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.

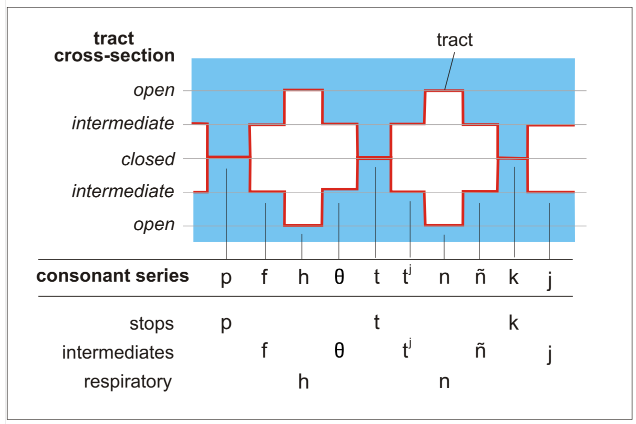
Both the tongue and the jaw actions distort the tract and through glottoregulative optimizing adjustment the closest alternate articulatory-phonatory frame is generated. Thus, jaw-tongue settings and glottoregulation together determine what particular consonants and vowels will be syllabically associated.

Appendix B.

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

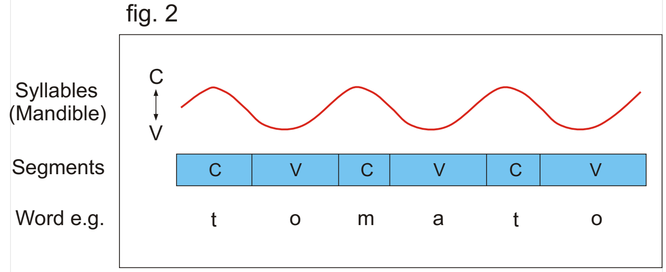
Relax all of the speech framework. Isolate the lingual anchors and keep phonation minimal. Then, slowly and carefully going through the articulation of the sequence of consonants in diagram XR, in either direction, observe the degree of tract closure to respiratory flow produced by each phoneme. The 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



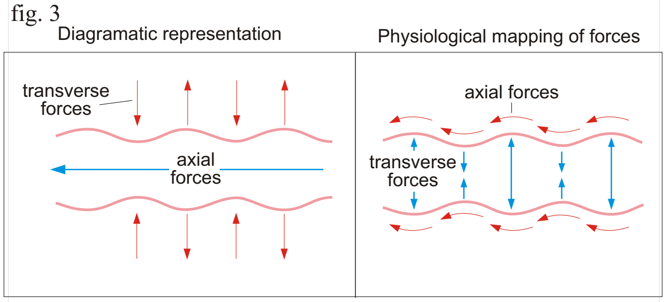
After slide in P. F. MacNeilage and B. Davis: *The Hand & the Mouth in the Evolution of Language*

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.

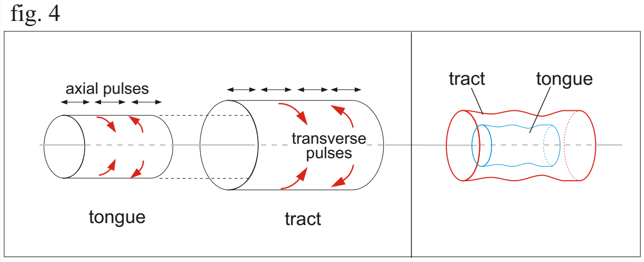
fig. 3



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.

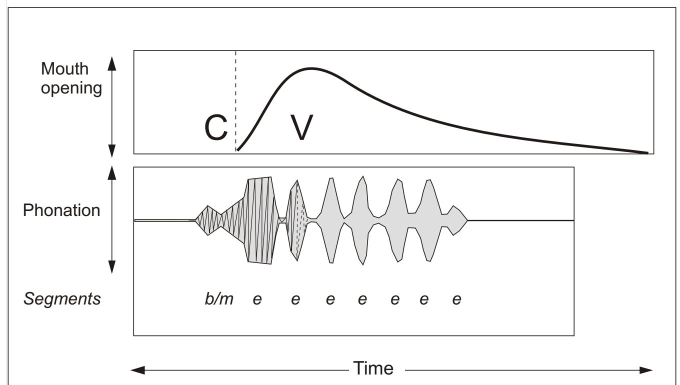
The **oro-pharyngeal** part of the upper visceral tract is a **metaperistaltic** device consisting of two concentric coaxial structures, the tongue and the tract. Each has an axial and a transverse regulatory function and working together can create a number of complex wave patterns such as appea in 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.

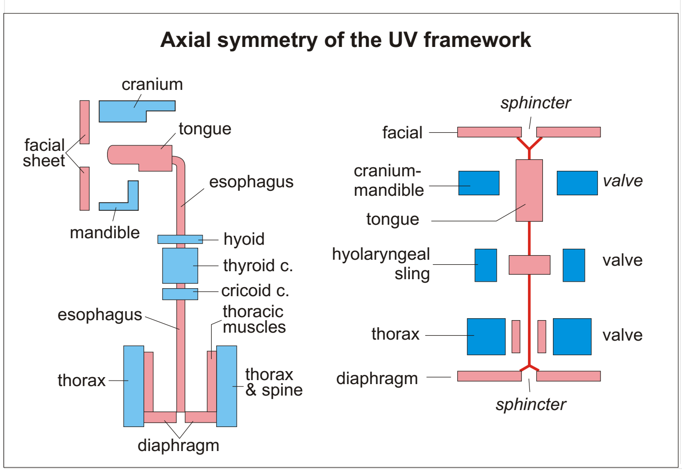
The three levels together may be seen as a modified segmental unit of organization. The modifications are no doubt due to the evolution of the UV from pharyngeal and gill structures. Resemblence to segmental structuring may be vestigial or secondarily developed. fig. 1

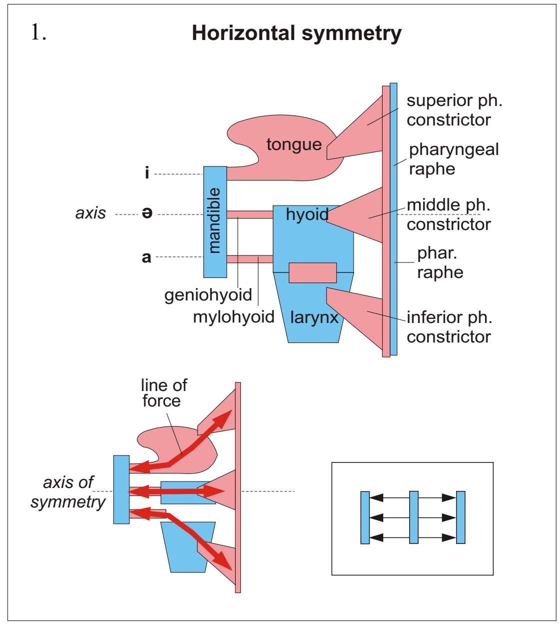
2. Vertical mandibulo-pharyngeal symmetry

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.

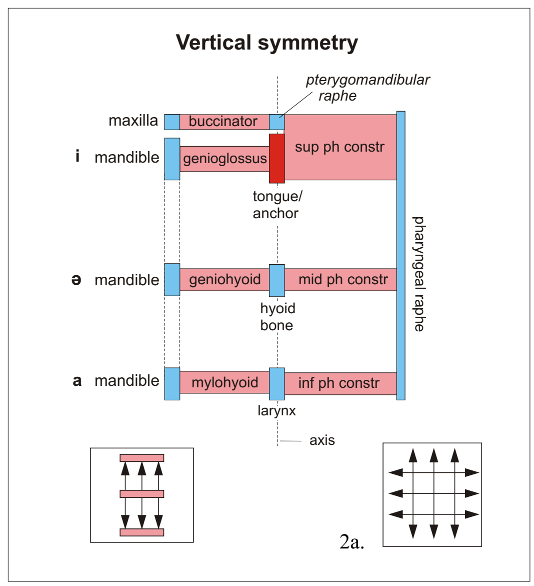
2a. The configuration of forces in the two symmetries above can be composed in 3x3 matrix. fig. 2a.

2b.





2.

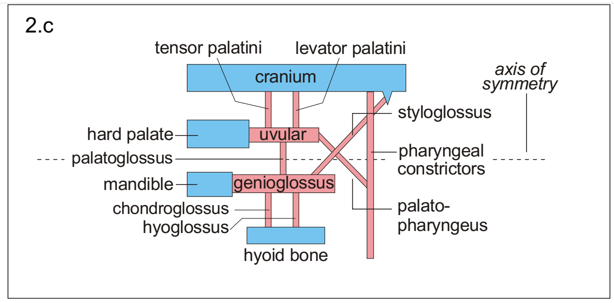


2b. Axial symmetry of the UV tract

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



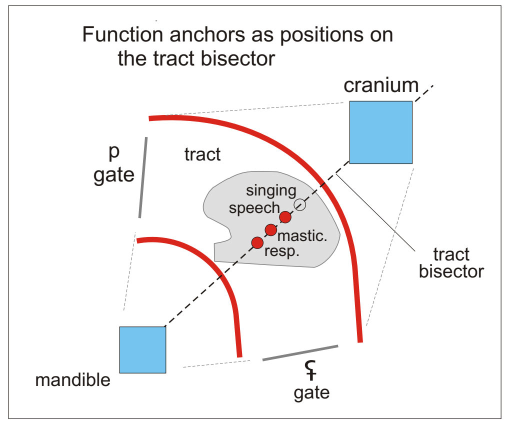
3. The mandibulo-cranial (or /p/-epiglottal stop tract) symmetry

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.

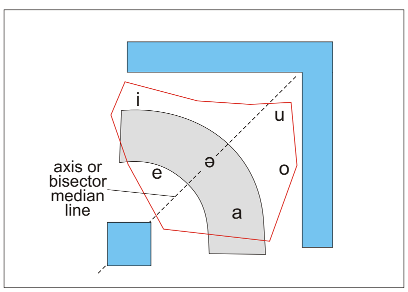
3a. Because the relations of these two vary with the rotation, the axis also varies in its angle and placement. (See also Structure/Appendix/p/-epiglottal stop tract). fig. 3.a.

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

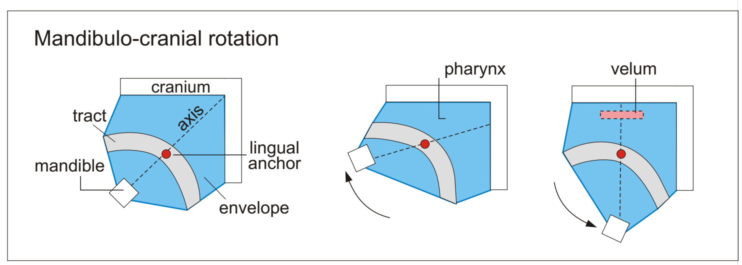
3



3.b

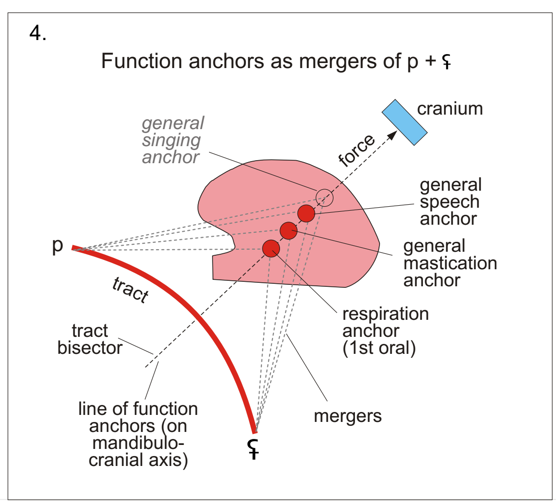


3.a



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.



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.

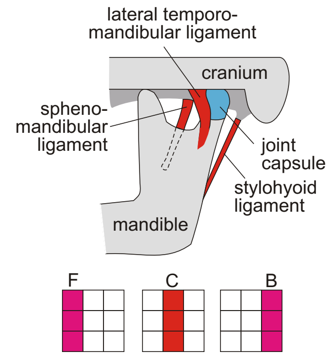
1) **Ligaments**: the mandible is attached to the cranium by three ligaments: the sphenomandibular, the lateral temporomandibular and the stylohyoid. These are aligned and attached along the sides of the mandible at anterior, central and posterior positions. Thus, they are capable of stabilizing front,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

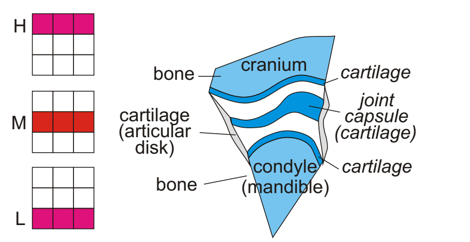
The three mandibular ligaments



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

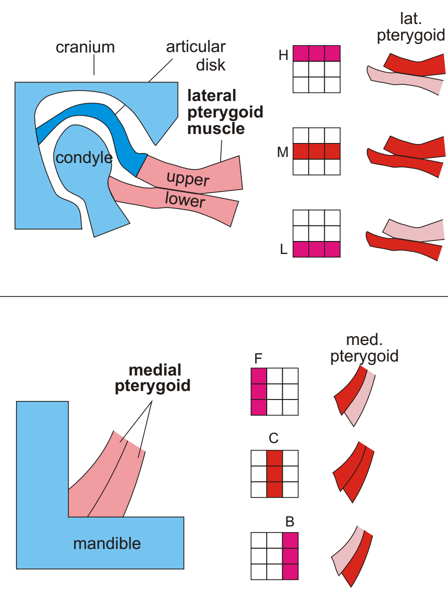
fig. 2

The triple parts of the temporomandibular joint



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

Appendix F. Gesticulation

Gesticulation has been considered as the prime evolutionary source of vocalization and speech. There is much evidence in present behavior of both humans and animals that indicates a degree of grounding of sound production in gesticulation, but it is more appropriate to regard the two functions as parallel developments. As stated by P. McNeilage in the slide presentation The Hand and the Mouth in the Evolution of Language: a) "Non-linguistic communicative gestures and speech could have evolved in parallel...(a la McNeill)" and b) "Gestures, while never linguistic, provided important, deictic (indexical) and expressive support for spoken language (McNeill and Goldin-Meadow)."

The anchoral matrix mechanics can support and clarify both of these statements. The subframework of forelimbs functioning in hand-wrist-arm-shoulder movement and that of the upper visceral system are physio-mechanically unified and coactive. There are several mechanical connections present: the larynx is directly united to the scapula by the omohyoid muscle; the trapezius, the largest muscle of the UV, takes part in all shoulder actions, and hence in all arm and hand movements, through this scapular attachment. Other less obvious connections are not discussed here.

The AMS interpretation shows patterns in which subframeworks and anchors of the forelimbs and the UV are linked and are monadically coactive in both emotional and phonetic/phonemic expression. These gesture patterns appear to have direct input to the ventral (vocalic) trisegment of mastication (and speech). See Mastication.

It can be concluded that the phonetic component of gesturing is part of the entire phonetic mechanism, and when effectively engaged, it physically shares the effort in generating sounds.

The monadic coaction of gesticulation and emotions is but one aspect of the physical bodily grounding of mental contents, an organization that also can be shown to form the built-in basis of grammatical cognition. See Correspondence with N. Chomsky, where this is system briefly described.

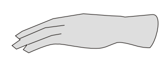
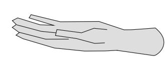
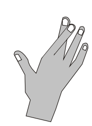
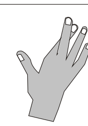
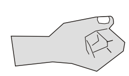
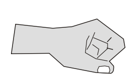
Diagram 1

Some associations of hand shaping gestures and phonetic framework presettings of the basic vowels are illustrated in diagram 1.

If the UV and the shoulder-arm-wrist-hand framework is sufficiently relaxed and balanced, distinct actions of the hand generate distinct presettings of the vocalic framework for the vowel envelop of the symmetrical pair /i/-/a/. Which of these alternates appears depends on the proportion of abdominal vs. thoracic respiratory modes, which is a function of body position configuration.

Note: The examples in some of these diagrams apply chiefly to speakers of English and Germanic languages, as well to Romance, certain Finno-Ugric and Sino-Tibetan languages. The converse alternate patterns occur for speakers of Slavic, Arabic, African, Indian languages, etc. That is, the abdominal-thoracic respiration modes generate the reverse patterns. The reason behind this lies in the physiological differences inherent in the anchoral classification of language families, a topic not covered here.

Diagram 1

hand behavior		vocalic presettings	
		abdominal respiration	**thoracic** respiration
palm open pronate		i	a
palm open supinate		a	i
index over third		i	a
third over index		a	i
palm closed supinate		i	a
palm closed pronate		a	i

(continued on next page)

Facial expressions are also monadically unified with the UV system, and so also express emotional and phonetic presettings.

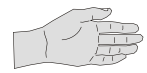
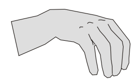
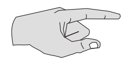
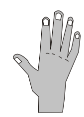
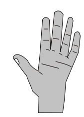
palm vertical		e	ə
hand pronate fingers neutral		e	æ
index pointing		i	a
palm pronate vertical hand		a	i
palm supine vertical hand		i	a

Diagram 2

Consonantal presettings of hand-finger configurations include the following:

/p/ = pinching with thumb and index finger at an acute angle. The association of a /p/ tongue presetting also provides the bodily grounding for using the word "pinch", which starts with a /p/.

/t/ = forceful comnpression of same the fingers with distal digits meeting as co-linearly as possible.

/ch/ = the same gesture with increased force

/d/ = the /t/ becomes voiced if the hand is pronated during the same gesture

/t/-/g/-/a/-k/ = the fingers in clawing position, held close to the palm. This is a presetting for efficiently moving between the articualtion of the this phonetic series. The point of start in the series is arbitrary.

diagram 2

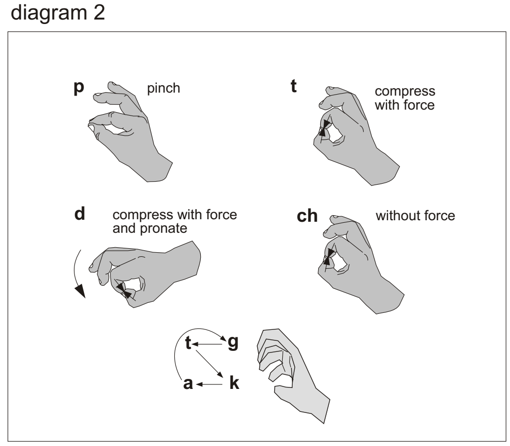


Diagram3

Rotation of hand in a para-sagittal plane with index finger extended generates a series of consonantal presettings ranging from none through t, s, f/h, n, l, m, and q.

Note: For speakers of English and anchorally comparable languages the vertically upward pointing hand constricts the airway, but for speakers of Arabic (and Hamitic languages) it is the setting for /ayin/. /../

diagram 3

Consonantal presetting determined by hand rotation with pointing index finger

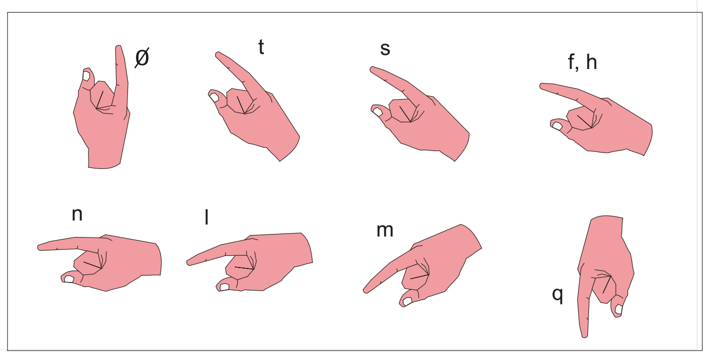


Diagram 4

Vertical placements of the open hand in the parasagittal plane preset for the **syllables** /hi/, /ha/ and /hu/. The choice of the syllable depends on the upward vs. downward direction of movement and on whether the mode of respiration is thoracic or abdominal.

diagram 4

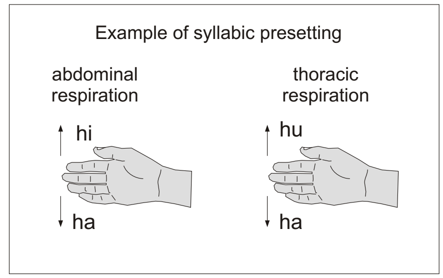
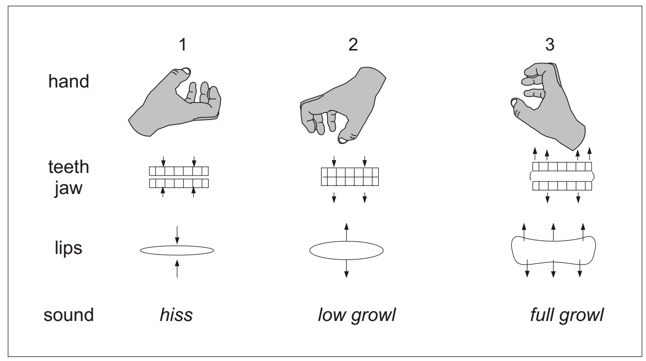


Diagram 5

A forceful **clawing** hand-finger gesture is coactive with lip and jaw behavior. With supine hand the lips and jaws close. With pronate hand the lips and jaw open to an extent. The vocal presettings are, respectively, a hiss and a low amplitude growl. With palm facing forward the lips curl and the jaw opens widely and the sound setting is for a full growl. This is a framework an animal expression of threat: the presetting and demonstration of claws and teeth.

diagram 5



Diagrams 6 through 9

Combinations of various emotional and phonetic presettings are brought about by hand-finger configurations:

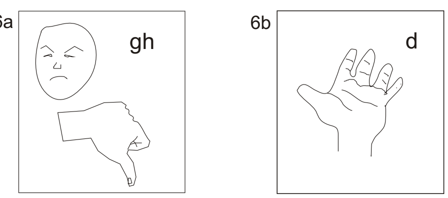
6a) Thumbs down = disapproval, disgust; /gh/ /../, Arabic *ghain*, or voiced /x/.

6b) Moderately or widely spread extended fingers with palms up = expression of innocence, incapabitity, puzzlement; /n/, /d/, /ae/. Such an open supine hand but with additional wrist movement (extension) expresses the notion of "maybe", " I don't know".

diagrams 6

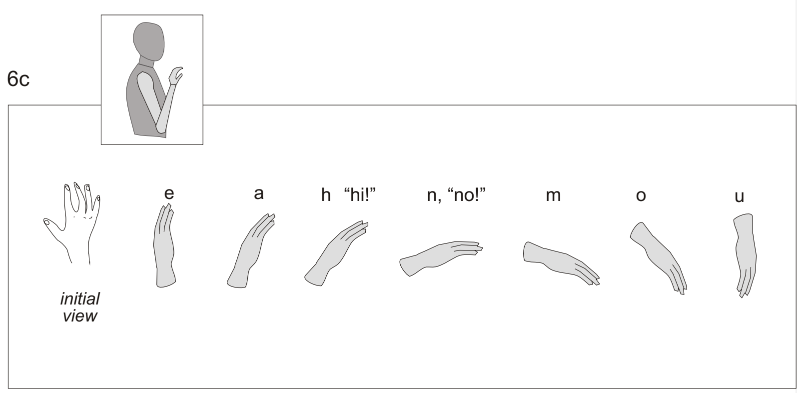
6a

6b



6c) Palm facing forward, hand open, fingers neutral in spread = calling for attention when hand plane is vertical. Gradual tilting of hand expresses increasing sense of negation ("no!"), moving through settings /a/, /h/ and /n/. Tilted just below the horizontal the presetting is for /m/. We can note that in the musical system of solfege the horizontal pronated hand stands for the note designation "mi". Further rotation yields /o/ and /u/.

6c



Appendix G.

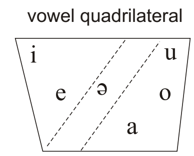
The vowel quadrilateral trisector

The vowel quadrilateral is a mapping of the front and back vowels as well as the high and low vowels mirrored, respectively around the mid-central vowel. fig. 5.

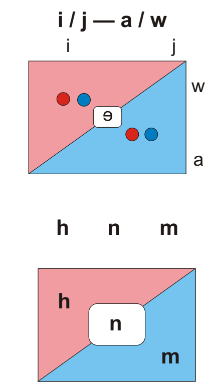
5a. When the respiratory consonants and the semivowels are included in it, the vowel quadrilateral can be **trisected** and then it reflects the important underlying symmetry of three envelopes of the lingual 3x3 matrix. This pattern consists of the i / j and the a / w envelopes centered around the neutral vowel (shewa) envelop. In terms of RSP consonants the pattern is formed by the h and m envelopes centered about the n envelope.

The SpLg (specific language) anchors, that is, the fundamental articulatory bases of all languages are found in one of these envelopes and they can be classified by further details of matricial location within these envelopes.

5.



5.a



Appendix H.

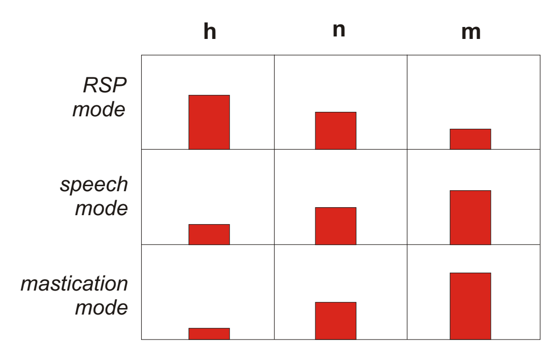
The nicto-phonetic functional symmetry

In this behavior we can observe functional coaction between three subframes, nictication (blinking), the respiratory consonant anchors and frameworks of various UV functions. The organs involved are the external eye muscles, the orbicularis oculi part of the facial sheet and the tongue. If the UV, face and eyes are sufficiently relaxed a pattern between the rate of blinking and RSP consonantal anchoring of the tongue can be observed. Here again a 3x3 matricial symmetry appears. The symmetry shows that the rate remains the same with n anchoring regardless of UV mode, and that the columns of the horizontal h and m as well as the vertical respiratory and speech+masticatory modes are symmetrical around the n column. fig. 6.

It can also be seen that the rate of blinking in the h column decreases while that in the m column increases in contrasting symmetry.

Note: the m anchoring in speech and mastication feature a noticeable blinking component. When searching for thoughts in speech and in thinking, blinking is typical. In mastication this action manifests at the moment of deglutition, an action triggered by passing through the m anchor, the eye lids close and the eyeballs rotate upward. This can be observed also in frogs when they swallow.

6.



Rate of blinking in relation to RSP consonant anchor and UV function mode

Appendix I.

Demonstration of global body frame action unity

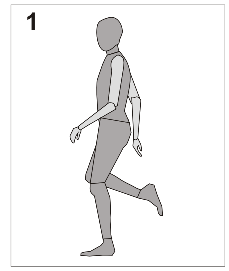
Distortion of any part of the body frame in complete or relative equipoise, causes distortion of the entire framework. This can be shown in the following experiments. It is important to keep the entire body and limbs sufficiently relaxed to allow spontaneous body action without conscious control .

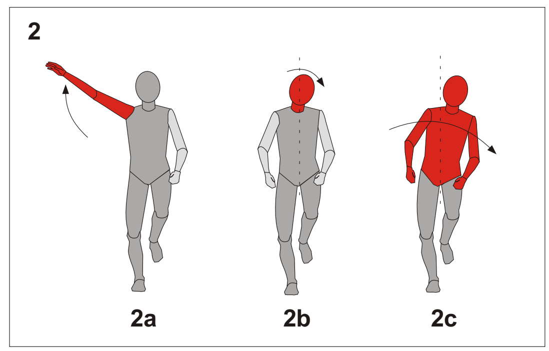
Experiment 1

1. Walk in a straight line, keeping body frame in a relaxed state, especially upper visceral system, head, neck, shoulders, arm, etc.

2. Unbalance the body frame by various actions:
   2a. Extend an arm and hold it
   2b. Keep the head tilted sideways
   2c. Keep torso tilted sideways

Note: Avoid conscious effort to walk in straight line. Allow body to behave spontaneously.





Experiment 2

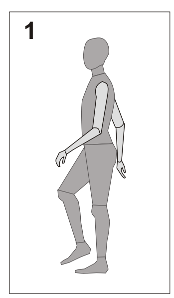
1. Walk in place, in a relaxed state. Point with index finger of extend arm (right arm) at a chosen object that lies straight ahead.

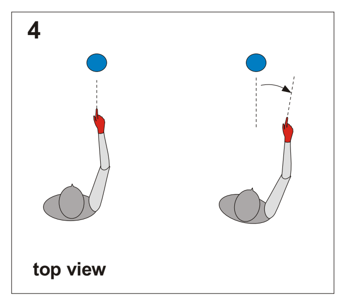
2. Close the eyes.

3. Count out c. 30 or more steps and open the eyes.

4. Result: the hand will be pointing to the right of the chosen object.

Note: Conscious effort to maintain position will have little effect.





Conclusion

These and many other possible examples show that partial geometric imbalance of the body framework alters the entire body framework, which in the above actions appears as distortion of direction of leg driven movement. This behavior may give the cause for:

a. walking in circles when lost the woods or other unfamiliar terrain
b. drivers of cars leaning the body in the direction of turning the wheel at corners
c. increasing forward tilt of body when running speed increases
d. why the moving Macedonian phalanx typically veered to the side