Facial Patterns *

A Theme on Variation

Allan G. Brodie, D.D.S., Ph. D.†

Chicago, Illinois

In the realm of music one is accustomed to listening to "Variations on a Theme" in which the artist, selecting a melody, alters it in various ways to indicate the degree to which it can be modified without changing it basically. This presentation will make a similar attempt, but the theme will be biological rather than musical. At the present time there is, in the author's opinion at least, a great necessity for more critical attention to the matter of variation. This need stems from our mania for classifications and for norms which, we vainly hope, will give us infallible guides.

It is not difficult to trace the steps that have led to our present mode of thinking. Early knowledge consisted largely of the collection of isolated facts or observations until it required a lifetime to learn them. Occasionally an individual with keener insight was able to discern relationships or similarities between certain of these observations. He began a sorting process in the field in which he was interested and ultimately announced a classification which permitted a cataloguing of the significant attributes of each group. From the standpoint of economy of teaching and learning this was a signal advance because general principles could be taught and men could have a common ground on which to meet and exchange ideas. Also, such classification tended to set off principles from details and this in turn served to accelerate the search for new principles. Experimentation could be used to test such principles.

These procedures were used to such great advantage by the physical scientist that it was inevitable that the biological scientist should attempt to employ them. He learned how to classify and catalogue, and the nature of much of his work began to change. For a long time he was kept busy at this task because of the infinite number of fields around him that demanded such treatment. Eventually, however, he had to face something which the physical scientist had not encountered. This was the matter of variation. Try as he might, he could not find two items in the same category that would exactly match each other in every characteristic or even in any characteristic. This necessitated the development of some method to deal with living matter which would possess, if possible, the same degree of accuracy as that inherent in the handling of nonvital materials and processes. This development was extremely slow although its roots were buried deep in the past.

As early as the sixteenth century men were collecting data on such ab-

---

* Presented to the Southern California Component of the Edward H. Angle Society of Orthodontists at Santa Barbara, California, March, 1947. Delay in the publication dates of the journal accounts for the appearance of this paper in an issue preceding the date of presentation.

† Department of Orthodontia, University of Illinois, College of Dentistry.

struse matters as the mortality of the population of London, while others were attempting to figure mathematically the odds involved in horse racing and in other games where gambling was an accompanying activity. Gradually it became apparent that there were fairly definite laws to the operation of chance and that highly accurate predictions could be made through the employment of these laws. But these matters were viewed largely as the mental gymnastics of impractical mathematicians.

One of the outstandingly successful, practical applications of these principles was that of life insurance. The apparently useless tables of mortality, painstakingly gathered over the years, permitted the mathematician to calculate the life expectancy of any large group and then to establish the odds on any member of that group. True, no single individual in the group might agree perfectly with the calculated age at death but the entire sample balanced out by earlier and later deaths.

Slowly at first and then more rapidly, the statistical approach was adopted by the biologist. The biometrician measured every conceivable thing he could find in sufficient numbers and expressed his results in means or averages. Only infrequently were his readers mathematically trained and instead of taking his results as indications merely of trends or central tendencies, they accepted them as true values. If a thing did not yield a value identical to that originally found it was pronounced abnormal.

Statistics will yield very definite information about groups and in this it is extremely valuable. It has been one of the most effective means of combating the aged voice of authority in its chant, "It is my considered opinion," and other highly biased viewpoints. But when statistical methods or data are applied in the evaluation or diagnosis *of an individual,* great care must be exercised if error in judgment is to be avoided. Here it is more important to know the *range* within which the normal may operate than the single figure representing the theoretical mean or ideal. In order to make this clear I shall have to explain, as simply as possible, one or two statistical terms. The first of these is the standard deviation. It is always expressed in terms of the units of measurements, i.e., if we are measuring in inches our standard deviation will be in inches; if in pounds it will be expressed in pounds. Briefly stated, the standard deviation reveals the range around the mean within which 66 percent of the sample falls. That is, one standard deviation above and below the mean embraces two-thirds of the cases. Obviously, the smaller the standard deviation, the more reliable and stable the mean. But this statistical yardstick has certain shortcomings. One of these is that unlike values cannot be compared. One cannot well compare inches with pounds. Another misleading factor relates to the magnitude of the item measured. If the mean length of one object is twelve inches and that of another is two inches, a standard deviation that was the same for both would actually indicate that the mean of the longer object was six times more reliable than that of the shorter. For these reasons the coefficient of variation is a more desirable method of expressing degrees of variation because here the range is stated in percentages of the mean. A few examples will make this clear. The weight of the spleen varies 50.58% from the mean; respiration rate per minute 17.80%; chest circumference 9.4%; skull capacity 7.36%; relative cell volume of blood 5.42%; stature 3.65%; oral temperature 0.49%. Note that these are measurements of different types, i. e., they represent ranges of weight, length, rate, capacity, and temperature, totally unlike things, yet they reveal that oral temperature would be 100 times more reliable as a diagnostic aid than would the weight of the spleen.

The statistical yardsticks I have mentioned were designed as measurements of individual variables. Thus the biometrician, in setting up life insurance tables, excludes all variables except age at death.

Other matters that have been subjected to statistical analysis are relationships between variables. These are the so-called correlations. In the physical sciences these correlations may assume the infallibility of law as those of Charles or of Boyle. The first of these states that the volume of a gas increases a definite amount for every degree increase in temperature. This is a positive correlation. The second states that the volume of a gas is inversely proportional to the pressure put upon it. This is a negative correlation. Both are definite and exact. It should be pointed out also that both of these laws involve only two variables.

When the same tests are applied in biological research such exactness is rarely, if ever, found. If sufficient data are available it may be possible to establish that there is a tendency toward either positive or negative correlation. This, however, does not permit one to make a definite prediction about any given case. Correlations, based only on observation, have led to a belief in many cause-and-effect relations which scientific investigation has subsequently proved not to exist.

Diagnostic procedures in orthodontia have been and continue to be largely morphological in nature. We have been interested in size, relations, and placement of anatomical parts. The maxillary first permanent molar of Angle, the axial inclination of the lower incisor of Tweed, the Frankfort horizontal of the physical anthropologist, Simon's orbital plane, and the Bolton plane of Broadbent are all examples of the effort to establish a base of reference upon which clinical judgment could rest. With the exception of Broadbent's early work there has been little effort made to establish the absolute or the relative reliability of these guides. And with the exception of the maxillary first molar, each of these involves a cutting across of areas which show individual variation of considerable range.

Orthodontists have to deal with certain relationships of parts and are faced with the necessity of reaching judgments on their rightness or wrongness. On these judgments rest our prognoses and treatments. In the past we have followed the road laid out by the great pioneers who have left us certain laws, and certain generalizations. Some of these generalizations have stood the test of strict scientific scrutiny and others have not. Progress consists in holding fast to those things that have been proven true and of researching the false.

The man for whom this society is named, Edward H. Angle, sought, throughout his life, to discover laws to guide the orthodontist. His promulgation of the idea of normal occlusion marked the elevation of orthodontia to the status of a science and his classification remains unchallenged to this day. He found difficult, as have all others, the task of giving to his followers the help that a law would provide without at the same time making them slavishly dependent on it. Even in the matter of the stability of the maxillary first molar he adds evidence that is intended to show its limitations.

> "The fact that the upper first permanent molar varies considerably mesially or distally as to its location in different individuals, which is always noted in anything like an extensive study of the subject, has led superficial students to regard these positions as abnormal, taken by chance, and out of harmony with other principles in the anatomy of individuals, but in reality these variations are to be expected and are necessary in the creation of different types and different individuals.
>
> "We know that while all human faces are greatly alike yet that all differ. Lines and rules for their measurement have been sought by artists and many have been the plans for determining some basic line or principle from which to detect variation from the normal, but no line, no measurement, admits of anything nearly like universal application."
>
> Angle, *Malocclusion of the Teeth*, 1907.

Another method of appraisal for diagnostic purposes that has been used for centuries is that of typing. Since man's earliest efforts to portray the human, we find notice being taken of certain groupings of characteristics. Hippocrates wrote on the diseases to which these so-called types were susceptible and even today in medicine we hear that the "disease fits the patient." Shakespeare noted the dour, lean, and hungry-looking Cassius in contrast to the obese, well-fed, and jolly Falstaff, thus linking physical and mental traits. It was inevitable that the effort should be made to define each type and I remember being forced as a student to memorize the characteristics of the nervous, the bilious, the sanguine, and the lymphatic types of men. This classification was based on the assumption that the various great body systems held ascendency in different individuals, one in a certain type and another in another type. The modern classification of body-build is that of Kretschmer, who gave us the tall-lean (ectomorph), the heavy-muscular (mesomorph), and the short-fat (endomorph). Almost every one would agree on examples of these. Lincoln has been used as the perfect ectomorph, Jack Dempsey as the mesomorph, and William Howard Taft as the endomorph. But the setting up of standards for pure types led inevitably to the assumption that those who were not pure types were harmonious deviations of varying degrees from pure types. Of recent years these concepts have been checked by statistical methods.

Sheldon and Tucker took as a sample a large number of students at the University of Chicago and, after determining the mean value of fifty different body measurements *for each of the three types*, they made measurements on their sample. They found very quickly that, although a person might be strongly ectomorphic in some of his physical characteristics, there were others where his measurements placed him well into meso- or even endomorphy.

Hellman, in 1937, did something very similar to this. He took twenty measurements of the heads of sixty-two Columbia University dental students, all of whom presented normal occlusions. He made measurements of the face and head, and for each measurement established a mean and a range representing its standard deviation. Since this latter measurement is an expression of both higher and lower values than that of the mean, he laid his figures out in the form of a symmetrical polygon. With this as a background he next laid out the values of all measurements on each individual, and it became apparent immediately that the individuals were not harmonious variants from the mean but actually presented plus values for some measurements and minus values for other. Furthermore, these values not infrequently exceeded the range expressed by the standard deviation. Where, then, is the value in typing?

Orthodontists have come to "type" malocclusions and it is a general practice to talk about Class I, Class II, and Class III faces. Each of these conjures up an image and each has been described in general terms that are commonly accepted. But, as Dr. Elsasser has recounted, this common acceptance was not the result of a unanimous opinion as to just what constituted the Class II deformity, to take one example. In other words, we have agreed only on outward appearance.

We have tended to think of the head as a unit although of recent years there has been recognition of the possibility that calvaria and face might not type together. This was proved quite thoroughly by the late J. Leon Williams who sought to establish correlations between the forms of the teeth, the face, and the cranium. The idea became an assumption, and today artificial tooth forms are sold to the dental profession on the basis of certain facial and cranial measurements. In the absence of any other guide this is entirely justifiable and probably leads to a better esthetic result than would otherwise be obtained. What is not generally known, however, is that Williams ultimately reversed his earlier contentions and concluded that no such correlations existed.

One has only to study in detail any small part or organ of the human body to reach the conclusion that it exhibits wide ranges of variation in its form, reactions, and qualities. The number of variants in even the smallest part seems endless, and one can never be sure that he is dealing with a single characteristic and not a combination. This being true, it should be apparent that any method of appraisal or diagnosis that is based on the acceptance of a norm which has been arrived at by grouping a series of untested variables must be highly unreliable.

When one wishes to study a complicated structure like the human face, it is possible only to divide it into its functional units and treat these as though they were units—which they are not. Thus we have that part of the face that is concerned with sight, and the skeletal parts associated with it. The orbits may be large or small and may be set close together or wide apart to mention only two easily observed variants.

The next division is concerned with respiration. The bony nose cavity may show an infinite number of variations. Some noses are narrow, some are wide, some exhibit almost true rectangular outlines when viewed from the lateral aspect, while others reveal bizarre patterns. The floor of the nose is highly variable, particularly in the anterior region.

The next area is one of those with which the orthodontist is concerned, viz., the upper alveolar process and teeth. I shall defer comment about this and about the process and teeth of the mandible temporarily and proceed to the ramus and body proper of the mandible. This bone is concerned with a number of functions. Besides mastication it is an indispensable part of the postural mechanism of the head. In addition it furnishes the only anterior point of suspension for the muscles that position the tongue in relation to cranium and face and it serves a like role for the hyoid bone, pharynx, and larynx. Indeed, it is one of the three points from which all anterior neck structures hang. The other two points are cranial.

The parts of this bone to which I have referred are a part of the skeletal system having to do with posture and movement, and again we find all sorts of variation. The ramus may be short or long, narrow or wide, while the body may show the same types of differences plus presence or absence of antegonial notching, prominence, or apparent absence of chin, great width, or extreme narrowness. Needless to say, the body and ramus may meet in a wide variety of angles.

When we come to scrutinize the teeth and alveolar processes we again find that, although influenced by the bones with which they are associated, they are capable of a relatively large degree of individual behavior. We find good height development at the symphasis associated with insufficient vertical dimensions in the molar area. We find all degrees of length development from jumbled dental conditions to those where the teeth are separated by generalized spacings. And we find similar degrees of variation in the relation of the process and teeth to underlying bone. Only the teeth themselves show a high degree of correlation, upper to lower, and even here we find differences within individuals that seem quite large as shown by the recent works of Ballard, Kloehn, and Seipel.

The parts I have mentioned in which variations are exhibited constitute only a very crude division. We shall unquestionably find many more as investigation continues. But when we remember that the variations of parts are harmonious or inharmonious to each other according to the chance of hereditary transmission plus environmental factors, it should give us a better explanation of the wide divergence we see in the human faces around us.

There is nothing that I have said that has not been said by others at different times, but little attention has been paid to it because such an attack has always seemed to remove ruthlessly the few supports upon which we have reared the structure of our thinking about the problems of orthodontia. It has been classed as destructive criticism and I must confess that it has aroused the same resentment in me that it has in others. However, two things have caused me to view it otherwise. The first of these is the overwhelming evidence of variation in the several parts of the face which variation cannot be ignored and the second is the possibility of formulating a more valid concept of what constitutes malocclusion—a concept which does not so seriously limit our thinking as does our present one. If anyone wishes to quarrel with the first of these he has only to spend the time to trace a number of headplates and compare the faces represented, area for area. To be convinced on the second point perhaps will require considerable persuasive argument.

My entire plea is for an abandonment of the norm concept. It is time that we ceased to compare each individual we treat with some pattern that has been arrived at either by an inner sense of proportions or by the careful compilation and averaging of large series of measurements of different individuals.

For the first of these I have never had anything but impatience, while with the second I have lost faith. This does not mean that I am done with all statistical methods, all averages, ranges, and so forth, in my own researches or those of my students. These are still of great value in sketching outlines, in the determination of trends and tendencies, and in sorting out the important from the unimportant. But if we abandon these criteria what do we have left to guide us? The answer is: The very individual whom we are treating. He carries with him the answer to his own treatment. We must understand him if we are to understand his problem and know whether that problem is soluble by orthodontic methods. The question, of course, arises: Do we know enough about the behavior of the individual to form judgments of this nature? I believe that we know enough to make a good start.

First of all we think we know that the pattern of the individual is established well before birth and thereafter is remarkably stable. True, certain temporary deformities known as molding occur as a result of the birth experience, but these disappear in the vast majority by the third or fourth day. This statement is made on the basis of studies recently completed by Ortiz, one of our graduate students, who x-rayed 138 consecutive newborns within twenty minutes after birth and then followed them while they were in the hospital, making exposures every forty-eight hours. Subsequent films were taken at two week intervals up until the fourth month. My own researches, published in 1941, embraced the growth of the head from the third month to the eighth year, and are at present being extended to include the records taken since that time. In no case have we seen any great change occur in the pattern although it is now realized that the word pattern embraces more than we first thought.

By pattern we meant relative proportions primarily. Thus, if we take a measurement of the total face height from nasion to bony chin point (gnathion) and divide it into segments representing nasal height (nasion to anterior nasal spine) and lower face height (anterior nasal spine to chin), it is found that these measurements will yield the same percentages at any age. If we measure total face height and length of lower border of mandible, these are found to remain constant in relation to each other. This rule seems to hold with regard to many measurements taken within the face but when a cranial measurement is plotted against one of the face, curves appear. Please bear in mind that these statements pertain to the behavior of the *individual*. Thus, nasal height may constitute 43% of total face in one individual and 50% in another, but if it is shown to be 43% at an early age it will continue to be 43% throughout life.

Of recent date Downs has been investigating the behavior of a group of growing individuals all of whom possess good to excellent dentures. He has found that some of these behave one way and some another in relation to the mean pattern. In the mean pattern it was shown that the chin point travelled downward and forward on a straight line. When *individuals* are studied some are found to behave as does the mean, in some the chin point tends to go forward, in others it goes backward as the face descends. This reflects, we believe, differences in the relative rates of vertical growth in the anterior and posterior portions of the face and again indicates a point of individual variation. Some of these cases present mandibular border angles that would place them in the category of unfavorable orthodontic risks according to recent theories, yet these are cases of good occlusion which it is doubtful anyone would try to improve. This would again seem to indicate that such an angle cannot be used as a prognostic aid. When a malocclusion is present in such a case it is not due to the steepness of this angle.

If one accepts the idea of a range of individual variation in every component part of the face, it immediately raises certain questions relative to the adjustments between two adjacent parts that may be inharmonious and yet firmly united to each other. Such zones might be mentioned as anterior cranial base to upper face; floor of nose to maxillary alveolar process and teeth; mandible to maxilla; and mandibular alveolar process and teeth to body and ramus. What happens under such conditions?

In the first case mentioned, viz., a disharmony between floor of cranium and upper face, all symptoms give one the impression that there has been a failure in the growth between sella turcica and nasion. The brain case continues to expand above and the face below the zone of union. The result is a bulging forehead, flattened and retruded nasal bridge and orbits. The lower part of the middle face may show almost complete fulfillment of its growth potential but, being held back above, the alveolar process and teeth present an unpleasant appearance of prominence. If now the mandible is normal it will appear prominent in contrast to the undersized middle face. We say the individual is dish-faced. Extreme cases of this sort are exhibited in achondroplasia.

In the next case we have the lower nose deficiency. This may take several forms and may be general or local. The general type exhibits the pinched nose, deficient in both length and width with maxillary alveolar process and teeth either presenting abnormal labial and buccal inclinations or lingual to their normal relations with the mandible. These are the cases which have been described by Lundstrom as being deficient in the "apical base." In the local type we may find an isolated area deficient in development. This may be in the premaxillary region in which case the incisors will be found either lingual to their accustomed relations to the lower, or inclined labially to an unpleasant degree. The mandible and its alveolar process and teeth may be perfectly normal and the maxillary buccal segments may bear normal relations to it. The canines of the upper arch are usually forced into a labial malposition. Another not infrequent local type is that where one buccal maxillary segment has failed to reach a development consistent with the rest of the denture. The teeth involved will be found in positions ranging from a cusp-to-cusp relation to complete lingual locking. All of these conditions seem to rest upon or to be caused by deficiencies in bones outside of the denture.

But disturbances of the maxillary alveolar process itself are not rare. We may find perfect cranial, middle face, and mandibular development with lack of vertical height of molar or incisal process or deficiency in length as in cases of congenital absence of teeth, notably the lateral incisors.

Turning now to the mandible and considering it by itself, we find a wide assortment of conditions reflecting the independence of its various parts. The body proper may be longer than average as in Class II Div. II or in Class III; it may present strong notching at antegonion or general convexity of the lower border. The ramus may be narrow or wide, high or short, and may meet the body at a wide variety of angles. Turning to the alveolar process we may find normal, infra- or supra-height development at various localities. In the length dimension we find cases where although the body is more than adequate the alveolar process is not, and the same can be said for its width. These last two conditions present jumbling of the teeth.

Finally, we come to the relative position of the mandible to the rest of the face and head. As has been indicated before, this is usually a matter of small variations in the cranial base but there are cases where a difference in the gonial angle can be shown to be the agent responsible for the anomaly.

For the present we are excluding the so-called Class III deformity from our consideration because of lack of sufficient study. Research may show that this condition is merely a chance grouping of variants which magnifies a trend. We do know that the Class III pattern exhibits an extreme range in most of its measurements.

All of the matters discussed thus far pertain to variations in the general structure of the face, somthing over which the orthodontist exercises no control. In these distortions the teeth are passive victims of circumstances. Their malocclusion, if it exists, is a skeletal, not a denture, dysplasia. There are malocclusions, however, that are strictly dental in nature and these will now be considered.

One such group of cases is that in which the teeth are crowded. This crowding may range from a few disturbed contacts to the complete blocking out of the teeth. Usually it first becomes apparent as the denture starts to change from the deciduous to the permanent state. The assumption has been made that since the pattern does not change there cannot be any logical procedure in these cases other than the extraction of teeth. In this there is a complete ignoring of the time and rate factors of growth and the order and time factors of eruption. In these matters we are again faced with variation. There is only one criterion for determining the adequacy or inadequacy of alveolar process growth and that is: Is it sufficient to accomodate all of the teeth without crowding? At present, this can be determined with certainty only when such growth is complete.

Different individuals grow at different rates and at different times. Some attain full stature by the fourteenth year while others continue to grow well past the twenty-first year. In passing I should like to point out that such stature growth does not seem to be correlated with face growth and should not be used as a diagnostic criterion. However, jaw growth shows the same wide degree of variation.

The teeth are quite another matter so far as their growth is concerned. The crowns of these organs are laid down and calcified in their ultimate form and size long before they appear in the mouth. They will never grow larger. Their eruption, however, is a highly individualized matter. It was formerly thought that the eruption of the teeth caused the growth of the maxilla and mandible and this is true so far as the alveolar process is concerned. It is not true for other portions of these bones. These grow as do all bones of the body, according to their own inherent potential. Like other bones they vary in the matter of time, rate, and magnitude. The same bone in different individuals will show a range between those which grow rapidly and attain their full potential at an early age to those which grow at a lower rate but for a longer period of time. Both ultimately may reach the same size.

Now, when we introduce the factor of eruption of full-sized teeth, it should not be too difficult to visualize what would happen if the teeth were to erupt before the jaw was developed sufficiently to receive them without crowding. The force of eruption is a powerful one and teeth, forcing their way occlusally, will come through even though they must deviate markedly from their accustomed positions. Once in such displaced arrangement, they are the prey of all of the well-known forces of occlusion, the inclined planes, musculature, and so forth, and show little or no power of self-recovery even though subsequent growth may be adequate. On the other hand, we see those cases where growth is early and prolific. Teeth erupting into such jaws will show spacing. Thus we must remember, when we examine a young denture, that we may be dealing with precocious eruption in normally-growing jaws, or average eruption in jaws that are growing slowly. Both of these cases would exhibit crowding of teeth and are examples of what Broadbent has aptly called the "ugly duckling" stage of dentition. But we must remember also that the teeth will never grow larger; the jaws are almost certain to.

Thus far this paper has been restricted to a consideration of the variables presented by the bony skeleton of the face. Another system which must not be neglected in our thinking is that made up of the musculature. Here again we must deal with a group of variables.

On the inside of the dental arches we have the tongue, and the usual headplate gives us certain information about this organ. It may be large or small; it may be carried high or low, forward or well back in the pharynx. The tongue is extremely large at birth, frequently flowing out over the alveolar processes and supporting lips and cheeks. In some infants it is too large to be accommodated within the mouth and it protrudes constantly. It grows on a rapidly decreasing gradient, however, as compared to those of the jaws, and these parts catch up and gradually inclose it. We have reported one case of macroglossia in which the tongue hung half way to the chin at 16 months yet at 4½ years was comfortably carried within the mouth. This was a case of actual muscle-fibre hypertrophy as determined by biopsy, as contrasted to the more commonly occurring lymphangioma. Macroglossia is almost unknown in the adult.

All studies indicate that the tongue grows very slowly. Its position in relation to the dental arches is determined mainly by its own growth and by the three points of its suspension, viz., bilaterally on the cranial base in the region of the mastoid and styloid processes and anteriorly on the mandible in the region of the symphysis. Naturally as the face descends and goes forward the tongue follows through the growth of its suspensory muscles but at a slower rate. Thus a generalized flaring outward of the alveolar processes and teeth is frequently nothing more than an indication that tongue and arches are not yet in harmony with each other. While it is true that this occasionally may prove still to be the case after full growth has occurred, it is folly to correct it before that time. And then it can probably be successful only if the tongue is surgically reduced in size.

There is a condition of antagonism between the tongue on the inside and the lips and cheeks on the outside and this antagonism largely determines the inclination and position of the teeth and alveolar processes in all cases except in those where maleruption, slow growth, or occlusal interference can be shown. Even in these cases it plays a powerful role. Given sufficient development of the alveolar process to accommodate the teeth, the tongue, lips, and cheeks will determine arch width and axial inclination and whether we like the result or not we cannot make them otherwise and maintain them.

In summarizing this wearisome diatribe may I say that its preparation has forced, perhaps prematurely, the formulation and expression of certain changes in concept that have been growing within me over the years. Looking back it is not difficult to trace the stepping stones. The first of these was the idea that the teeth were the most important elements in the face and that their normal function caused development not only of the bone immediately surrounding them but also of that upon which it rested. Then came the most unwelcome discovery that the effects of orthodontic treatment were limited to the alveolar process.

Following the trends of scientific thought of the time we next switched to the techniques of physical anthropometry. This called for the working out of norms of type which might in turn lead to the discovery of relationships sufficiently stable to serve as diagnostic aids. This work has not been fruitless, as you will see from subsequent papers to be presented.

The growth studies on the pattern of the face, although not undertaken from the viewpoint of clinical application, were the first encouragement we gained that certain principles might be stated. These principles were not of the order we had been seeking and for quite a long time we failed to sense their possible application. The chief of these was the remarkable stability of the pattern. Here the clinching evidence was furnished by grossly abnormal cases. The patterns were twisted and warped but the bricks were laid on in the same orderly and regular manner as in the normal. Like the normals they showed no change; they became neither better nor worse as they grew.

Until this time attention had been focused on the total face in its relation to cranium. In the growth studies, however, we had been partitioning the face in order to determine the relative contribution made by each part to total growth. Such examination of parts revealed the same wide range of individual variation but at the same time showed that the parts retained their original proportionality to each other within the individual.

Wylie's work on the genetic aspect of the pattern showed quite clearly that there did not seem to by any close correlations between the various parts, and further work of a similar nature forced us to abandon entirely the whole idea of harmonious deviations. True, the majority of cases showed degrees of difference small enough not to startle one but occasionally a case would be seen in which opposite or antagonistic trends would be shown in adjacent areas. Such disharmonies are apparent to even the uninitiated. Actual measurement of such cases revealed that each of the areas might yield figures that were within the range of the standard deviation for them but, being at opposite ends of their respective ranges, so to speak, they were decidedly out of harmony with each other. On the other hand, cases were seen where both areas were at the same end of the range, and here one gained the impression of a piling of insult upon injury.

Finally came the realization that everything we could measure was a variant and that, therefore, we could expect any conceivable combination. It would seem that we are dealing with the permutations of an infinite number of values.

This view point puts the teeth in an entirely different light from that originally held. Instead of their being the guides to the destiny of the face they became more or less passive and at the mercy of the behavior of the parts around them. Malocclusion, with the exception of those traceable to local environmental causes, becomes the visible symptom of inharmonious relationships between parts closely adjacent to or quite remote from the mouth proper. And such disharmony, apparently, can be traced only to the chance operation of genetic laws.

At first glance this seemed like a bleak outlook, like a return to the starting line where we had no classifications, no general principles to guide us. But then came the realization that we did have certain facts to comfort us. The chief one of these was that these patterns did not change. We might not like the combination that was presented to us but we could rely on its not growing worse. At the same time we could not make it better except in the dental region. In this area we knew from our own experience and that of all other orthodontists that proper treatment frequently led to marked improvement. This seemed to be a contradiction.

But it is not a contradiction. Our confusion on this point stems from our forgetfulness of the fact that bones and teeth lie in two entirely different categories. Were the teeth like bones in their growth, we would be born with them in place and they would increase in size proportionately with the bones as age advanced. Any disharmony between their size and that of their supporting bone would be apparent right from the start. But teeth are *not* like bones. Their inital patterns are laid down in full size and at this stage they are so large in comparison to the jaws that we find them disposed at various levels and in quite different positions from those they will ultimately occupy. In order that they may be accommodated there must be a steady growth of the jaws, and their eruption must be timed to coincide with this growth. As we know, they are admitted to the arch only one or two at a time, but we also know that their time and their order of eruption are highly variable qualities. When we place these two together with the variables of rate and time of jaw growth we are again faced with a large number of permutations. But in this case our ratio becomes steadily more favorable as age advances, because while the teeth do not become larger the jaws generally do.

At the present time we are in great need of two types of information. One of these is the path of development being followed by any given case. The other is the matter of rate of growth so that the full potential of an individual may be predicted. At present no method seems to offer better promise than does serial roentgenology but the term *serial* must be stressed. Neither prediction could possibly be based on less than two exposures made with a considerable time interval between. Three exposures would be much better. In closing may I sum up the points I have tried to make.

1. The human face is a complex collection of parts composed of a number of bones and serving jointly a number of functions.

2. These bones and the areas to which they contribute show wide ranges

of variability in the matters of rate and time of growth, sequence and size attainment.

3. The variants are not always in the same direction; indeed, they may be quite opposite. Thus adjacent areas may be inharmonious and areas remote from each other may be in harmony. Any combination seems to be possible.

4. The growth of the pattern is proportional. This means that the disharmony is present from before birth; it becomes neither better nor worse. It cannot be changed by treatment.

5. The teeth and alveolar processes constitute the only area of the face where changes may be expected or induced. This rests upon the fact that teeth and bones differ in their growth and also that we have here to deal with a phenomenon not present in any other part, i.e., eruption.

6. Eruption order and time vary greatly in different individuals, and this introduces possibilities not present in a grouping of bones. Precocious eruption in jaws growing at an average rate, or average eruption in jaws growing at a slow rate introduce temporary disharmonies that are frequently not self-correcting. Such cases can be controlled by orthodontic means provided growth ultimately catches up.

7. The tongue, lips, and cheeks constitute the major environmental factors of the alveolar processes and teeth. Their harmony in growth, size, and tensions with the teeth and processes are necessary for stability. Their patterns seem, like those of the bones, to be unchangeable.

In conclusion, this paper presents a plea for the abandonment of the norm concept. This does not mean that all statistical methods are to be discarded. Indeed, the further elucidation of the growth of the face will demand an ever greater utilization of the tools of biometrics. We must determine such things as the relative variability of parts and the ranges of such variability in order to place the findings on any given individual in proper relation to each other. We must study growth increments and employ mathematics to plot their gradients.

We should stop, however, comparing every face that we see with some mental image that is pleasing to us or to one that has been set up by the compilation of a group of averages. This can only lead to disappointment because it has been shown that we cannot alter the basic pattern that presents itself for treatment.

It would seem that our only hope for progress lies along the road which starts with the realization that it may be possible to find means of determining the course of development of any given face and to predict its ultimate potential.

808 South Wood Street, Chicago, Illinois