The Creativity of Edward H. Angle: Retrospect and Prospect

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On the wall in my office there is a placard labelled "Creativity." It was given me by Dick Stucklen, D.M.D., friend and fellow student. It is unsigned and reads as follows:

The man who follows the crowd will usually get no further than the crowd. The man who walks alone is likely to find himself in places no one has ever been before. Creativity in living is not without its attendant difficulties, for peculiarity breeds contempt. And the unfortunate thing about being ahead of your time is that when people finally realize you were right they'll say it was obvious all along.

You have two choices in life: you can dissolve into the mainstream, or you can be distinct. To be distinct you must be different. To be different you must strive to be what no one else but you can be.

It is not my purpose in this lecture to defend Edward Angle, he doesn't really need it, neither from clinician (which I am not) nor from basic researcher (which I am). What I propose to do is to offer some observations and interpretations, and even, perhaps, an evaluation.

Edward Angle was a naturalist in the broadest sense of the term, i.e., he believed in a designed orderliness of Nature. There was in a sense a primal arrangement which was both functionally and structurally "perfect." He felt, literally, that if things were, so to speak, "as they should be" it was because this was "natural." Because of this firmly entrenched belief in the orderliness of natural design, Angle was basically an environmentalist. Individual deviation from structurofunctional harmony was due to a faulty environment (outside factors). For example, a Class II, Division 1 malocclusion was viewed as basically due to an underdeveloped mandible, due, in turn, to an environmental failure or discrepancy. Hence, "ideal" dental alignment and interdigitation (as Nature intended) did not reach "full expression." It follows, then, that appliance therapy must also be environmental, aimed at restoring normal function to "make-up" for an unachieved "normal (mandibular) growth." In his seventh edition[4] Angle refers to the "growth of the jaws" during which the deciduous teeth are "carried forward . . . thus the mesio-distal lengthening of the alveolar process takes place." It is worth noting, however, that growth is not listed in the index of that edition.

As an interesting spin-off of this environmentalism it was held that growth could be stimulated and/or guided, in that a faulty occlusion was the result of an inhibitory growth condition. Orthodontic therapy could well release and direct the surge of pent-up growth.

It is at this point that I must refer to what I consider to be a blind spot in Angle's thinking. So insistent was he in his demand that Nature be "respected" in her provision for a "full complement of 32 teeth" that he was an adamant nonextractionist. As a basic scientist I can but observe that an unyielding extreme in one direction is as bad as one in an opposite direction. In my opinion he was just as wrong as those routine 100% extractionists he condemned so vigorously, even contemptuously. I must confess that I do not quite understand his uncompromising attitude, for, as a man who recognized the need for tooth-bone growth synchrony, he must have been aware of the possibility of a

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nonsynchrony, i.e., too much tooth for bone or not enough bone for tooth.

Angle's earliest writings emphasized conformity to "natural law." Tooth movements could only be as determined by the "line of the arch." In 1887[2] he enunciated five directional movements: forward, backward, inward, outward, rotational (partial); in 1892[3] he added "occasionally elongation and depression." Thus he established tooth movement within the same space-frame in which growth movement occurred: three planes, sagittal (forward, backward), transverse (outward, inward), and vertical (elongation, depression). In all this there was conformity to "natural" forces; in 1887 he wrote, "In applying forces to a tooth, it should be sufficient to accomplish the movement as rapidly as possible . . . consistent with physiological law."

There is reason to believe that Angle, the naturalist, was completely conversant with the observations of other naturalists and, of course, with other toilers in the vineyard of orthodontic thinking and practice (see Brodie[6]). When Sassouni and I wrote our *Syllabus* in 1957[23] we incorporated the canons of facial proportion established by Albrecht Dürer in the 1700's. Dürer discussed his canons as standards or norms *from* which a deviation is assessed, not *toward* which a correction or adjustment should be aimed. Here, again, is a conformity to the "natural" which Angle must have incorporated in his "ideal" occlusion.

In the 1860's Angell stated that the $\frac{M1}{M1}$ relationship was the key to the proper alignment of the teeth, both intra- and interarch, a concept basic to Angle's classification of occlusion. I have always felt that this $\frac{M1}{M1}$ focus of "normalcy" or "naturalness" was inherent in the tooth-arch alignment itself. Certainly, the selection of $\frac{M1}{M1}$ as pivotal is well within the *principle of limited possibility:* there is really no other tooth that so well fulfills the role of arbiter of orderliness.* It is the first tooth to be added to the deciduous dental arch; arch length, anterior M1, is complete upon its eruption; in growth-time it comes into place at the beginning of a stable period of midchildhood growth (six to about ten years).

In the 1700's Pietrus Camper defined the *facial angle* which he felt to be a stable relationship (particularly with reference to ethnic physiognomy). In the 1830's Blandin challenged the alleged immutability of this angle pointing out that it changed with differential facial growth in height and depth. In the 1700's John Hunter had begun his studies in comparative and human odontology, carried on by Owen in the mid-1800's. Here, within races of man and species of animals, the specifics of arch and tooth alignment were "natural" conformities to differences in form and function. In the midnineteenth century Taylor pointed to the transitory disharmonies of the deciduous-permanent succession which today we call the "ugly duckling stage."

Of all the environmental factors that may impact upon the occlusion none is more potentially direct than *habit,* i.e., the effect of habitual circumstances upon dento-osteologic-myological balances. Angle was greatly influenced by

*I regard the $\frac{C}{C}$ (the German Eckzahn or "corner tooth") as also pivotal in tooth-arch alignment. It is the turning point of transverse and sagittal *forces* in jaw dynamics, and it is the transition in the transverse and sagittal *vectors of growth.* Also, phylogenetically, it is positionally the most stable of all mammalian teeth.

George Catlin* who in 1861[9] thundered against mouth breathing as a fundamental psychosocial and dentofacial evil. Here are a few quotations:

"Exposing his (man's) teeth to the air through a great portion of the day, and, oftentimes, during the whole of the night," results in his being "oftentimes toothless in middle age, and, in 7 cases of 10, in his grave before he is 50."

Due to "the infernal habit which I am condemning they (the teeth) project in unnatural and unequal lengths, or take different and unnatural directions, producing those disagreeable and unfortunate combinations which are frequently seen in civilized societies and often sadly disfiguring the human face for life."

"During the day it (the mouth) is generally eating, drinking, singing, laughing, grinning, pouting, talking, smoking, scolding, chewing, or spitting, all of which have a tendency to keep it open." Add to this open-mouth sleeping and there must result "derangement of the teeth . . . and a deformed mouth."

In all this the Indian was remarkably exempt.** As the Indian mother removed the child from the breast she "presses its lips together as it falls to sleep in its cradle in the open air." The "stoicism" of the Indian, often deduced from the passivity of his facial features, is because he's learned the importance of a closed mouth. He has emotions but does not show (betray) them physiognomically.

In 1925 (Pasadena, 11/1/25) Edward Angle wrote a *Preface* to a reissue of Catlin's 1861 book, and said, "In his belief that some forms of malocclusion of the teeth and facial deformity are due to mouth-breathing, we only too well know Mr. Catlin to be entirely correct."*** Angle attributed the observed increase in malocclusion in the U.S. to be in "direct ratio" to the increase in mouth-breathing, or "holding the mouth open to breathe or from habit." He called upon American mothers who had mouth-breathing children to "correct the habit early."

Angle was deeply aware of the fact that the movement of teeth orthodontically involved a feedback situation in which tooth and bone reacted reciprocally. In the mid-1800's Lord Bridgewater of England set up a fund which became famous for the *Bridgewater Treatises* to expound the evidences of Divine design in Nature. Among those who wrote such a Treatise was Sir Charles Bell, whose Treatises I have read with great pleasure, for they are poetry in prose. In one of his discussions he observed that "strength in a bone (is achieved) by the least possible expense of material," which, in part, explains the economical dispersion of functional stresses in the dentofacial complex. By far, however, Angle's thinking was influenced by Julius Wolff who in the 1880's promulgated what today we call "Wolff's Law":

"Every change in the form of a bone or the function of a bone, or of its function alone, is followed by certain definite changes in their internal structure and equally definite secondary alterations in their external conformation in accordance with mathematical laws."

Angle's recognition of tooth-bone interplay in orthodontic treatment was limited to a gross evaluation. He did not, apparently, feel the need to understand the basic changes in bone at mi-

*Catlin was an extraordinary person. At the age of 34, after six years of the study and practice of law, he took up miniature and portrait painting for eight years. At 42 he began to visit, study, and paint Indian tribes of the Americas. But, as he wrote, he *first cured himself of his own mouth-breathing habits.* He visited 150 tribes and observed "two million souls." He was a trained and gifted observer. His paintings of native scenes and of individual Indians are part of our national heritage.

**In the 7th edition Angle features the faces of two adult male Plains Indians. The "law of balance" is seen in their faces, especially in "the mouths (which) are in perfect balance with the rest of their features, making certain that their dentures must have been normal."

***In the same edition Angle had referred to "the evil effects of mouth-breathing."

croscopic (histological) level. It is almost anachronistic, therefore, that he refers to "physiological law" rather than to "anatomical law" (or "morphological law"), for the finer details of the physiology of bone were not within his ken. In 1907 he said of tooth movement that "the best result is obtained by applying only that degree of force necessary to bring about physiological changes *in the tissues*" (italics W.M.K.).

To sum to this point, we have Edward H. Angle in *retrospect:* Angle, the environmentalist. We can appreciate his terms "natural," "integrity of arch form," or of "the line of the arch," "full complement of teeth." These were all in harmony with Nature, for this is what Nature intended. It is logical, therefore, that he recognized that tooth movement occurred in the three planes of space—sagittal, transverse, vertical—which is equivalent to saying that tooth movement is in the three planes of the avenues of growth in dentofacial depth, breadth, height. In this correlation the key position of $\frac{M1}{M1}$ is a logical deduction.

I regard Angle's handling of "normal" or "standard" as an inspiration: a norm is a yardstick of interpretation, not a mold of conformity. This leads, with equal logic, to the recognition of a dentofacial pattern within which adjustive differential growth must occur. From this flows the idea that habit, as an external factor, may modify (inhibit, deviate) a "naturally harmonious" growth pattern by upsetting tooth-bone interbalances.

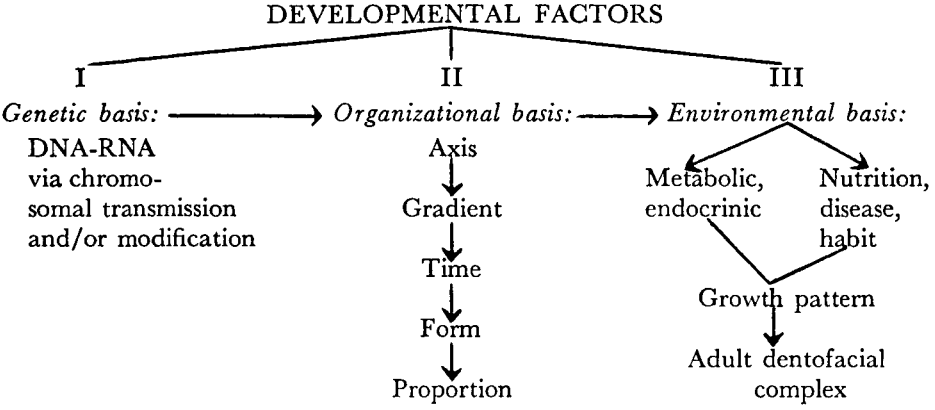
We can come to but one conclusion: Edward H. Angle built solidly upon the foundation knowledge of almost three centuries of biological thought.

In 1948[19] I wrote that "perfection may be the standard, but adequacy is the goal." In this sense I want now to turn to Angle in *prospect.* In so doing I full well recognize that his was certainly not the final word; perfection was not then attained, nor, indeed, was full adequacy.

In Chart I is a modification of a scheme that I outlined in my 1948[19] article on the role of growth analysis in orthodontic interpretation.

Column I is, in a way, the child's phylogeny: it is his ancestral (family-line) background, and "it determines the credits and debits that (the child) will have in the bank of his life processes." Column II is basically the child's ontogeny, though with some holdover from Column I. Axis and gradient are a basic vertebrate heritage: a main longitudinal (cephalocaudal) axis, plus

CHART I



two axes at right angles to it and to each other (dorsoventral and mediolateral). Time relates to growth-time, measured by chronological age and by biological ages (dental, skeletal). Form and proportion are, of course, the result of differential growth in the three axes and their gradients or directions. Column III represents the working economy of inherent growth potential and its lability in terms of environmental vicissitudes.

On an over-all, comprehensive basis it is in the areas of the above outline that Angle's system of classification is being redefined, modified, and re-interpreted.

It is true that Angle postulated tooth movement in three planes, but it seems to me to be equally true that the main focus of his classification was in one plane, i.e., sagittal or mesiodistal (anteroposterior). But in growth, as a possible adjunct to tooth movement, we are working in three planes of space. Hence, we must think in terms of what I called *spatial accommodation,*[19] which involves bone-bone and bone-tooth relationships. Here then, at the very least, are two major sets of variables: 1) complementary or compensatory three-plane growth gradients; and 2) developmental relations between two structural components, bone and teeth, "that stand to one another in the dynamic roles of size, form, and supporting configuration."

In my faciodental researches I have long recognized and emphasized that any interpretation of intra- and interdental arch interrelationships must rest upon the understanding of *total growth* and the consideration of *total variability* in growth changes in bone and teeth. In 1950[20] I wrote on the growth of the "whole child" in relation to dental problems. In 1963[25] I offered a brief but detailed bill of specifics:

I. Variables in the total organism.
   1. the total growth potential and its expression in growth-time.
   2. health, nutritional, endocrinic, genetic, and constitutional background.
   3. local (habit) traumata.
   4. osteomyologic structural and functional interrelationships.
   5. the total pattern or ensemble of the craniofacial configuration.

II. Variables in the faciodental complex.
   1. factors of bilateral symmetry.
   2. pathway of mandibular opening/closing.
   3. arch size, symmetry, shape, and their interrelationships, not only within the arches, but also with reference to adjacent and/or supporting bones.
   4. form, size, cuspidation of individual teeth.
   5. axial inclination and possible rotational position of teeth, anteriorly and posteriorly.
   6. mesial and/or distal drift in tooth loss whether by disease or extraction.

It is obvious that the foregoing is essentially morphological, for it is within my area of competence. Equally obvious, there must be a recognition of clinical variables. In recent years excellent articles on morphological variables and on morphological-clinical variables have appeared.

In 1969 Ackerman and Proffit[1] offered what they defined as a modern approach to classification and diagnosis of malocclusion. The thrust of the "modern approach" is contained in this sentence, "We are suggesting not that the Angle system be discarded but, rather, that it be enhanced systematically." Common to *all* dentitions is the degree of alignment of the teeth within their arches. This is Group 1, the UNIVERSE. Within such a Universe is found Group 2, the PROFILE, a

major set. Groups 3-9 deal with variable combinations of deviations in the three planes of sagittal, transverse, and vertical dimensionality. The explicit detail of this system provides a point-by-point analytic insight into a given case of malocclusion.

In 1973 Hirschfeld, Moyers and Enlow[15] derived a number of subgroups in a craniofacial population based on morphomensurational relationships. Five categories, A-E, were established in three main groups: maxillary protrusion, A,B,C; balanced profile (spectrum), D; mandibular protrusion, E. Categories A,B,C seem to be subgroups of Angle Class II, while D and E correspond more to Class I and Class III, respectively. The authors, while recognizing an indebtedness to the Angle classification, feel that "the categories are more realistic and informative than the Angle classes."

In 1973 Proffit and Ackerman[31] added to their earlier systematic classification by turning to the patient as a physico-psycho-social entity: history of medical/dental health; patient self-image; functional analysis of mastication, swallowing, speech, and psychosocial behavioral patterns. Further systematicization was introduced by a six-point rating scale for each occlusal characteristic: 0 = ideal; 1 = slight; 2 = slight to moderate; 3 = moderate; 4 = moderate to severe; 5 = severe.

In 1973 Baume, Horowitz, et al.[5] reported on a method for measuring occlusal traits. This was the report of a Committee on Dentofacial Anomalies of the FDI Commission on Classification and Statistics for Oral Conditions. They set up three categories: 1) dental measurements (congenital anomalies of development, missing, supernumerary, malformed, impacted and transposed teeth, tooth loss via extraction or trauma, retained deciduous teeth); 2) intraarch measurements (crowding, spacing, anterior irregularities, maxillary midline symmetry, I1-I1 space); 3) interarch measurements (lateral segment—molar relation, posterior open bite, posterior crossbite; incisal segment—overjet, overbite, midline deviation, soft tissue impingement.)

As I view these present-day refinements I hark back to my early days with the microscope. The analogy is not too farfetched: the "old" (Angle) is the gross magnification; the "new" (the current emphasis upon correlative detail) is the finer adjustment of the 'scope. But, either way, the basic structure of the slide under the lens is unchanged, either in actual or potential fact.

There is one area which in the past few decades has contributed much to a deeper insight into the etiology of malocclusion, viz., genetics. In earlier publications[24,26,28,29] I have presented extensive survey articles on the role of genetic factors with reference to the specifics of dental genetics. In this lecture I shall limit myself to the area of possible parent-child genetic transmission in both the orthodontic and the cleft palate areas.

In 1961 Brown[7] reported on six families in which 30 children were involved (16 M, 14 F), ages 2:6-17:0. He employed three endocranial outlines (over-all, anterior, and posterior) in principle following the unit method of Kraus, Wise, Frei.[16] Brown concluded that resemblances between parents and their children and children of the same family "may or may not exist when the different bony outlines are compared." In his study several children had maloccluded teeth.

In 1973 Harris, Kowalski, and Watnick[12] also adapted the unit principle of lateral radiographic contoural traits: posterior border of ramus, gonial angle, antegonial notch, subsymphyseal outline, lingual symphysis, chin prom-

inence, anterior nasal floor, palate and posterior nasal floor. It was found that in each subgroup (brother/brother, sister/sister, brother/sister) "the proportion of concordant measurements is *always* higher for sibs than for the nonrelated controls." Interestingly enough, it was found that where function might overweigh genetic anlage, as in the palate and posterior ramal border, concordance was lower than, for example, chin prominence.

Watnick in 1972[33] had previously sorted out similar craniofacial units in terms of "predominantly genetic," "predominantly environmental" and "genetic plus environmental." I venture to summarize as follows (Chart II).

Harris, Kowalski and Walker[13,14] have pursued the problem of the genetic content of malocclusion in greater detail. In the first study[13] they conclude that the familial tendency in the development of Class II and Class III malocclusion "strongly supports" a polygenic model of inheritance of craniofacial skeletal and dental relationships. The sibs of Class II patients were significantly closer to the Class II population. The same general conclusion held also for the sibs of Class III patients.

In this study it was held that the ANB angle is an excellent indicator variable of occlusal status: "it reflects the anterior/posterior relationship of the mandible to the maxilla, as well as the molar relationship as defined by Angle."

In the second study[14] the authors come to a most significant clinical conclusion, viz., that "the family unit offers us an effective alternative to the use of population norms, and may be expected to supplement significantly the data available from the primary source, the patient alone."

In the cleft palate family, Fraser and Pashayan[11] studied parental face shape where a child had CL(P). They found that the parents tended to have the following facial traits: flatter anterior facial surface; upper lip less prominent relative to lower lip; bizygomatic and intraocular-chin dimension less; greater frequency of rectangular and trapezoid face-types. In 1972 Coccaro, D'Amico and Chavoor[10] found that, as between parents with and without CL(P) children, the former had faces that were less convex with a relative tendency to mandibular prognathism; the vertical and horizontal dimensions of the upper face were shorter, as was the nose length. The findings were "consistent for both mothers and fathers of CL(P) children when considered collectively." Very few differences in relationship existed when all fathers were compared with all mothers. In 1974 Kurisu[30] et al. stated "that there are in fact detectable alterations in facial morphol-

CHART II

Predominantly Genetic	*Predominantly Environmental*
lingual symphysis	gonial angle
lateral ramal surface	antegonial notch area
frontal curvature of mandible	
? response of bone to functional demand	

Genetic + Environmental
posterior ramal border
subsymphyseal contour
labial symphysis

ogy in parents of children with CL(P)." However, the differences are quite small and are "probably no greater than those which might ordinarily be expected to obtain between two ethnically diverse samples obtained in geographically separate areas of the U.S." Such changes as were registered do not support or relate to, or constitute a part of, a multifactorial genetic predisposition.

I may summarize the role of genetics in the dento-facio-occlusal complex somewhat as follows:

1. The individual dentofacial pattern has a genetic basis.
2. This genetic basis runs in family lines.
3. The family-line pattern must recognize the contribution of genetic traits (or units?) from each parental line.
4. The resulting combination (may) (may not) conduce to an actual intradental, interdental, or dentofacial disharmony.
5. In either case an inherited craniofacial pattern is subject to alteration by any one of a set of environmental factors.
6. Orthodontic treatment must take cognizance of this interplay of genetic and environmental circumstances.

There is another phase of genetic predisposition that I'd like to mention, that of biological timing of the expression of growth potential. I surveyed this area in 1951[21] and again in 1968.[27] There is no doubt but that early, mid, and late maturers, as measured by skeletal maturation, run in family lines. Moreover, general bodily growth (highly correlated with skeletal age) bears a time-linked relation to craniofacial dimensional growth and to dental development (see Shumaker[32] on tooth eruption and skeletal age). The relationship between certain aspects of facial growth and linear body growth is seen as early as the second trimester of fetal development. Burdi[8] found that increases in certain naso-maxillary dimensions were synchronous with increase in crown-rump length (CRL).

I think it must be recognized that heredity, as seen in possible family-line transmission, has to be considered as basic whenever the problem of prediction is tackled. I do not think that it is my function in this paper to roil the muddied waters of the crystal-ball game. I accept *growth trend* in an individual set of craniofacial dimensions as establishing a *growth pattern* for that individual. But I also accept variability and, hence, a measure of unpredictability, within the progressive unfolding of that pattern.

Prediction in faciodental growth must be based on the phenotype, which is the genetic constitution that we see and measure. If I predict, I am in a sense betting that the past growth of an individual phenotype can foretell the as yet unrealized or future phenotypic growth of that individual. That just "ain't necessarily so," for we simply do not, and cannot, know the individual genotype, the true genetic constitution. I may say, for example, that the odds are 100:1 that a given event *may* occur, but that does not say *when* it will occur, anywhere between the 1st and the 100th time. Prediction can take advantage of average growth trend, and even of individual trend where there are serial data; it can place a patient somewhere within a normal range of variation, but it still cannot say *precisely where* he or she will be within that statistical norm-framework.

I have not yet given full credit to the three men who in my opinion have done so much to objectify and scientifically validate the growth-dynamics of face

and jaws: Hellman with his craniometry (see Krogman[18]), Todd with his cephalometry and Broadbent's roentgenographic cephalometry (see Krogman[17,22]). These are the men who brought physical anthropology into the orthodontic arena; these are the men with whom I studied and from whom I learned. They are the men who paved the way for the mensurational researches that have had such factual and clinical import. Their work, and that of all who have come after them, has led to the present powerful tool of computerization.

Finally, what introspective words may we add to Angle's "creativity"? Just as in retrospect he did not create *de novo,* so in prospect there will be no creation *de novo.* Creativity will be along paths set for Angle and which he further set. It will be in the direction of an ever clearer knowledge, insight, and clinical care of the individual child in the orthodontic chair. In a way Angle "created" a dental specialty. Today we clarify and provide an in-depth amplification of orthodontics, a scientific dental specialty.

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REFERENCES

1. Ackerman, J. L. and W. E. Proffit: The characteristics of malocclusion: a modern approach to classification and diagnosis. *Am. J. Orthod.* 56: 443-454, 1969.
2. Angle, E. H.: Extracts of notes on orthodontia, with a new system by regulation and retention (9th Internat. Med. Cong., Dental Section). Printed in L. P. Haskel's *Students Manual or Handbook for the Dental Laboratory* (ed. 1). Weller Dental Co., Phila. 1887.
3. ————: The Angle system of regulation and retention of teeth. Printed in ed. 2 of Haskel's *Students Manual or Handbook for the Dental Laboratory* by Wilmington Dental Mfg. Co., Phila., 1892.
4. ————: *Treatment of Malocclusion of the Teeth:* Angle's system (7th ed.). S. S. White, Phila., 1907.
5. Baume, L. J., Horowitz, H. S., et al.: A method for measuring occlusal traits. *Int. Dent. J.* 23:530-537, 1973.
6. Brodie, A. G.: Orthodontic concepts prior to the death of Edward H. Angle. *Angle Orthod.* 26:144-154, 1956.
7. Brown, W. A. B.: A cephalometric study of parents and their children. *Europ. Orthod. Soc.,* pp. 409-418, 1961.
8. Burdi, A. R.: Sagittal growth of the naso-respiratory complex during the second trimester of human prenatal development. *J. Dent. Res.* 44:112-125, 1965.
9. Catlin, George: *The Breath of Life: or Mal-Respiration and its Effects Upon the Enjoyments and Life of Man.* Wiley, N.Y., 1861; reprinted 1925 with *Preface* by E. H. Angle.
10. Coccaro, F. J., D'Amico, R., Chavoor, A.: Craniofacial morphology of parents with and without CL(P) children. *Cl. Pal. J.* 9:28-38, 1972.
11. Fraser, F. C., Pashayan, H.: Relation of face shape to susceptibility to congenital cleft lip: a preliminary report. *J. Med. Gen.* 7:112-117, 1970.
12. Harris, J. E., Kowalski, C. J., Watnick, S. S.: Genetic factors in the shape of the craniofacial complex. *Angle Orthod.* 43:107-111, 1973.
13. Harris, J. E., Kowalski, C. J., Walker, G. F.: Dentofacial differences between "normal" sibs of Cl. II and Cl. III patients. *Angle Orthod.* 45: 103-107, 1975.
14. ————: Intrafamilial dentofacial association for Class II (1) probands. *Am. J. Orthod.* 67:563-570, 1975.
15. Hirschfeld, W. J., Moyers, R. E., Enlow, D. H.: Method of deriving subgroups of a population: study of craniofacial taxonomy. *Am. J. Phys. Anthrop.* 39:279-290, 1973.
16. Kraus, B. S., Wise, W. J., Frei, H.: Heredity and the craniofacial complex. *Am. J. Orthod.* 45:172-191, 1959.
17. Krogman, W. M.: Contributions of T. Wingate Todd to anatomy and physical anthropology. *Am. J. Phys. Anthrop.* 29:145-186, 1939.
18. ————: The contributions of Milo Hellman to physical anthropology. *Am. J. Orthod.* 34:61-82, 1948.
19. ————: The role of growth analysis in orthodontic interpretation. *Am. J. Orthod.* 34:703-713, 1948.
20. ————: The growth of the "whole child" in relation to dental problems. *Oral Surg., Oral Med., Oral Path.* 3:427-445, 1950.

21. ————: The problem of "timing" in facial growth with special reference to the period of the changing dentition. *Am. J. Orthod.* 37:253-276, 1951.
22. ————: T. Wingate Todd: catalyst in growth research. *Am. J. Orthod.* 37:679-687, 1951.
23. Krogman, W. M. and Sassouni, V.: *Syllabus of roentgenographic cephalometry.* Publ. by Phila. Center for Research in Child Growth. 1957.
24. Krogman, W. M.: Oral structures genetically and anthropologically considered. *Ann. N.Y. Acad. Sci.* 85: 17-41, 1960.
25. ————: Golden lives and golden opportunities. *Am. J. Orthod.* 49: 598-604, 1963.
26. ————: The role of genetic factors in the human face, jaws and teeth: a resumé. *Eugenics Review.* 59:165-192, 1967.
27. ————: Biological timing and the dentofacial complex. *J. Dent. Children.* 35:175-185; 328-341, 377-381, 1968.
23. ————: Forty years of growth research and orthodontics. *Am. J. Orthod.* 63:357-365, 1973.
29. ————: Craniofacial growth and development: an appraisal. *J. Am. Dent. Assoc.* (Spec. Issue). 87:1037-1043, 1973. (The full text is in press, *Yrbk. of Physical Anthropology* 1975)
30. Kurisu, K., Niswander, J. D., Johnston, M. C., Mazaheri, M.: Facial morphology as an indicator of genetic predisposition to CL(P). *Am. J. Hum. Genet.* 26:702-714, 1974.
31. Proffit, W. E. and Ackerman, J. L.: Rating the characteristics of malocclusion: a systematic approach for planning treatment. *Am. J. Orthod.* 64:258-269, 1973.
32. Shumaker, D. B.: A comparison of chronological age and physiologic age as predictors of tooth eruption. *Am. J. Orthod.* 68:50-57, 1974.
33. Watnick, S. S.: Inheritance of craniofacial morphology. *Angle Orthod.* 42:339-351, 1972.