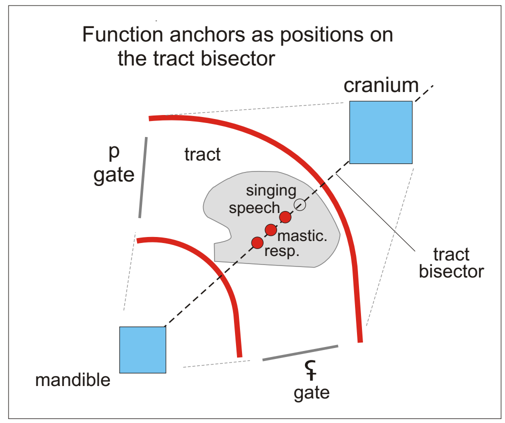
3. The mandibulo-cranial (or /p/-epiglottal stop tract) symmetry

The axis of symmetry connecting the mandible and the cranium intersects the (oral) tract and the tongue. This symmetry governs the relationships between rotation and pivot of the jaw and placement and shaping of the tongue. fig. 3.

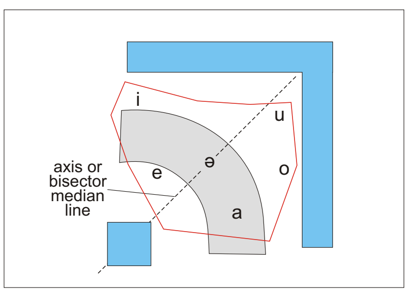
3a. Because the relations of these two vary with the rotation, the axis also varies in its angle and placement. (See also Structure/Appendix/p/-epiglottal stop tract). fig. 3.a.

3b. The vowel quadrilateral can be found centered on thep-epiglottal stop axis. fig. 3b.

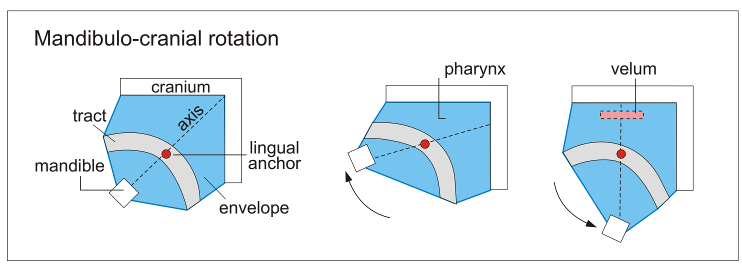
3



3.b



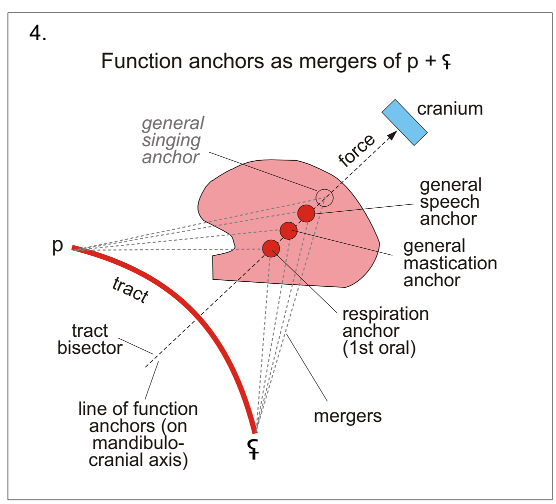
3.a



4. The/p/-epiglottal stop tract symmetry

The lingual function anchors are aligned on the tract bisecting mandibulo-cranial axis. These anchors are produced by the mergers of the lingual anchors of p and of the epiglottic stop that are **symmetrically** located at the two ends of the tract. fig. 4.

4.



Appendix E.

Mandibular pivot matrix mechanics

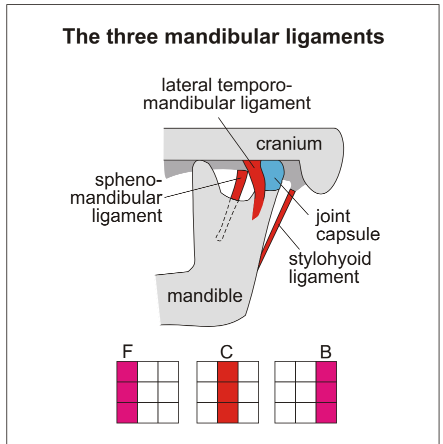
A physiological basis for the 3x3 temporomandibular pivot matrix may be indicated by **three** configurations in the mandibular joint structure.

1) **Ligaments**: the mandible is attached to the cranium by three ligaments: the sphenomandibular, the lateral temporomandibular and the stylohyoid. These are aligned and attached along the sides of the mandible at anterior, central and posterior positions. Thus, they are capable of stabilizing front, central and back pivot positions in the matrix. fig. 1

2) The **temporotmandibular joint** is a **three** part structure in the vertical plane and it consists of bone (cranium), cartilage (articular cartilage) and bone (mandibular condyle). Such a configuration suggests the potential for stabilizing the jaw in three the vertical pivot positions. fig. 2

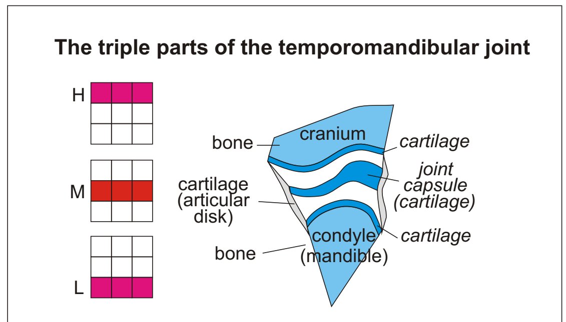
3) The **masseter** and **pterygoid** muscles which join the mandible to the cranium each consist of **two** parts. The masseter possesses a superficial and a deep layer. The medial pterygoid consists of a larger portion and a smaller slip, and the lateral pterygoid is divided into an upper and lower head. These last two parts insert, respectively, into the articular disk and the mandibular condyle. Thus, the high and low and the front and back positions of the pivot can be controlled by the primacy of either of the muscle pairs, while the middle and central positions can be maintained by the combination, or equal primacy of the two parts. fig. 3

fig. 1



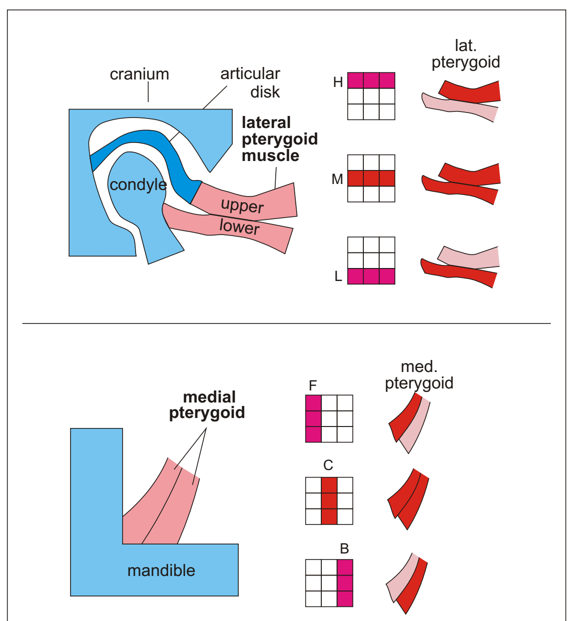
Based on plate 11, Frank H. Netter, *Atlas of Human Anatomy*, CIBA-GEIGY, 1989.

fig. 2



Based on plate 1, Frank H. Netter, *Atlas of Human Anatomy*, CIBA-GEIGY, 1989.

fig. 3



Based on R. T. Woodburne, *Essentials of Human Anatomy*, 6th ed., Oxford U. P., 1978