Musical and Architectural Proportions in the Anatomy of the Facial System

An Anthropometric Approach

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A discussion and analysis of facial anatomy based on the principles of harmony and natural variation, recognizing normality as a range rather than the single mean point on a normal distribution curve. Those anthropometric principles are then applied to the development of a simplified profile analysis.

NECESSITY FOR KNOWLEDGE OF THE TYPICAL ANATOMY OF THE FACIAL SYSTEM

A postulate introduces this work: the necessity that orthodontists and plastic and reconstructive surgeons who apply their therapy to the shape of the facial system should know the normal morphologic anatomy of that system.

We are not talking about the physical anatomy that is normally explained in treatises in which organs are generally described by their faces, sides, edges, etc., without considering the shape derived from relations with other organs. What we are talking about is a general morphologic anatomy, externally visible, which derives from normal reciprocal relations among organs as they vary from one individual to another.

This is a dynamic anatomy, which presupposes a knowledge of the normal mutual relations among facial organs. Consequently, the lack of such knowledge means a lack of essential knowledge of anatomy.

This last deduction carries heavy consequences, because the clinician who does not know the normal morphologic state of the facial system does not know the anatomy of the organ being treated. In such a situation, one cannot understand how it might be treated without resigning oneself to acting within the narrow limits of empiricism.

The clinician gifted with great intuition, even without knowing the normal morphologic anatomy, may gain sufficient experience through empiricism for the effective solution of therapeutic problems. But action on this basis must necessarily be limited to the mechanical field of therapeutic devices, without the assistance of a wide range of particularly important cognitions deriving from a knowledge of anatomy.

There should be knowledge of the positions that the organs must take on the profile line in order to compose a normal state, and of the way in which they can take position to make the profile vary from one individual to another without changing the racial character.

We should know around which craniofacial plane these organs move with growth to reach their final position, and which directions they follow. The way that these changes might adjust during puberty can be especially important in orthodontics. In short, the clinician must know the normal typal anatomy to be able to deduce the morphogenesis of the facial structure and its mechanism of formation.

That information is the basis for knowing how the facial apparatus can best be changed by therapy. It is clear that the clinician who lacks this knowledge will find bigger obstacles in predicting the ways in which growth can develop, especially in cases where growth is either retarded or lacking.

This also leaves a serious gap in the possibilities for carrying out really scientific studies. As in any branch of medicine, anatomy is *conditio sine qua non* to start any speculative study related to facial form. No such information can be reliable if it does not start from a scientifically normal organic structural reference base.

PART ONE

Harmony as a Diagnostic Tool

When the Feeling of Harmony Was the Criterion for the Normal State of the Facial System

Discussion of the external anatomy of the facial system began a relatively short time ago, but the common cognitions about it are those that can be derived from the esthetic sensitivity every person has toward the facial structure. This sensitivity helps a person to see that the face of another is not altered by discordant characteristics, and that it has no malformations which such sensitivity helps to discern. It allows the consequent deduction that the face of another person can be considered as normal because it is characterized by *harmony*.

The whole of classical antiquity recognized and availed itself of this abstract but very real concept of harmony. During the early Christian era the normal state of the facial system was not known, and scholars continued to refer to the feeling of harmony whenever they needed to describe the normal image of the face. This feeling is often used in the arts and in various branches of biology. Typical is the selection of samples of "typical individuals" for research studies.

This situation went on for centuries. However, as orthodontics and facial surgery approached the current level of development, things changed. Facial anatomy became a part of the essential cultural base for the specialist, since both diagnosis and therapy depend on it.

The point is that harmony derived from the esthetic sensitivity of the culture and from the lack of malformations is an impression that cannot be quantified. Therefore, it cannot be reduced to simple metric terms, and this subjectivity can also lead to errors.

It is not a question of merely seeing malformations on the face or not, and making a description of them. It is a matter of knowing which are the characters that express the normal state necessary to describe the anatomy. It is also a matter of knowing the typical normal state of the face from quantitative and qualitative points of view, and how it should be reconstructed to restore a normal state that is hidden by a malformation or altered by a traumatic lesion.

The impression we get through the feeling of harmony is not enough to allow us to identify the key character to define the typical normal state of the face and carry out an analysis. Especially in health care, it is the knowledge of such a key character that is missing, as is the anthropological reference for the reconstruction of a face that has been altered by innate or external noxious agents.

The abstract feelings of harmony alone do not satisfy the scientific and didactic requirements, but leave to the specialist the difficult task of solving all the problems of diagnosis.

THE CONCRETE PRINCIPLE OF PROPORTION BETWEEN FACIAL ORGANS REPLACES THE ABSTRACT FEELING OF HARMONY

Things changed in the middle of the Nineteenth century, when the development of biometrics, or *anthropometrics,* provided the elements necessary for a knowledge of the normal typal anatomy of the facial system and its restoration.

Around the year 1939, the Author's search for a scientific means for deepening his specialization led to anthropometrics. However, experience showed this science to be difficult to understand in its classical exposition expounded through mathematical interpretation. The present study offers a more clear and easily understood exposition.

What we said before about harmony is true. If a person is able, on the basis of esthetic sensitvity, to establish that there are no morphologic distortions on a certain face, there is also a possibility of establishing that it is normal because it is harmonic.

It is a fact that harmony in a face expresses the morphologic perfection connected with normality, and its charm is unquestionable. But it has already been pointed out that harmony, because it is an abstract feeling, can never be an adequate means for positively identifying such normality.

We can pass from that abstract position to a concrete one when the identification of normality is established through the factor that causes the feeling of harmony. That key factor is *proportion.* There is a certain affinity between proportion and harmony, as Leonardo Da Vinci pointed out when he talked of "proportional beauties of an angelic face." Unlike harmony, *proportion can be quantified* and put into practical application.

What we are mantaining here may be better explained with an example than by academic reasoning; not a pleonastic example but a demonstrative one, that shows the effects of a musical impulse on the esthetic sense of man.

SIMILARITY BETWEEN PROPORTIONS OF THE FACIAL ORGANS AND THE PROPORTIONS OF MUSICAL MODULATIONS

Suppose we are listening to the last part of any musical piece, from the simplest one of a song to the more complex one of a composition by Wagner. The piece is about to end with one precise chord that the listener has anticipated while listening, and is therefore expecting. The result may be any of several.

1) The last chord is missing, so the piece does not have a conclusion. There is an annoying feeling of interruption, and the listener is so anxious to finish the piece that this is done by mentally forming the missing chord.

2) The piece ends with musical modulations that are discordant from its musical leading system. The esthetic sense and the sense organs are struck by annoying impulses. There is no doubt that the dissonance can be considered as having an abnormal value.

3) The final chord of the piece, following the gradual sequence of the preceding chords, reaches the esthetic sense of the listener with the expected sounds. There is pleasant satisfaction, and there is no doubt that this emotional state, coupled by a sensory balance, has a *normal value.*

The meaning of the example is further clarified by two considerations:

1) The "normal" musical chord is the outcome of *proportion,* reached through the evaluation of the relation of the different musical values and brought into effect following the precise rules of the complex science of *harmony* and *counterpoint.*

2) This proportion, definable through the mathematical calculus of musical values, is not the result of a subjective esthetic judgment, but can be expressed quantitatively and has a normal value.

We are following the development of harmony from an abstract feeling to a concrete entity. The proportional relations underlying harmony are of first importance, since—going back to the subject of this study—they hint at a new basis for research into the normal state of the facial system.

Suppose that proportional relations could express the harmony of the features of the face with the same concreteness that they express the harmony of sounds through quantitative evaluation. This could give us a first glimpse of metric knowledge of the normal anatomy of the face.

This raises a question. Is it possible that a certain coordination of the organs could enable us to trace on the face a combination of lines, masses and angles giving the double result of forming a proportion that gives rise to the feeling of satisfaction in the observer and also be so meaningful as to provide the dimensional and positional data that are necessary for restoring the normal state?

SIMILARITY BETWEEN THE PROPORTION OF THE FACIAL ELEMENTS AND PROPORTION OF ARCHITECTURAL ELEMENTS

As one answer, we can look at an example taken from architecture, because if a monument is plastic music (Schelling), a human face is plastic music, too.

Architecture, like orthodontics, is a combination of art and science. The architect studies the distribution of architectural elements (masses, voids, volumes, etc.) and derived combinations of lines and angles, in order to achieve harmony in the building or monument being planned.

An architect always has the desire to perceive by intuition, to accomplish in his own original way a combination of architectural elements most fit for conveying impulses that could give rise to a feeling of esthetic satisfaction. This happens sometimes in managing to perceive more clearly the unconscious figurative balance that stems from the uniform order of natural phenomena, according to which the whole universe is moulded. It is usually based on acquired knowledge, following various ways and theories over the years. Among those which are most interesting for us are the theory of imitation of human organs, and particularly that of geometrical analogy.

In ancient times, an architect imagined a plan for construction by deriving it from the shapes of human beings, to take advantage of the harmony certainly given by nature. The plan often emphasized those shapes that experience had proved to be more appreciated by the observer, trying unconsciously again to find a meeting point with the preferences of the esthetic sense of man. These architects followed an approach based on the uniform order of natural phenomena, as described in the theory of *geometrical analogy* advanced by G. B. Alberti and issued by Thiersch.

Repetition

Thiersch observed that "in the best works of all times a fundamental form repeats itself and particulars compose figures similar to it." The law of constant proportion states that "harmony derives from the repetition of the principal figure in its subdivisions." Therefore, *repetition* of an architectural element becomes one of the basic factors of architectural harmony.

The connection between this subject and research into proportion in the facial system suggests an example. A most meaningful one is given by the Pantheon in Rome, an exact copy of which has been built in Washington, D.C. The overall form of this building is characterized by a sphere, a basic geometrical figure that totally circumscribes its inside. It is divided into forty parts, each one of them coming downward from the top. Through the rhythm of relation of their forms and curves, all refer to the basic spherical shape (Fig. 1).

The repetition in this example is obvious, but it is not casual. Repetition alone would not reach any satisfactory result for the esthetic feeling which is indissolubly linked to the rhythms of natural shapes; it must be a repetition that also respects the criterion of *symmetry*. Symmetry me-

Fig. 1 The Pantheon, demonstrating symmetry, repetition and rhythm in architectural form.

thodically rules distances and positions of the various architectural elements in a "rhythmic composition of the whole based on a stylistic unity" (Vitruvius).

If we carefully consider that statement, we find that the inventive effort, the followed devices, the observation of the fixed rules taken from the experience gained through the course of time, all contribute to coordination of architectural elements to achieve a *proportion* among them. Such a proportion is a measurable entity.

The geometrical development of proportion dates back to the ancient times of the Pythagorean school that distinguished arithmetic proportion, geometric proportion and harmonic proportion. Still, in ancient times proportion was derived from the perfection of human organs (squaring).

In the Middle Ages, Pacioli looked for the rhythm of perfect human relations in the "divine proportion" which Baud[1] recently declared that he could verify in the distribution of the three heights that divide the facial profile.

In summary, *proportion* is the typical expression, the *carrying structure of normality,* which etymologically has precisely this meaning of respect for the laws (norms) that rule a certain sector.

Keeping in mind the reason for dealing with musical and architectural arguments as an introduction to anthropometric methods applied to the anatomy of the facial system, we reach the following deductions.

There is a similarity between the structure of an architectural construction and the structure of the facial system. A building or a monument is made of architectural elements—shape, size and position—which are coordinated according to rules of proportion to produce what we recognize as a state of normality.

Seemingly, the facial system is based on characters of shape, size and position which are also coordinated in some way to reach the proportion that corresponds to its normal morphological state. The criteria used for carrying on a valuation exam in the face can be compared to those of architecture, but the procedure is much more complex.

In the case of a monument, the rules are well known and the architect knows the basic geometrical figure and its subdivisions of shape and size. There is full freedom to choose and coordinate the materials of unchangeable nonliving substance as may be desired.

In the case of the facial system, no such background information was known until the beginning of anthropometrics, and it is still in an early stage of development. The organs that should form the proportion are unknown, changeable and most important of all, they are predetermined.

At this point the Author started his research. It was necesary to find which characters on the face were coordinated to form the facial system.

MORPHOLOGICAL CHARACTERS THAT FORM THE FACIAL SYSTEM

A Short General Analysis

In beginning his study of the characters that form the facial system, the author first had to face the fact of how facial peculiarities of man vary continuously and are never repetitive, while those that form the somatic hereditary characteristics remain unchanged or constant. It appeared logical to suppose that this happens through the existence of some natural mechanism—a *rule of typical variation* —that includes the contemporary existence of two models, one characterized by constancy, the other by variability.

The presence of characters having such peculiar attributes requires that their initial analysis be carried out in an elementary state, studying the phenomenon at its origin. However, since such a study would imply difficult phylogenetic aspects, we will start the analysis at the moment when the maturation of these characters is about to make for their morphologic destiny.

The characters that form the facial system can be divided into four types according to their properties:

Fundamental generic characters

The first type includes the characters in their undifferentiated state, equal for everyone, in which we can recognize the property of being fundamental-generic. In this non-differentiated structure, they correspond to the organs of the frontal, ocular, zygomatic, nasal, chin, auditory, cheek and oral rim regions. They are considered in their undeveloped rather than their primitive state, already destined to take the appropriate shape, dimensions and proportions.

Constitutional characters

The characters of the second type are the constitutional ones. These give the face the peculiarities inherent to the biotype. One of the most important of these is the relationship between the length and width of the face. Either length or the width can predominate. According to the Italian school, for example (De Giovanni, Viola, Pende), the case in which the width is predominant corresponds to the *brevilinear type,* the case in which the length is predominant corresponds to the *longilinear type,* and the case in which neither predominates over the other corresponds to the *mesolinear type.*

Racial characters

The characters of the third type are those ethnically typical constants related to racial differentiation.

Physiognomic characters

The characters of the fourth type, which can be called physiognomic, are superimposed on the first three. They make one face different from another, independent of the various peculiarities specific to the other types of characteristics. The origin of such variability has become the subject of a phylogenetic debate between those who think they derive from genetic factors, and those who think they depend on environmental factors. However, in the absence of positive proofs this debate remains in the realm of academic disquisitions.

RACIAL CHARACTERS AND THE NATURAL DISTRIBUTION OF CHANGING CHARACTERS IN INDIVIDUALS

Those four types of characteristics combine to form the facial system. When we analyze them to find those that form the key proportions, we find that the third is the most important, yet unknown. It is this one, that differentiates one race from another, that is a major hindrance to research on proportion in the facial structure. Without more knowledge of this contribution to facial proportions, we cannot know which are individual physiognomic variations and which are racial characteristics.

We have seen that the architect draws subdivisions from the basic geometric figure, with or without its connected ornaments. These are gathered in groups (orders), to find the rhythm of relation among them which, according to the rules of *symmetry,* forms the acceptable proportions.

The biologist does not know the distribution of the characters of the facial system in man, and he cannot compose homogeneous groups in order to proceed to their comparison. This leaves no guided choice of the elements to compare and verify whether there is a fundamental proportion among them or not.

PART TWO

Anthropometrics Shows How Facial Characteristics Are Distributed

DETAIL OF METHODOLOGICAL ORDER

The usefulness of anthropometric information lies in overcoming the difficulties of methodological order. It is well to note the advice of those such as Gini, who states; "The field of statistical application to biologic studies has been little and badly developed, since most of the statistics' supporters have studied economics and mathematics, not biology; on the other hand, biology scholars have little knowledge of mathematics."[2]

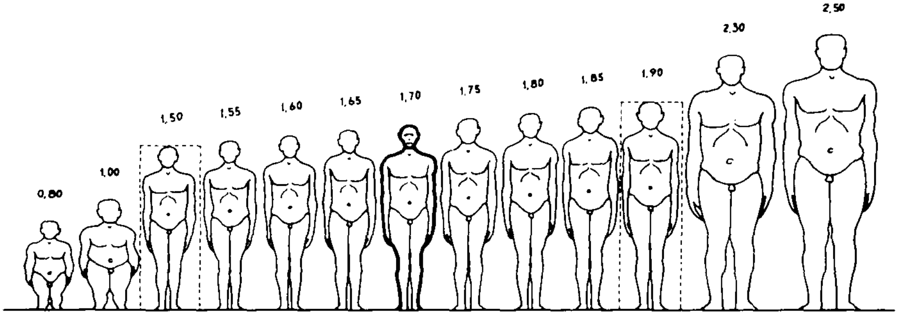


Fig. 2 Progression of height in a normal population, with two extremes that exceed the normal limit values at either end.

This is still the cause of much of the lack of understanding of anthropometric methodology. A clinician might refuse anthropometrics, not understanding its scientific aims and its usefulness. It is actually the only science which could enable a recognition of the normal typal characters, and it also provides a means for keeping in mind almost figuratively the natural organization of the varying physical characteristics that combine to form man.

It is quite true, as Barbensi says, that practical application "needs only an empiric use (of mathematical calculation) . . . not too hard a task with the help of tables of calculuses and the use of calculators."[3] But the clinician must already know the facts to which these statistical data refer in order to reach a solution to the problem.

The solution requires an approach that inverts the explanatory method of teaching, so that the meaning to which statistical data refer must be known beforehand. This enables a precognition of the natural phenomena involved in the formation of varying characters.

We shall follow this criterion and take the first step, observing the distribution of variations of characters in individuals. A clear example is given by the height characteristic.

NORMAL VALUES
ABNORMAL VALUES
NORMAL LIMIT VALUES

How are they Distributed?

Let's imagine the individuals of a vast population lined up in order of increasing height, ranging from those progressively smaller than 1.5 meters to those taller than 1.9 meters. There is no precise natural limit to the variability of this dimensional character, giving the possibility of exceeding what is called the *normal limit values* (Fig. 2).

Heights may occasionally exceed the minimum or maximum normal limit values, so that nanism and gigantism are considered to be abnormalities. The consequences of such abnormalities are both organic, in the case of anatomic disproportions or physiological disorders, and psychological in that they hurt the feeling of esthetics.

The graduality with which the distribution of height follows the continuous line of increase common to all characters is clear. But how are the various components of the same height distributed in man? Let's ask ourselves the questions that could have been asked in pre-biometric times. Perhaps people are distributed in the same percentages: people 1.5 meters high, people 1.6 meters high and those 1.9 meters high. Or they could be distributed so that people whose chest has a height corresponding to a height of 1.9 meters have lower limbs whose length corresponds to the height of 1.5 meters. Or, the other way around, individuals whose lower limbs of a length corresponding to the height of 1.9 meters have a chest of a height that corresponds to the height of 1.5 meters. This would remind us of the time when even monsters represented a phase of the evolution toward perfection of living beings (Maupertuis).

Up to this point we still don't know which pattern is followed in nature so that the size of human organs varies to make us proportional whether height be tall or small.

Shall this ignorance of the normal external typological anatomy of the facial system go on endlessly because the missing solution to the problem is not dealt with? This was actually the case before the introduction of anthropometrics toward the middle of the 19th century by F. Gauss (1777-1855) and by A. Quĕtelet (1796-1874). Anthropometrics verified that there is a uniform natural order, with attributes of living beings coordinated according to that perfect functional-somatic balance that can be found in proportion. That balance is supported by laws that form the carrying structure of anthropometric science.

OBSERVATIONS OF F. GAUSS ON THE BINOMIAL BEHAVIOR OF ACCIDENTAL ERRORS

Gauss ascertained that the measurement of a size, such as the width of a lake, is liable to accidental errors, so that different values will result when it is repeated several times.

Accidental errors follow the terms of development of the binomial $(\frac{1}{2} + \frac{1}{2})n$. This can be illustrated by a schematic example (Fig. 3). Suppose that you want to build a building exactly one kilometer from the shore of a lake and, as a first operation, you establish this distance with the following sequences.

1. A first measurement of 1,000 meters is carried out with the help of a normal means of measurement, starting from a landing place on the lake and fixing the point of arrival with a pole at point A (Fig. 3A). A second measurement of 1,000 meters is made in the same way, but the point of arrival is 2 meters farther than the preceding one and is fixed at Point B. Because of the great difference, many other measurements are made. The resulting data, divided into classes and reduced by statistical calculation, are schematically reported with rounded figures.
2. Of six measurements, three are 50 cm beyond point A, at point A1, and three are 50 cm ahead of Point B, at point B1. This reduces the error to 1 meter.
3. Out of ten other measurements of the 1 km distance, five are 25 cm beyond point A1, at A2, and five are 25 cm before point B1, at B2. This reduces the error to 25 cm on each side.
4. Out of twelve of the measurements, six are 12.5 cm beyond point A2, at A3, and six are at 12.5 cm be-

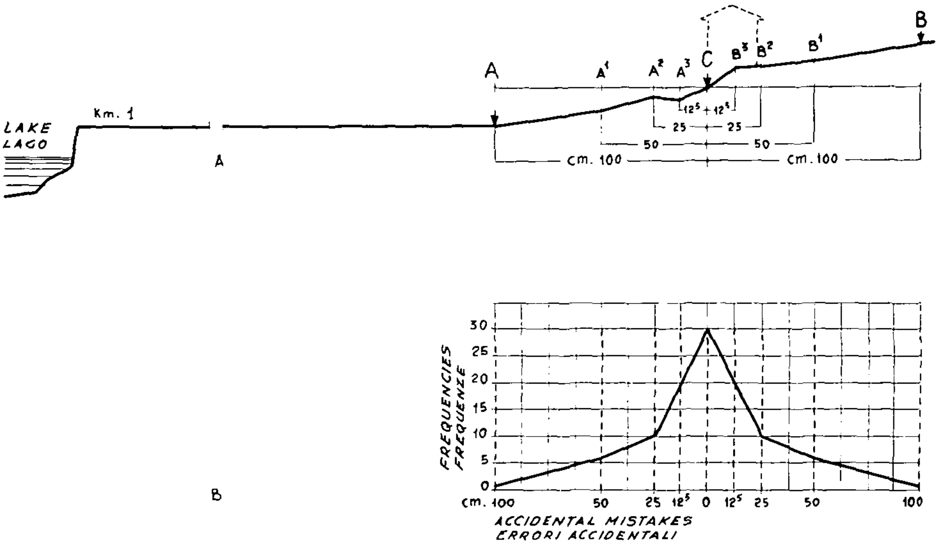


Fig. 3 A. Errors in the measurement of a 1 km distance.
B. Distribution of the above errors.

fore point B2, at B3. The error has been reduced again.

5. The result of thirty other measurements reaches a point called C. Now we can make the folowing observations:

a) the major percentage of measurements of the same distance has no relevant error, ending up at the same point C. There is therefore a good probability of not making errors.

b) From point C we can notice accidental errors distributed equally on both sides of it.

c) The farther they get from point C (increased intensity or seriousness), the more their frequency decreases. Therefore, the probability of accidental errors becomes more rare as their seriousness increases.

As a consequence, Gauss affirmed that parameter C, in which there is the major coincidence of measurements corresponding to the arithmetic mean, represents the *most plausible measurement value.*

We can give the same example schematized on a diagram with Cartesian coordinates by the method of statistical serialization (Fig. 3B). We place the severities of accidental errors on the axis of the abscissae, and their frequencies on the ordinates. Both severity and frequency are distributed in both directions from the point of greatest incidence, descending obliquely to form a *polygon of frequency* or a *curve of frequency.*

A. QUÈTELET AND ANTHROPOMETRICS

The Exponential Law,
the first aspect of the uniform order of natural phenomena

A. Quètelet, starting from the above principle, thought that the already-known harmony of the organic world (Saint-Hilaire) was supported by a behavior of the characteristics corresponding to the binomial distribution shown by Gauss, so that the deductions drawn for accidental errors could be applied to organic phenomena. The greatest frequency of organic characters would be regarded as the most acceptable, and the distribution would be binomial.

Following Quètelet's approach, but leaving its mathematical development aside to reach our deductions faster, we can refer again to the example of height to answer the first question that we asked: "how are people distributed in the population?"

As the Author explained on another occasion, "When we would think that nature may be disorderly displaying unlimited reductions and augmentations in body dimensions, some of them extending into the field of abnormalities, we are surprised to discover how nature itself keeps us from the danger of excesses. The perfection of the mechanism makes its reduction into a mathematical formula possible."

This plan makes distribution suitable to the necessities of material and spiritual life, working in such a way as to reduce the number of individuals whose characters are too excessive in one way or another, limiting the danger of noxious effects. Moreover, it follows a pattern that gives most individuals characters of intermediate intensity, which are not noxious. The regularity of this distribution has been rendered intelligible by anthropometric methods."[4]

By reconstructing the polygon of frequency, also called the binomial curve, we ascertain how the probability of noxious characters thins out (Fig. 4).

About half of the population ranges around the average height of 1.7 meters, far from the extreme dimensions. From this average, intensities and frequencies vary gradually in an orderly pattern.

Heights diminish progressively on the side below the mean, along with the number of individuals bearing them. At the end there is only one individual, 1.5 meters tall, still within the normal limit value but close to nanism, which is extremely rare.

The side in excess of the mean follows a similar pattern. As heights increase toward the danger of unfavorable life conditions, the numbers again thin out. Here too, at the end there is only one individual 1.9 meters tall, barely within the normal limit value.

The binomial curve is an expression of the uniform order that shows its universal nature. It shows the reality of the binomial distribution of intensities and frequencies of characters, indicating its mathematical development and allowing the establishment of the exponential law.

The Correlation Law,
second aspect of the uniform order of natural phenomena

A second question must still be answered; how are characters distributed in the individual person?

In order to examine it, we must go back to the preceding example of the individuals graphically represented in an increasing order of height. In this case, we can consider separate char-

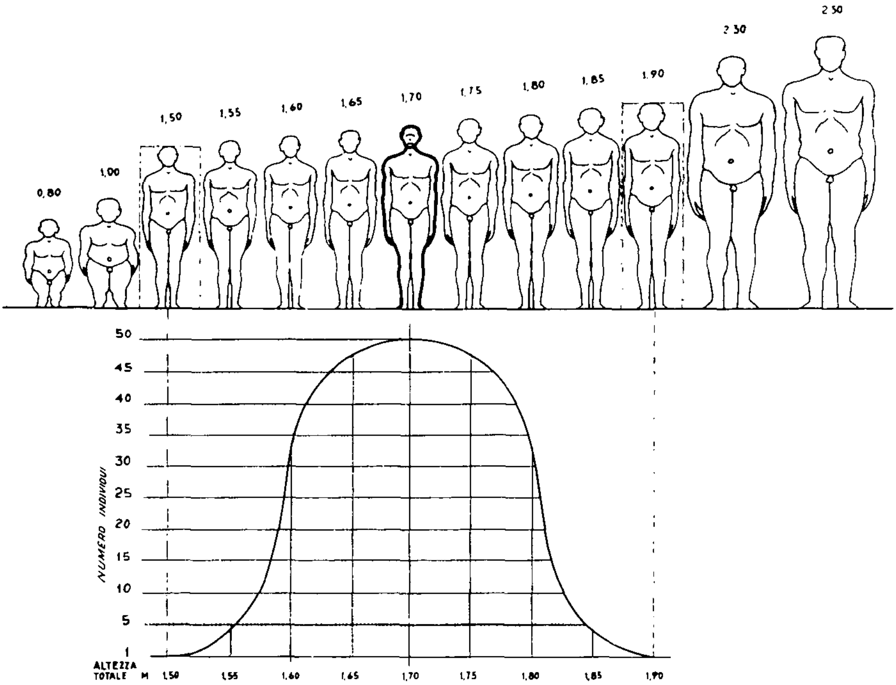


Fig. 4 Distribution of incidence of height in the population shown in Fig. 2.

acters formed by the chest and the lower limbs, and further by the thigh and the leg.

The simple graphic representation stresses the phenomenon of the peculiar combination of characters. The length of the lower limbs and the height of the chest decrease and increase together. Similarly in the dimensional characteristics of leg and thigh the decrease or increase of one is matched by a decrease or increase in the other (Fig. 5). So it is for most of the body characters.

The importance of the correlation is that it represents a ratio of quantitative and qualitative reciprocity between body organs. Specifically, it is important because it represents the correct size ratio, the proportionality of the structural elements of the organism with their functional balance. This correlation is the second phase of the typologic variation method.

It is clear that what happens in the height or other characteristics of the individual also happens in the facial system.

CONCISE CONCLUSIONS DRAWN FROM ANTHROPOMETRIC INFORMATION

By explaining the method of typological variation, with the natural distribution of the varying characters, anthropometrics opens new possibilities for research on the typical normal somatic state.

According to the exponential law, there is a relation between severity of deviation and frequency of characters —as deviation away from the average increases in either direction, the frequency decreases (Fig. 4).

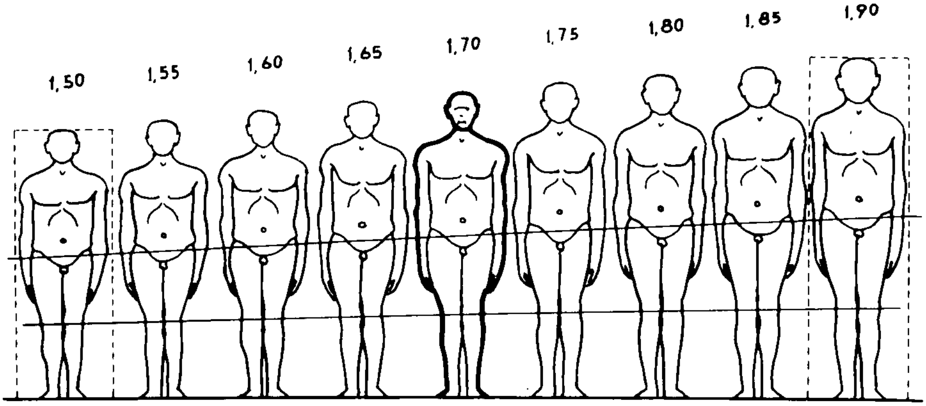


Fig. 5 Proportional relationships of individual parts tend to remain the same, regardless of size.

According to the correlation law, there are also relations of quantitative and qualitative reciprocity, correlations between the characters of an organic apparatus (Figs. 4, 5). If an organ is structured according to a given somatic-functional pattern, the other organs of the same apparatus are structured the same way. If one organ varies in a certain way, the related organs vary in a similar way.

As a consequence, the normal somatic-functional state expressed by proportion is not represented by the size, shape or position of one single organ of the apparatus, but by the correlated relation between all of the organs that form it. It is a *correlated relation* among organs that constitutes the *fundamental canon of the normal somatic-functional state.*

PART THREE

Application of Anthropometric Methodology in Orthodontics

THE APPLICATION OF ANTHROPOMETRICS ACCORDING TO THE INTERPRETATIONS OF PAUL SIMON

Anthropometrics was applied by Paul Simon in 1922, in a methodology that started from his singular interpretation of Quëtelet's theory. The same approach is used in most present-day systems of cephalometric analysis.

This Author, after having subjected it to critics, has arrived at a different interpretation of anthropometric theory, with a different resultant methodology.

There is a radical difference between the two interpretations, but the scientific basis of this new approach will be more understandable after first becoming acquainted with that of Simon.

Simon's interpretation of Quëtelet's theory assumes that only the person whose characters correspond to an average value is a healthy person. Having been misled by the discussion about that theory, which seemed reasonable at that time, he progressed to some extreme conclusions.

He maintained that, since only the average person was healthy and normal, only his single organs that were also of average value were normal. Those corresponding to other values, the variants or swerves in the binomial distribution line, were considered abnormal.

He therefore prepared an experimental procedure in which he planned to subject the non-average variants to corrective treatment as if they were abnormal characters. He nevertheless gave in to the technical necessity of accepting the position of the Frankfurt horizontal plane in the head as a constant, in order to have a reference for drawing the vertical line that was to indicate the average "normal" position of the upper cuspid (Fig. 6).

It is clear that only something arbitrary can come out of such an interpretation. It raises such questions as whether only the characters of average value are really normal, and whether the position of the Frankfurt plane is really a valid constant. With regard to the first doubt, we can point out that if non-average values also proved to be normal, both Simon's interpretation and his experimental approach would be erroneous. We will try to clarify this assumption with a simple schematic experiment, rather than with a long academic discourse.

Let's assume, without granting it, that Simon's interpretation is correct, that only the average character, only the average organic apparatus and only the average person are normal.

To establish how the normal position of the gnathion point on the profile could be determined, it would be enough to apply a measuring method of Simon's type. We draw a basal plane such as sella-nasion (S-N) and statistically search out which angular opening of the line connecting nasion to gnathion represents the average of all cases.

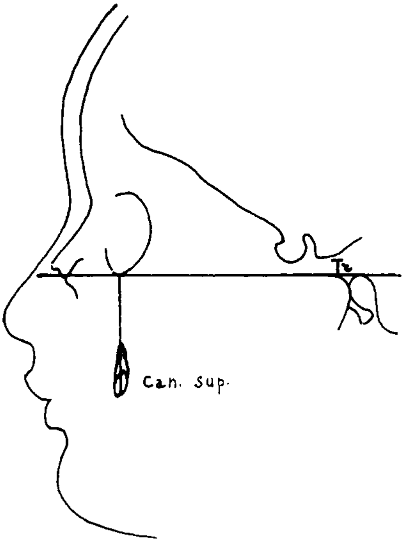


Fig. 6 Paul Simon's average 'normal' position of the upper cuspid.

Suppose that we have established that this average angular opening is about 79° in a heterogeneous population of otherwise normal individuals, including prognathic and retrognathic types (Fig. 7). Suppose that we also determine the results on the non-average subjects in that sample.

If Simon's idea were correct, Gn should coincide in all cases with the reference line corresponding to the average value of 79°. It turns out that in some types the average is placed posteriorly, very far from the original average (Fig. 7A), indicating a retruded position of the chin, and in others it is placed anteriorly, far from the same line, pointing out a protruded position of the chin (Fig. 7C).

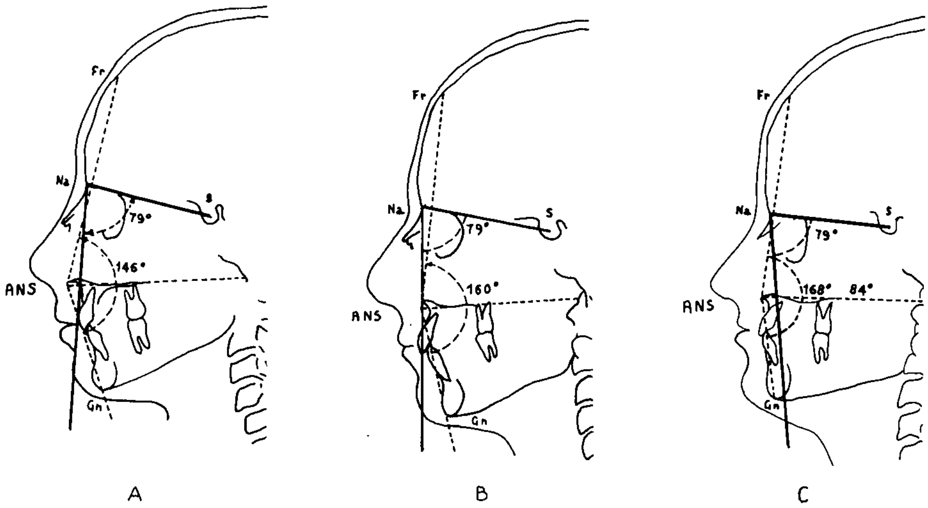


Fig. 7 An average S-N-Gn angle (179°) does not fit faces of all types.

It is clear that in the first case, if the clinician wanted to follow the numbers, it would be necessary to push, or somehow move, the chin anteriorly until the gnathion point was near the line. This would actually produce a malformation that did not exist before. An equally unfavorable change would be produced by such an approach to treatment of the type shown in Fig. 7C.

This clearly demonstrates the inappropriateness of subjecting characteristics that do not correspond to the average value to "corrective" therapy merely to make them average.

From today's vantage point, the negative result of basing treatment on only average values shows the precariousness of Simon's approach. However, referring it to its time, this present-day precariousness does not injure Simon's merit in having recognized anthropometrics as the appropriate means for determining the normal typological anatomy of the facial system.

As far as the second doubt is concerned, the Frankfurt plane turns out to be not constant, but highly variable from many viewpoints. This variability will be transferred to any measuring reference line that is based on it, further aggravating the diagnostic inappropriateness of the basic method.

APPLICATION OF ANTHROPOMETRICS ACCORDING TO EDMONDO MUZJ'S INTERPRETATIONS

Declarative Proposition

The Author, with a conceptual detachment, places himself in a position opposite to that of Simon's interpretation. He accepts Golton's criterion which considers the differences among individuals to be fundamentally genetic and the average as a value that represents the most frequent conditions. This regards the non-average person ranging within normal limit values as also normal (Fig. 2).

This leads to the following deductions related to our theme:

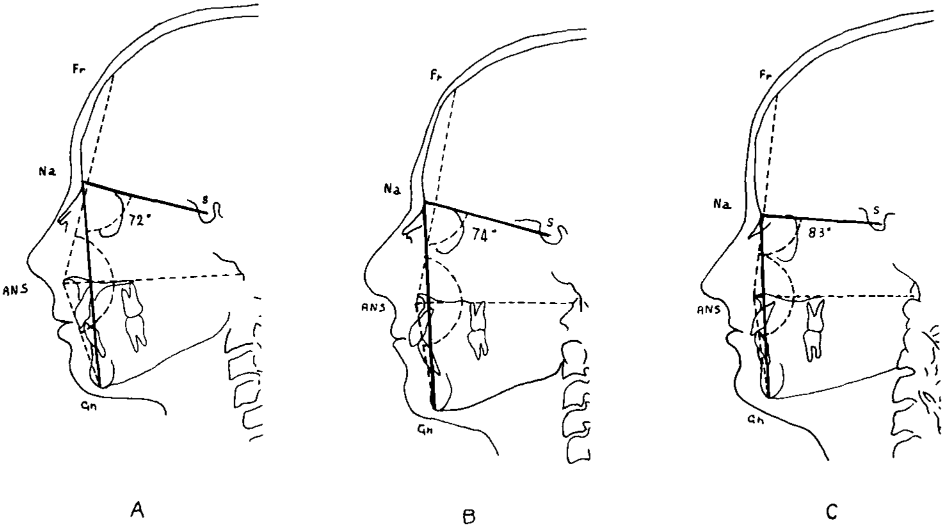


Fig. 8 Angle S-N-Gn varies among individuals of different facial types, all of which can be considered normal even though they may not be average.

a) The facial system is represented by many normal types. The principle which shows that the heights of man may vary from 1.5 meters to 1.9 meters and still be included in normality has already been demonstrated in Fig. 2. From this we can deduce that the facial constitutional variants and physiognomic dimensional and positional variants that form different types of faces may also vary widely without being regarded as abnormal.

This can be further demonstrated by referring to that preceding experiment, modified as in Fig. 8. If we apply the same schematic measurement to types with varying degrees of protrusion, this time joining Na and Gn with a line in each case, the result is three different angular openings, demonstrating that the normal facial system can be represented by many different models.

b) In these different types, the normal typal state, as in every structure, is not given by a special form of one organ or part, or by a part in a position of average value; it consists of proportionality among many parts, as among architectural elements.

c) Measurements carried out only on the part of the face which is below some horizontal plane, as is done in most usual procedures, are not valid. We must adopt a procedure that suits the sense of the correlation law, which says that every character contributing to a *system* of the body, including the facial system, is a function of one or more other characters.

Every character has relations of quantitative and qualitative reciprocity with the related characters. If, for example, one part of the facial system is small or large, the same should be found for the other parts of the same system in a similar proportion. The relation of equivalence remains. This brings about the proportion expressing the morphologic normality among the parts of the individual, regardless of the quantitative and qualitative

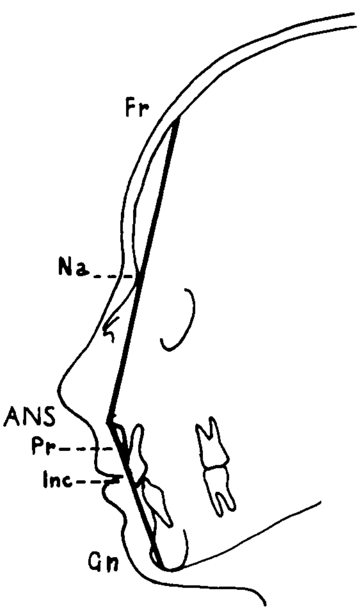


Fig. 9 Muzj's frontofacial angle is formed by an anterior nasal spine point, frontal point, and gnathion. Nasion, prosthion and incision lie close to the sides of the angle.

variations that they might undergo because of different constitution, different ethnic background, or different physiognomy.

d) Only measurements based on at least two correlated parts can be valid, since a proportion can exist only between two or more parts.

e) A measurement is valid only if it is carried out on characters whose properties also reflect racial peculiarities, since these are an essential component of the normal typal state.

Edmondo Muzj's Method for Determining the Normal Typal Anatomy of the Facial System

Research on the racial characteristics that are a part of the correlation.

It is not difficult to find correlated characters on the face, since a relation of reciprocity can take place among many parts and in different, even pathological, local structural conditions. But mere correlation is not enough.

It is necessary that the correlation be typical of race, with the property of representing its anthropologic marking character, since only this can establish the existence of the normal typal state. It is also necessary that it have the property of representing such a character as a constant among all those belonging to the race, and still be a variable character within each individual, who will always be different from the others.

Such correlation must exist on the entire facial system, so that we get to know the morphological properties that such correlation brings about in all the facial regions. It is a complex phenomenon indeed.

We must leave out descriptions of the special work done in the fields of anthropology, paleontology, phylogenesis and orofacial medicine in order to concentrate on the essential correlation.

The Author recognizes the means for determining such anatomy in the following characteristics.

Muzj's Frontofacial Angle

The frontofacial angle, a measure of convexity, defines the terms of the correlation. This is based on the opening or closing of the profile over the gnathic apparatus. It divides the face into two parts, upper and lower, definable by two lines forming an angle (Fig. 9).

This angle can be found in all vertebrates. It can be found in fishes, in amphibians, in reptiles and mammalians in general, as well as in present-day man (Fig. 10).

The frontofacial angle outlines the shape of the facial profile. Its two

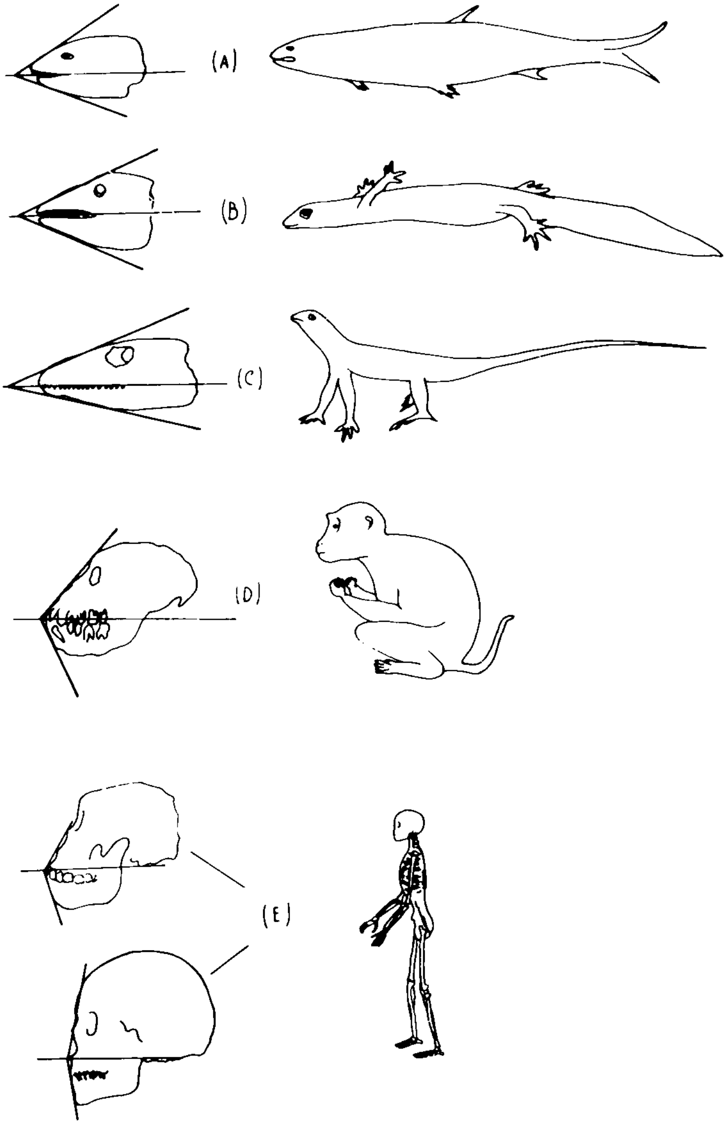


Fig. 10 The frontofacial angle varies widely among the vertebrates.

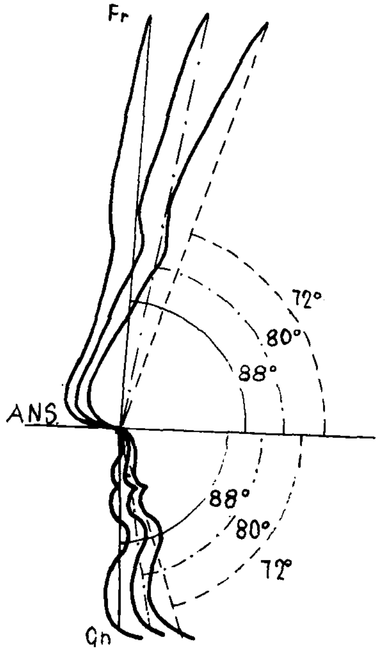


Fig. 11 There is a harmony between upper and lower face, with the angles tending to be the same in normal individuals.

sides extend from the region of the anterior nasal spine, upward to the frontal point and downward to gnathion.

Since the forehead has been included, departing from the age-long rule of considering it as alien to the face, we can call it Muzj's frontofacial angle, or more simply Muzj's FFA. This will distinguish it from other angles based only in the lower face.

It is interesting to observe that, according to researches carried out by Ruiz-Moreno, this angle can be identified in man immediately after birth.

Postions of key structures along the sides of Muzj's FFA

The structure that divides the two sides of the profile is ANS, the anterior nasal spine (Fig. 9). Close to the upper and lower sides of Muzj's FFA, corresponding to the upper and lower parts of the profile, are the key structures that are part of the correlation. These are indicated by the following skeletal anthropometric points:

Frontal point (already used by Björk), which for this purpose is the highest and the most anterior point of the forehead
Nasion
Incision superior
Prosthion
Gnathion

Reciprocal Relations among the Correlated Structures

The third characteristic is based on the tendency of the upper and lower parts of the face to structurally organize in relation to Muzj's FFA, in accordance with the fundamental uniform order of organic proportionality shared by all organisms.

This aptitude can also be found in the fact that the same facial parts, or the principal structures of the profile, form a homothetic correlation in the sense that, if the upper part is inclined dorsally or straightened ventrally, the lower part will tend to also be inclined dorsally or straightened ventrally to a similar degree (Fig. 11).

The fact is that in all individuals of the Caucasian race the two sides of Muzj's FFA keep the same relationship of inclination, constituting a constant model of racial character. The fact that the opening of this angle varies among individuals of the same race constitutes the variable component of the model. Thus Muzj's FFA also becomes an individual characteristic.

The interaction of these phenomena gives rise to the correlated angular whole that makes up the face. This is the synthetic expression of the genetic factors that create the shape of the facial system, of the contribution of anthropometrics to point out the phenomena in it, and of the experimental and inductive work carried out to determine the external normal typological anatomy.

ANTHROPOMETRIC CONTROL

In order to check the scientific truth of this declarative proposition, the author carried out a statistical study using anthropometric methodology on a group of 110 subjects. All were judged to have a normal typical Caucasian profile according to the criterion of the "typical individual."

The study was based on a triangle defined by the two sides of Muzj's FFA and a line connecting the frontal point to gnathion to form the longer side. This triangle was then bisected by a perpendicular drawn from ANS to the frontal-gnathion line (Fig. 12).

The necessity of mentioning the first basic experimentation and of following the chronologic course of the studies carried out, induced the author to refer to an often repeated figure.

Facial profiles were found in a continuum from one having a minimum opening of 146° to one having a maximum opening of 174°. The data for angular opening and frequency for this series can be plotted to form a polygon of frequency. In this polygon, the major percentage of cases corresponds to the profile of average angular opening of 162°. Starting from the average value, the percentage gradually and symmetrically decreases to reach the farthest extreme below the mean with a single case of 146°. In the other direction we reach the extreme opening above the mean with a single case of 174° (Fig. 13).

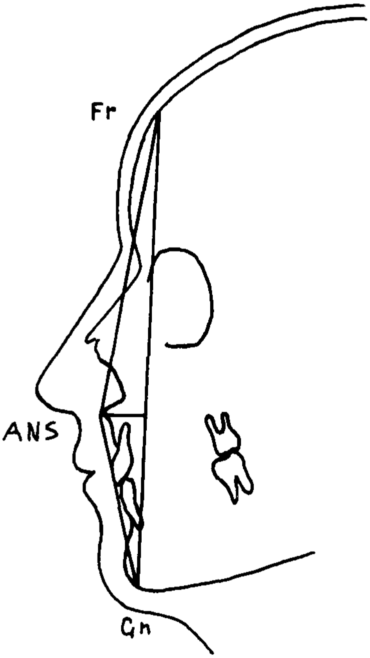


Fig. 12 A triangle is formed by Muzj's frontofacial angle and the line connecting Fr and Gn. This is then bisected by a perpendicular to the anterior nasal spine.

These results show the following:

1) Muzj's FFA is systematical in the profile, and along its sides are placed the major structures.

2) Muzj's FFA is not chaotically distributed in man, but follows a series of variations ordered according to the exponential law, as seen in the polygon of frequency.

3) Muzj's FFA, which in this first experimental group belongs to a normal typical profile because it was chosen according to the criterion of the "typical individual," is divided by the bisector into two equal and therefore correlated angles.

On this basis, we can draw the following deductions:

1) The proportion identified by the correlation between upper and lower

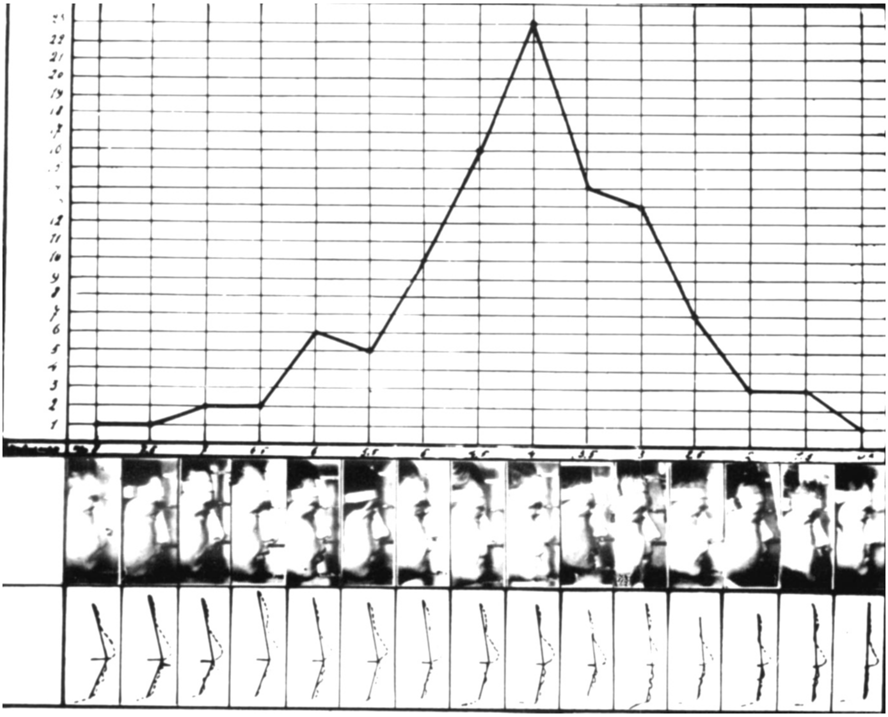


Fig. 13 Frontofacial angles range around a central value, much as height and other physical characteristics, with the greatest number of individuals exhibiting values near the mean.

angles that combine to form Muzj's FFA marks all subjects of the group. This demonstrates statistically that they were all normal typical; therefore, the facial angular correlation qualifies as a scientific truth.

2) Muzj's FFA and associated correlations, repeating in all individuals of the Caucasian race, represents a constant character, which may also serve to differentiate them from individuals of different races.

3) Since the degree of opening may be different in each subject, Muzj's FFA also constitutes the *variable character,* bound to differentiate one individual from another within the same race. This defines a particular physiognomic peculiarity, the *individual Muzj's FFA* (Fig. 14).

PARALLELISM BETWEEN THE ARCHITECTURAL STRUCTURE OF A BUILDING AND THE STRUCTURE OF THE FACE

Thinking over what we said before about the architectural structure of a building and structure of the face, it is easy to see the similarity in these structures. This clarifies how the correlation forms a proportion in the face that satisfies the feeling of esthetics and so brings about the state of typical normality.

Symmetry must inevitably introduce proportion into an architectural building. If there was no symmetry, there would be a great loss of proportion and harmony, as we can see in the example of the Pantheon (Fig. 1).

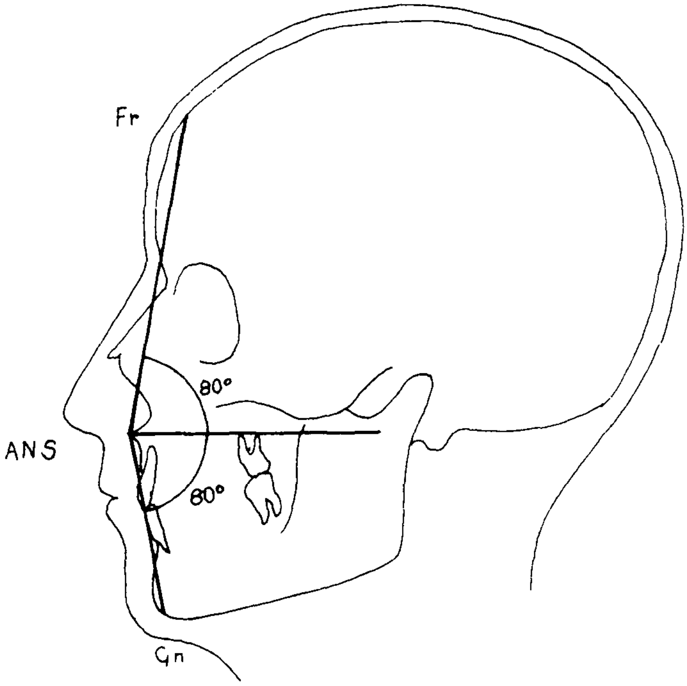


Fig. 14 In the normal experimental group, Muzj's frontofacial angle was found to be divided equally between upper and lower angles.

Suppose the radial subdivisions of half of the cupola had a larger or smaller width than the subdivisions of the other half, or a longer or shorter length. With such a misshapen plan, so lacking in proportion, the whole architectural structure would seem discordant and discontinuous.

The same is true of the structures of the organism, as can be seen in the example of the symmetrical alignment of the clavicles. The two clavicles, which can be compared to architectural elements, form equal angles with the spine (Fig. 15A).

It is convenient to resort to the same example to show the behavior whenever the correlation is annulled by a malformation. This is the case when a damaged right clavicle is abnormally lowered, forming an angle of smaller opening than the undamaged left clavicle (Fig. 16A). Similarly on the profile, the lower side of Muzj's FFA may be abnormally retruded, forming an angle of smaller opening than the one formed by the upper side (Fig. 16B). Such lack of vertical symmetry results in a disharmony that cannot be considered typical normal.

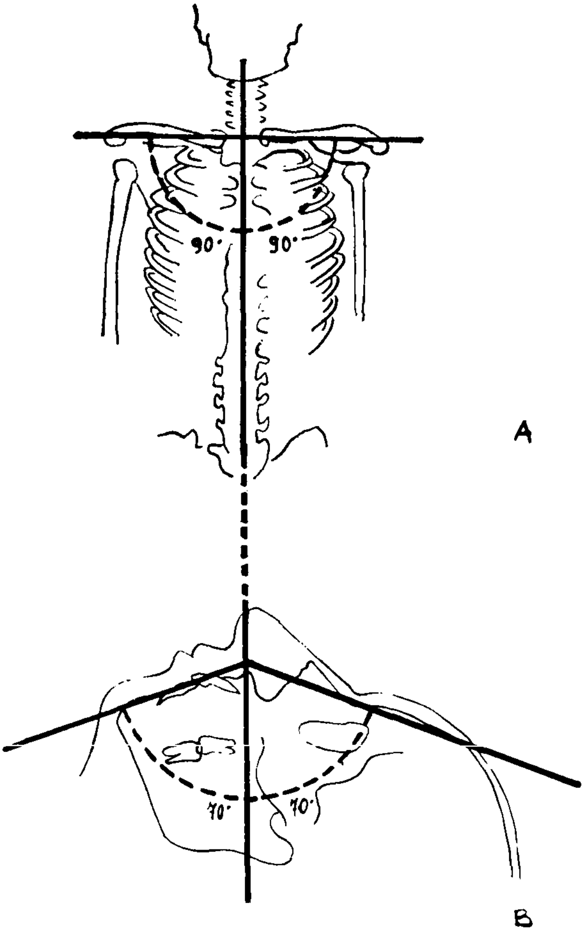


Fig. 15 Clavicles are normally aligned symmetrically, forming equal angles with the spinal column. The upper and lower face are similarly aligned symmetrically around the palate.

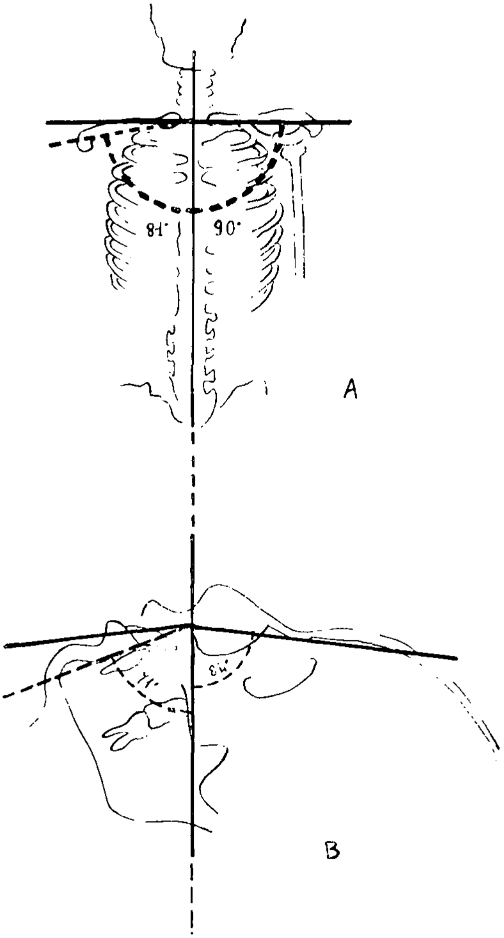


Fig. 16 A malformation causing a misalignment in clavicle or face will be reflected by unequal angles, which serve to indicate the changes required for correction.

PART FOUR

Practical Application of Muzj's Methods

The knowledge of anthropometric methods gives the opportunity to check, through the proportion, whether or not the normal typal state exists in an individual. This also provides a means for reconstructing the proportion for diagnostic purposes in cases where there is lack of proportion because of a malformation.

Such a reconstruction is obtained using the law of proportion, according to which the size of one of the constituents, or key characters, of the proportion must be known. This is then used as a reference parameter to determine the appropriate size of the other (damaged) key character. The procedure is not always the same.

We can see how restoration can be accomplished in the example of the simple case of the dimensional proportion between the lengths of the lower limbs and the height of the chest.. If height is modified by a somatic alteration localized in the lower limbs, the normal height of the chest can serve as a reference to which the limbs can be compared in order to mathematically determine their normal length (Fig. 5).

We can also see how a similar reconstruction can be accomplished in the more complex case of an annulled positional correlation of the clavicles. If we know the degree of opening that one undamaged clavicle forms with the axis of the spine, we can plan how to correct the misplaced clavicle to its normal position by aligning it to form an angle with the same degree of opening (Fig. 16A).

Finally, we come to the much more complex case of determining how the positional correlation between the upper and lower parts of the facial system can be restored when it has been annulled by a malformation. It is also necessary in this case that one of the two facial parts be unaffected, so that it can be used as a reference parameter for comparison with the other.

The undamaged facial part is usually the upper, with the malformation in the dental rather than nasal or frontal area. In order to plan the restoration of the malformation, we draw Muzj's FFA on the profile and measure the upper and lower angles to determine whether the lower angle has an equal, smaller or larger degree of opening than the upper one. Differences between the two angles will indicate whether the lower side of Muzj's FFA is in a normal position or misplaced horizontally.

This calls for the division of Muzj's FFA into two parts by means of the bisector that represents the inside common side of the two angles. A perpendicular from the long line from the frontal point can no longer be used if the chin is displaced.

The identification of a horizontal cranial plane that will represent this bisector is the researcher's most complex task. There are no visible structural characteristics in the region that can help to define this line, and an incorrect definition would give the corresponding facial parts a wrong position. For this reason, the indispensable horizontal plane acting as a bisector was the object of a long three-phase study.

1) In the first phase, an effort was made to eliminate the definition of

the bisector. For this purpose, the inclination of the upper part was assumed to have a determining function for the whole facial structure. It was used to form a normal FFA, deriving the inclination of the lower side from that of the upper side, using the geometrical procedure shown in Fig. 17. The bisector obtained in this way has no determining function, but only a secondary technical function.

Other experimental works on various phenomena have been carried out using this approach. These confirm the validity of the method, but at the same time they point out the necessity for improving the selection of the bisector.

2) In the second phase, under the influence of the available knowledge, the horizontal cranial plane that connects the Bolton basal occipital point and ANS was used as the bisector. Many experimental studies were carried out with this horizontal plane, but it offered no advantage in establishing a diagnosis of malformations that call for a more detailed local analysis.

3) In the third phase, the Author went partially back to the first. It was his intuition, strengthened by the development of his studies on the subject, that the facial system (including the frontal part of neurocranium) is subject to a variability of its own. This variability is independent of the general cephalic variability, but more closely related to the known reciprocal or proportional relations that are characteristic of racial type.

This allows the facial system a certain independence from the cranial base. Being disengaged from it and moved by its own inherent dynamism, it forms variants that bring about both a different orientation of its single organs and a different inclination of its whole in relation to the dorsally situated neurocranium.

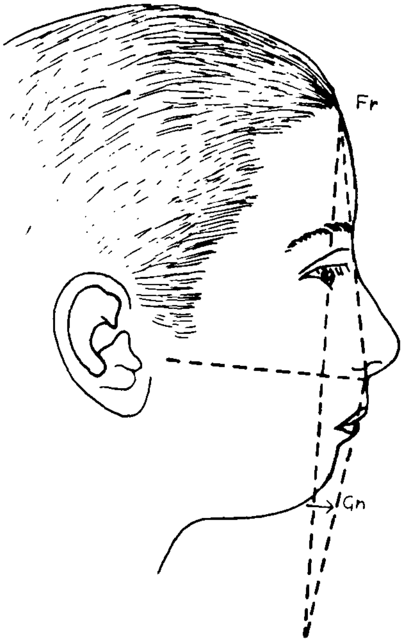


Fig. 17 Using the inclination of the upper part of Muzj's FFA as a basis for the lower is a simple approach, but it lacks the advantages of a specific bisector.

It is clear that the middle nasopalatal region and the plane that geometrically represents it are influenced by this independence of the facial system.

Gerhard H. Müller^5 indirectly confirms this in his studies of the influence exerted by the variable growth action of the central cartillage of the nose on facial morphology. He found a vertical lowering of the line passing across ANS and PNS in relation to the condylion point during growth. This lowering sometimes exceeded 10 millimeters.

It is the Author's conviction that the ontogenetic change of the upper and lower parts forming the facial sys-

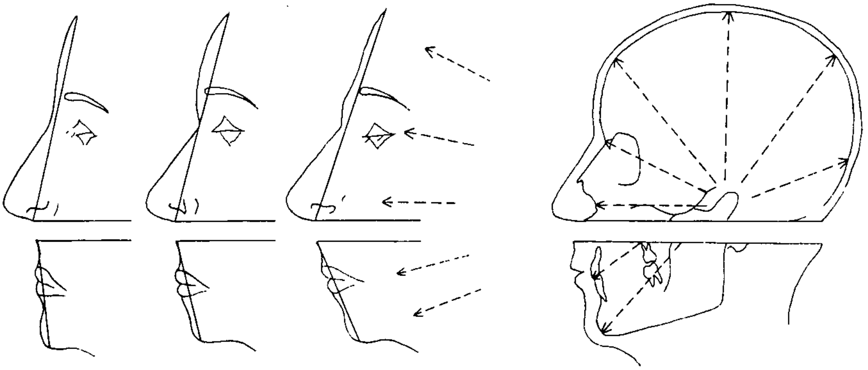


Fig. 18 Growth of upper and lower face can be considered separately, even though they are part of a coordinated whole.

tem takes place under the influence of a local dynamic component of their own. This local component is capable of structuring these parts with correlated reciprocal relations.

Furthermore, he believes that this dynamic component, radiating in the head from some central focus, is divided in the nasopalatal region into two branches, one oriented upward and the other downward (Fig. 18). It is these two segments that are instrumental in forming the correlated parts of the face.

Another conviction is that this nasopalatal region, which is common to both upper and lower facial parts, is less variable vertically, following general cephalic changes.

To this we can add that the nasopalatal region itself, particularly the hard palate, is a very strong organ, firmly attached to the sides of the oronasal vault and fixed to the bones of the cranial base. It bears the heavy and varied loads developed by the energy of the masticatory and tongue muscles, and the functions of respiration, phonation and deglutition. The hard palate is a center that gathers these mechanical energies and redistributes them, and this energy contributes to governing the development of the surrounding organs.

Considering what has just been said, the Author maintains that the plane which divides the correlated facial parts must be located in the palatal region. More precisely, it is located within the hard part of the palate, where we find the favorable conditions for a plane of symmetry easily detectable by x-ray.

The Author also believes that such a palatal plane could be the one traced across the region between the upper and lower layers of the hard palate. The line must be chosen to avoid the influence of the anterior nasal spine and the curve of the hard palate, both of which can be quite variable (Fig. 19).

The disorderly variability in the position of the ANS is due to the fact that the anterior parts of the palatal vault and the nasal floor can be directed upward or downward with an effect as great as 5 mm. This means that a horizontal cranial plane based on ANS anteriorly can often be displaced upward or downward at its anterior end, radically altering any re-

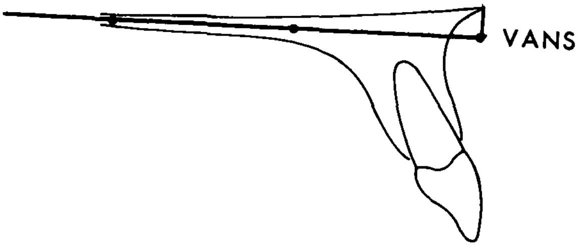


Fig. 19 The palatal plane is drawn through the central part of the palate and the virtual ANS projected to that line. This serves as the base for the upper part of the frontofacial angle.

sulting measurement. Therefore, the *ANS cannot be used to indicate the anterior end of the palatal plane,* even though they may sometimes coincide.

Instead, *the plane must be determined in the horizontal part of the palate.* The anteriormost point of the plane, corresponding to ANS, is then obtained by drawing a short vertical line from ANS to the palatal plane. This point, which is independent of the vertical variations in the anterior part of the nasal cavity, can therefore be called a "virtual ANS" or VANS.

The practical procedure is extremely simple, carried out through the following sequences.

A) The nasopalatal plane is traced on the radiograph according to the palatal structures, and the Virtual ANS marked on the line (Fig. 19).

B) The Virtual ANS is connected to the frontal point (Fig. 20).

C) The resulting angle is measured and a lower angle is drawn with the same degree of opening (Fig. 14).

The result may show a typical normal state or an abnormal one.

Normal positions

The principal characteristics of the profile are normally located close to the sides of Muzj's FFA. This is true for the superior and inferior incision points, prosthion, ANS, frontal nasion, and gnathion. When these relationships exist, the correlation between the upper and the lower parts of the facial system is intact. The facial profile is normal for the type. (Fig. 9).

Abnormal positions

We must differentiate between deviations involving the key characters of the correlation of the frontal and gnathion points from deviations involving only intermediate structures.

Deviations Involving the Key Character Gnathion

When the key component gnathion (Gn) is displaced, the correlation is annulled and the resulting malformations involve the whole facial structure.

If Gnathion is located dorsal to its normal position, backward or retrusive, there will be a consequent malformation which can be evaluated by connecting the Virtual ANS to Gn and measuring the angle in relation to the upper angle (Fig. 21).

A ventral position, abnormally forward or protrusive, can be evaluated in the same way. (Fig. 22).

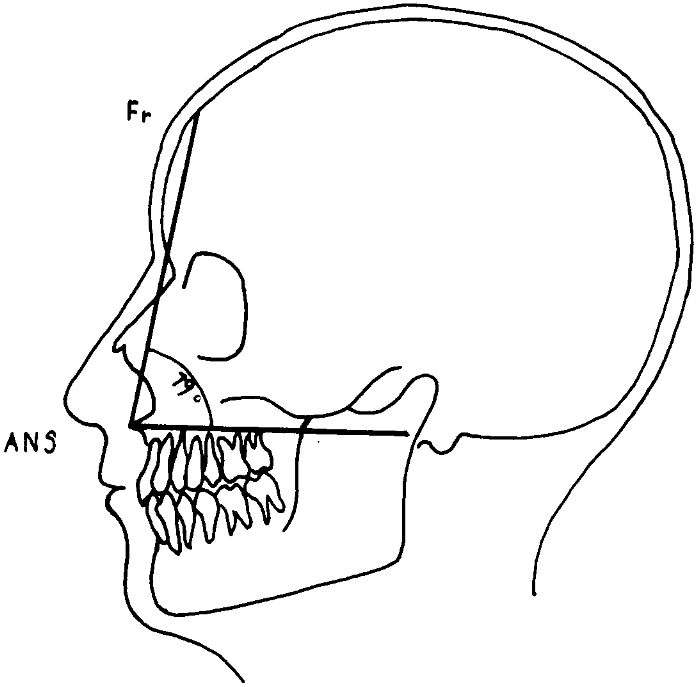


Fig. 20 The upper half of Muzj's frontofacial angle is completed by connecting VANS to Fr point.

Deviations Involving Intermediate Structures

Deviations of intermediate points do not annull the proportion in its overall general lines, because the key points Fr and Gn are not affected. The deviations of intermediate structures are local and extraneous to the overall structural correlation, but still important in treatment. The following are the most significant.

Incision points

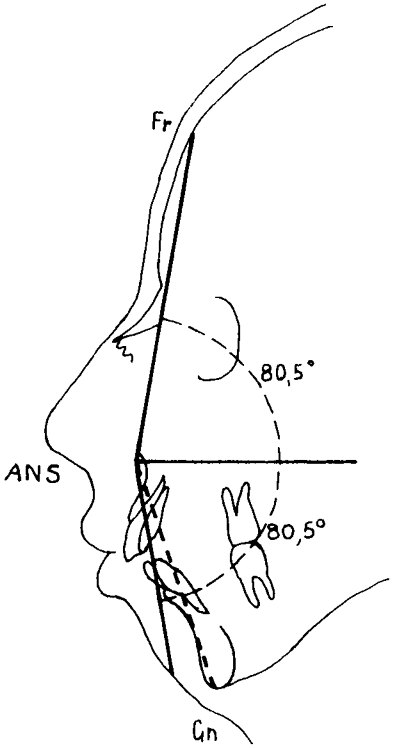
If superior or inferior incision point, or both, are not found near the lower side of Muzj's FFA, but are located anteriorly or posteriorly, this must be regarded as a malformation (Fig. 23).

Nasion

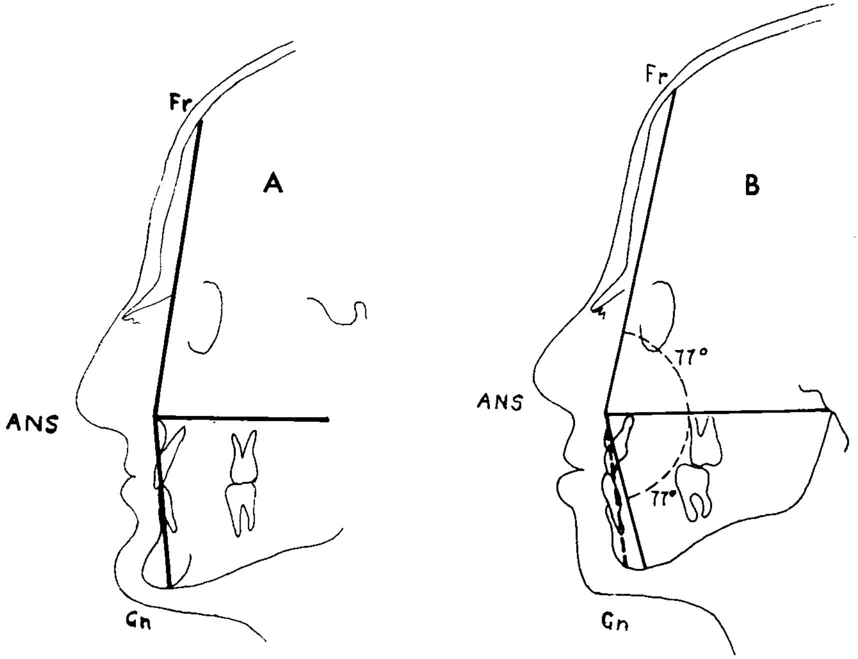
If nasion (N) is displaced dorsally (retruded), it indicates a type of profile regarded as non-Caucasian prognathism (Fig. 24).

If nasion (N) is displaced ventrally (forward), it indicates a common subtype of curvilinear profile generally accepted as normal in the Caucasian population (Fig. 25).

right
Fig. 21 The malformation in which Gn is retruded in relation to the FFA.



below
Fig. 22 Gnathion can be protrusive in relation to Muzj's FFA with the incisors in a normal relationship (A), or the incisors may also be protrusive (B).



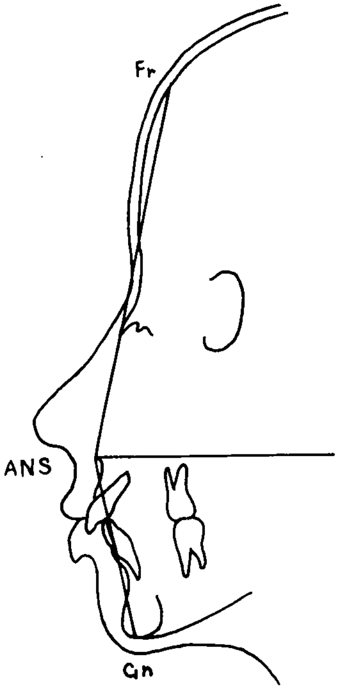


Fig. 23 If upper or lower incisor is anterior to the lower side of Muzj's FFA, it must be regarded as a malformation.

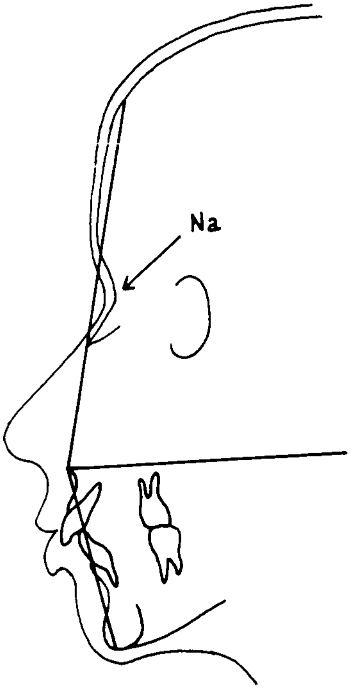


Fig. 24 If nasion is retruded in relation to Muzj's FFA, it is indicative of a non-Caucasian type of profile.

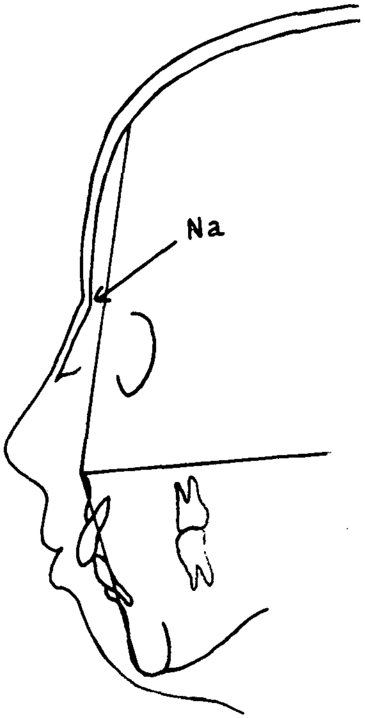


Fig. 25 Nasion displaced ahead of Muzj's FFA indicates a common variant of the Caucasian profile.

SUMMARY

Half a century of researches aimed at finding a theoretical-practical procedure suitable for identifying the representative character of the normal facial system has still left many questions unanswered and problems unsolved.

The cephalometric diagnostic procedures derived from Paul Simon's approach have proven to be inadequate for establishing clinical objectives. The opposite approach of Edmondo Muzj, based on anthropometrics, is difficult to assimilate because of the complexity of the subject.

This treatise is a clarification of that new approach, which stresses the importance of including the entire face in the analysis. Normality is judged by the proportional relations between the nasofrontal segment that constitutes the upper face and the dental region that constitutes the lower face.

The difference between the two approaches is the introduction of harmony and proportion, combined with a recognition that normality covers a much broader range than is indicated by single average values. Proportions reflect harmony in the normal face,

much the same as in architecture and music.

The Author's theoretical position can be summarized as follows:

The normal typical state of individuals is represented by a relationship among the parts of the facial system that satisfies the esthetic feeling of other individuals of the same race. Such happy combinations correspond to the state of *harmony;* we can say that harmony expresses the morphologic normality of the human face.

The problem is that since harmony depends on esthetic feeling, it is difficult to express it in metric terms. Harmony alone cannot be applied scientifically to establish the normal state of the face. But this difficulty fades away when we realize that in *proportion* we have a term corresponding to harmony which can be expressed in precise scientifically applicable metric terms.

The major difficulty lies in knowing which characters form the key proportion in the face. They must not only form a proportion; they must also be variable in order to differentiate the individuals of the same race, and at the same time they must be constant in order to preserve the typical peculiarities of the race.

The three key phenomena are:

1) the facial system is conformed according to Muzj's frontofacial angle.

2) the key organs of the profile are located along the two sides of the frontofacial angle.

3) there is a correlation between the upper and lower parts.

These correlations have been statistically verified, leading to the conclusion that the presence of the proportion is normal, while a disproportion indicates a malformation.

However, orthodontists who up to now have tried to find the value of characters with mathematical precision still have some work left to do. Since each person is different from the others and the organs cannot repeat themselves in a precise way, the correlation cannot be perfect. There may be a limited difference between the upper and lower parts of the face.

In marginal cases, when the correlation is present but imperfect, the orthodontist must add a professional contribution to the diagnosis by inductively distinguishing, on the basis of valid anthropometric knowledge, whether the cause of the imperfect correlation is a negligible physiognomic variation or a pathologic deviation.

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