

Longitudinal changes in three normal facial types



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The purpose of this study was to describe and compare the dentofacial relationships of three *normal* facial types (long, average, and short). Comparisons of the absolute and incremental changes between 5 years and 25.5 years of age were made both longitudinally and cross-sectionally. The subjects consisted of 20 males and 15 females for whom complete sets of data were available for the period of this study. All subjects had clinically acceptable occlusion and had not undergone previous orthodontic treatment. Descriptive statistics summarized the changes in 48 parameters, including that of height for males and females at 5, 10, 15, and 25.5 years of age. Longitudinal comparisons of the growth curves evaluated the curve profiles and curve magnitudes for the three facial types for both males and females. The analysis of variance was also used to compare the absolute and incremental changes at ages 5, 10, 15, and 25.5 years. The investigation resulted in the following findings. (1) Most persons (77%) have been categorized as having the same facial type at 5 and at 25.5 years of age. There is a strong tendency to maintain the original facial type with age. (2) Comparisons of the growth curves of the different parameters—with the exception of the incremental curves for MP:SN and Pog:NB in males—consistently demonstrated parallelism of the curves, regardless of the facial type. On the other hand, comparisons of curve magnitude indicated significant differences among the three facial types. (3) The persons within each facial type expressed a relatively large variation in the size and relationships of the various dentofacial structures. (4) Significant differences in the dentofacial parameters were present between males and females with the same facial type. The differences among facial types were not identical in males and females. (5) Longitudinal analysis of the data lends more consistent and, therefore, more meaningful results than cross-sectional comparisons when facial growth trends need to be evaluated. This is because growth changes are often subtle and of magnitudes not readily observed when the data are evaluated cross-sectionally. Standards that are age-, sex- and facial type-specific are presented. (AM J ORTHOD 88: 466-502, 1985.)

Key words: Facial growth, cephalometrics, facial types, longitudinal, normals

The description of the dentofacial relationships of persons with normal and abnormal facial morphology is one of the most frequently addressed subjects in the orthodontic literature.¹⁻¹⁷ This wealth of knowledge has consistently pointed to the large variation that exists in each population evaluated. As a result, many attempts have been made to describe the range of normal variation of the human face and design a system that identifies the various facial types. It is assumed that such a classification would be of value in the diagnosis and treatment planning of different craniofacial and dental discrepancies.

A facial-body type classification was presented by Salzmann⁸ using Kretschmer's description of somatic types. These types were divided into (1) leptosomatic—

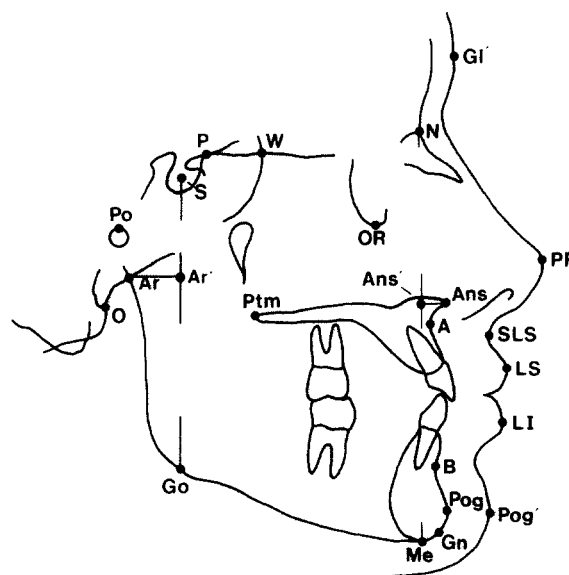


Fig. 1.

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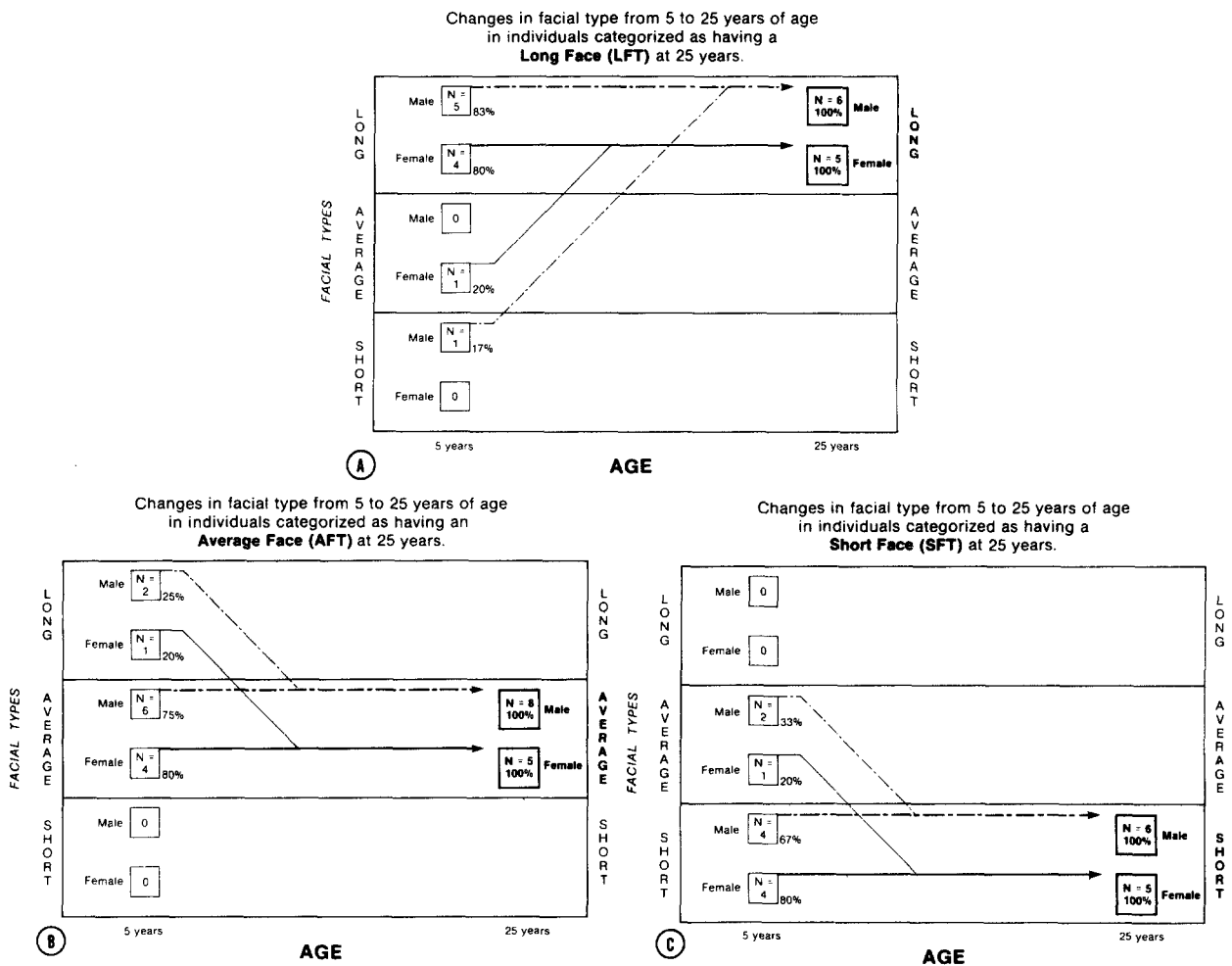


Fig. 2, A-C.

long and slender with a facial height of similar proportions, (2) pyknic—short and squat with a face more broad and less high, and (3) the athletic somatic type characterized by a well-developed square mandible.

With the introduction of radiographic cephalometry, the interest in the variability of facial patterns was advanced. Now facial types could be studied with emphasis on their association with malocclusion and skeletal relationships.

Björk¹² examined children with and without malocclusion and also children with pathologic conditions. By means of the implant method, he described two different types of mandibular condylar growth—forward and backward. The expression of this condylar growth is influenced by the location of the center of rotation of the mandible whether it is at the incisors, premolars, or the condyle.

Schudy^{13,14} investigated the interaction of antero-

posterior and vertical facial dysplasias and emphasized the importance of the vertical facial dimension in orthodontic treatment. Schudy used the MP:SN angle to divide his sample into three groups—average, retrognathic, and prognathic groups. Schudy concluded that the MP:SN angle is useful to describe different facial types and should be taken into consideration in treatment planning. Bishara and Augspurger¹⁵ found that normal variation in the relationship of the mandibular plane to the S-N plane is associated with variation in the skeletal and dental relationships.

Popovich and Thompson¹⁶ introduced cephalometric templates for six different ages for females and seven ages for males between 4 and 20 years. In addition to being age- and sex-specific, the templates were available for three different face types—average, vertical, and horizontal. Fields and associates¹⁷ pointed to the limited descriptive data available for children and adults

Table 1. Descriptive statistics on the **absolute** values for five **cranial base** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
NSO°	M	135.9	3.6	130.4	3.8	128.5	5.5	134.0	1.9	129.2	4.5	127.6	5.3
	F	130.1	3.1	134.7	5.4	133.8	3.8	128.0	3.9	134.3	4.8	132.7	2.8
NSAr°	M	128.2	4.4	123.3	3.5	123.7	6.4	127.2	4.0	123.6	4.1	123.6	5.9
	F	120.5	2.1	127.7	5.4	127.4	4.2	120.0	4.5	128.3	5.4	128.0	3.6
S-N mm	M	62.8	6.5	61.8	1.9	56.7	8.0	67.2	1.6	65.9	1.8	64.6	2.1
	F	60.4	2.7	60.3	2.9	59.8	1.1	64.5	3.1	64.2	4.0	62.7	2.5
S-O mm	M	35.6	2.2	34.3	1.8	32.3	4.8	39.9	2.1	38.6	2.1	38.7	2.0
	F	33.0	2.8	32.4	6.0	33.7	1.0	37.4	4.0	36.2	5.4	37.6	1.7
N-O mm	M	91.8	1.9	88.0	2.7	80.9	11.5	99.1	2.3	95.1	3.3	93.0	3.7
	F	85.5	4.1	86.7	4.4	86.7	1.2	92.3	5.5	94.1	5.4	92.4	3.4
		15 years						25 years					
NSO°	M	134.2	2.1	129.9	4.7	127.7	5.6	133.4	2.1	128.7	4.5	126.4	5.6
	F	128.5	3.9	134.4	4.9	133.7	4.2	128.4	3.3	133.4	5.6	132.3	3.9
NSAr°	M	128.3	4.8	125.3	4.2	124.8	5.8	128.4	4.4	125.0	4.7	124.3	6.0
	F	120.2	5.0	128.9	5.7	129.6	5.4	120.7	5.4	128.8	5.8	128.5	4.8
S-N mm	M	71.8	2.3	70.1	3.0	68.9	2.5	74.2	3.1	72.5	2.8	71.6	2.4
	F	67.7	3.1	66.6	4.4	66.1	1.2	69.0	2.8	67.9	4.0	67.5	1.5
S-O mm	M	43.6	1.2	43.3	2.0	42.1	1.8	44.8	1.1	44.5	2.3	44.6	1.1
	F	39.1	3.9	38.7	5.7	40.2	2.4	39.7	4.1	40.1	4.5	41.4	3.0
N-O mm	M	106.9	1.8	103.3	4.2	100.0	4.1	110.0	2.4	106.2	3.9	104.5	3.8
	F	97.0	5.4	98.5	6.0	98.2	2.8	98.6	4.6	100.9	5.6	100.2	2.7

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

who were selected for normal vertical facial proportions. In their study they offered a number of measurements obtained cross-sectionally on children and young adults with three facial types—long, average, and short. Studies describing the longitudinal changes in these three facial types in a “normal” population are not available in the literature.

PURPOSE OF THE STUDY

The purpose of this investigation was to describe the range of variation in the cranio-facial-dental relationships in a population with normal occlusion. The sample examined is divided according to their vertical relationship into 3 facial types—long, average, and short. The classification is predicated on the degree of variation in two parameters—the ratio of posterior to anterior face heights and the steepness of the mandibular plane as related to Frankfort horizontal plane.

Comparisons of the absolute and incremental changes in the three facial types between 5 years and 25.5 years of age were made both longitudinally and cross-sectionally.

MATERIALS AND METHODS

Sample

The subjects in this investigation were participants in a longitudinal facial growth study at the University of Iowa. Lateral cephalograms were obtained biennially between the ages of 4.5 and 12 years and annually through age 17. A final set of records was also available at adulthood (mean age, 25.5 years). The cephalograms were obtained with the subject's head positioned in a cephalostat and oriented to the Frankfort horizontal plane.

All subjects had clinically acceptable occlusions with no apparent facial disharmony. These persons exhibited a Class I molar and canine relationship with less than 3 mm crowding and no gross asymmetries in the dental arches and face. All subjects were white; 97% were of northern European ancestry. None of the subjects had undergone orthodontic therapy.

The sample group consisted of 20 males and 15 females for whom complete sets of data were available for the period under study. This criterion in the selection of the sample had the disadvantage of limiting the num-

Table II. Descriptive statistics on the **incremental** changes for five **cranial base** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
NSO°	M	-2.0	2.2	-1.1	2.0	-0.9	1.9	0.3	1.5	0.6	1.1	0.1	0.7
	F	-2.0	1.4	-0.3	2.0	-1.1	1.6	0.5	0.6	0.0	1.2	1.0	1.8
NSAr°	M	-1.0	2.0	-0.3	2.0	-0.1	2.1	1.1	1.7	1.7	0.9	1.2	1.7
	F	-0.5	2.6	0.6	1.8	0.6	1.5	0.1	1.4	0.6	0.8	1.6	1.9
S-N mm	M	4.4	1.2	4.1	0.6	7.9	8.5	4.6	1.7	4.3	1.8	4.2	0.6
	F	4.1	0.5	3.9	1.1	2.8	2.5	3.2	0.4	2.5	0.8	3.4	2.7
S-O mm	M	4.3	0.5	4.3	1.0	6.4	4.3	3.7	2.1	4.7	1.2	3.4	1.1
	F	4.4	1.5	3.8	1.0	4.0	1.4	1.7	0.9	2.5	0.6	2.6	1.7
N-O mm	M	7.4	0.9	7.1	1.3	12.0	11.8	7.8	2.8	8.2	2.5	7.0	1.3
	F	6.8	1.5	7.4	2.2	5.7	3.2	4.7	0.9	4.4	1.4	5.9	3.8
		15 to 25 years						5 to 25 years					
NSO°	M	-0.9	0.7	-1.2	1.2	-1.3	0.8	-2.6	3.6	-1.7	2.8	-2.1	3.2
	F	-0.1	1.4	-1.0	0.8	-1.4	0.5	-1.6	2.3	-1.2	3.5	-1.5	2.3
NSAr°	M	-0.1	1.7	-0.3	0.7	-0.4	0.7	2.2	4.5	1.7	2.4	0.7	4.2
	F	0.5	0.7	-0.1	1.1	-1.1	1.0	1.6	4.0	1.1	3.4	1.1	2.2
S-N mm	M	2.5	1.4	2.3	1.3	2.8	0.9	11.4	2.8	10.7	2.4	14.9	8.5
	F	1.4	0.8	1.2	0.4	1.4	0.8	8.7	0.9	7.6	1.5	7.7	1.4
S-O mm	M	1.2	1.3	1.2	1.0	2.5	1.5	9.2	2.5	10.2	1.7	12.3	4.2
	F	0.6	0.8	1.4	1.5	1.2	0.9	6.7	1.8	7.7	1.8	7.7	2.2
N-O mm	M	3.0	2.4	2.9	1.6	4.5	1.1	18.2	2.9	18.2	2.6	23.5	12.0
	F	1.6	0.9	2.3	1.3	1.9	0.6	13.1	1.2	14.2	3.0	13.5	1.8

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

ber of persons to be included in the study. On the other hand, it had the advantage of providing purely longitudinal sets of data. With mixed longitudinal data, an increase or decrease in the number of persons included at different ages will cause the mean value and the variance to fluctuate between consecutive ages. Such variation is not an age-related change in either the size or the relationship of the parameter measured. The cause of such random variation can be eliminated by examining only those subjects for whom complete sets of data are available.

There is another advantage of purely longitudinal data as compared to mixed and/or cross-sectional data. Tanner¹⁸ addressed this point in detail when he wrote, "More accurately stated and assuming the usual figure for year-to-year correlation in body measurements, it takes twenty or more times as many subjects measured cross-sectionally to locate the mean increment with the same precision, or standard error, as it would using subjects followed longitudinally. The advantage of longitudinal over cross-sectional data for defining the mean velocity is so great, indeed, that in mixed longitudinal

series it is usually better to drop the subjects who were not present at both ages, and simply to use the longitudinal element when estimating an increment."

Admittedly, the number of persons in each face type in the present study is relatively small, yet it compares favorably with other *purely* longitudinal data collected. For example, of the 217 persons in the Burlington study who were followed between 10 and 20 years of age, it is estimated that 12% had normal or ideal occlusion (approximately 26 persons).¹⁹⁻²² Similarly, the Bolton longitudinal standards²³ were obtained from available records on 15 males and 15 females.

The three face types

The 20 male and 15 female subjects were categorized according to one of three *normal* facial types—namely, relatively long, average, and relatively short faces. Males and females were separately ranked and then divided into the three facial types according to the adult measurements of two facial parameters—the ratio of the posterior to the anterior face heights (S-Go/N-Me) and the Frankfort horizontal mandibular plane

Table III. Longitudinal comparisons of the absolute and incremental changes in the cranial base parameters between 5 and 25 years of age for the three facial types*

Facial type parameter		Type of comparison					
		Curve parallelism comparison			Curve magnitude comparison		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>							
NSO°	M	NS	NS	NS	S(LFT)*	S(AFT)	S(LFT)
	F	NS	NS	NS	S(AFT)	NS	S(SFT)
NSAr°	M	NS	NS	NS	S(LFT)	NS	S(LFT)
	F	NS	NS	NS	S(AFT)	NS	S(SFT)
S-N mm	M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
	F	NS	NS	NS	NS	S(SFT)	NS
S-O mm	M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
	F	NS	NS	NS	S(AFT)	NS	NS
N-O mm	M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
	F	NS	NS	NS	NS	NS	S(LFT)
<i>Incremental changes</i>							
NSO°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
NSAr°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
S-N mm	M	NS	NS	NS	NS	S(SFT)	NS
	F	NS	NS	NS	NS	NS	NS
S-O mm	M	NS	NS	NS	NS	NS	S(SFT)
	F	NS	NS	NS	NS	NS	NS
N-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

angle (FH:MP). The adult cephalograms (rather than those at 5 years of age) were used to identify facial type because the differences among facial types are more pronounced at adulthood.

The rationale behind the use of these two facial parameters is that one parameter is constructed from anatomic landmarks (S-Go/N-Me), while the other parameter (FH:MP) involves a plane of orientation. This ensures that neither anatomic variation nor inaccurate orientation will, by itself, adversely influence the disposition of the cases with respect to their appropriate facial types.

When the ranking of the subjects differed for the two parameters (this occurred in 10 out of 35 cases), the cephalograms were evaluated clinically by two orthodontists to place them in the appropriate facial type. These clinical judgments were predicated on Björk's¹² seven structural signs. Björk found these signs to be clinically useful to detect "extreme" types of

mandibular rotation occurring during growth. The seven signs are related to the following features—(1) inclination of the condylar head, (2) curvature of the mandibular canal, (3) shape of the lower border of the mandible, (4) inclination of the symphysis, (5) interincisal angle, (6) inter-premolar or intermolar angles, and (7) anterior lower face height. As many of these clinical signs as could be evaluated from the lateral cephalograms were taken into consideration in classifying the 10 cases by the appropriate facial types.

As can be seen from Tables XXIV, XXV, and XXVIII, this approach resulted in 3 groups that were significantly different from each other in both their angular and linear vertical relationships. These findings indicate that the method of differentiation of the facial types in this study was appropriate.

By means of this approach, the 20 male subjects were subdivided into 8 with an average facial type (AFT), 6 with a long facial type (LFT), and 6 with a

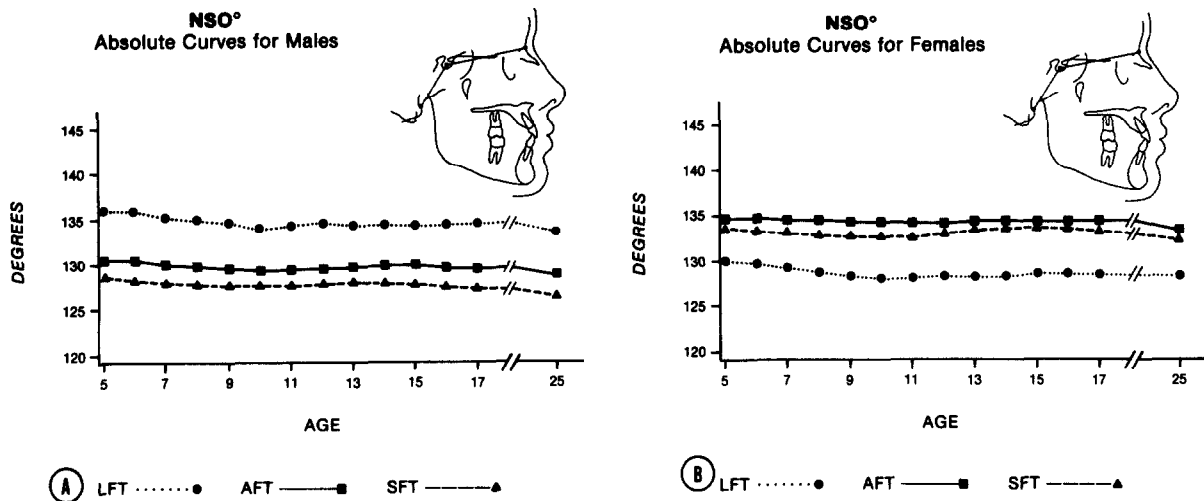


Fig. 3, A and B.

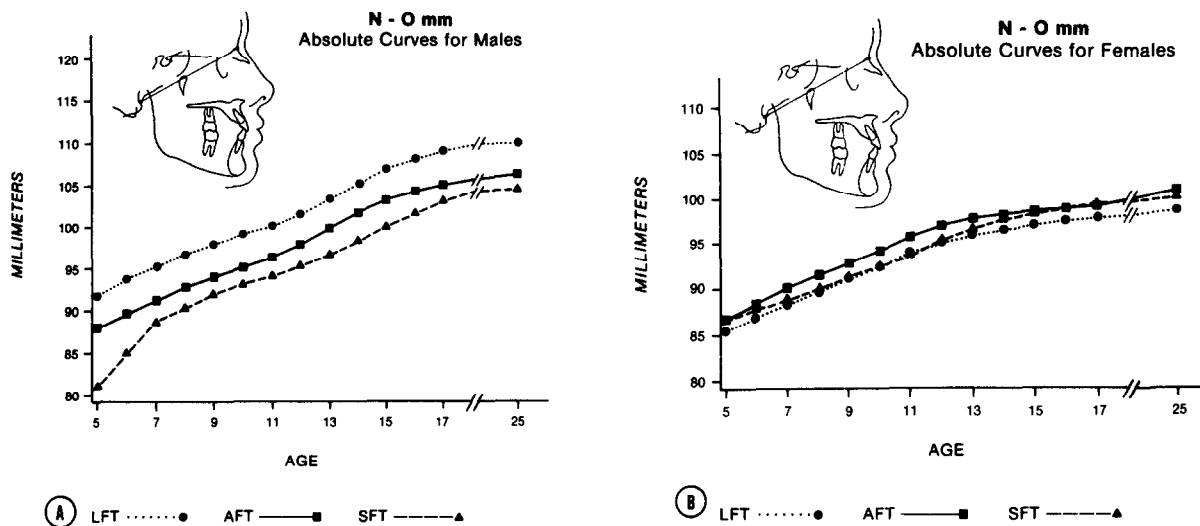


Fig. 4, A and B.

short facial type (SFT). The 15 females were equally subdivided among the 3 facial types. It must be emphasized that the three facial types in the present study reflected the variation within a normal population. This, by definition, excludes persons with abnormal skeletal patterns and with malocclusions.

Landmarks and measurements

The following landmarks were identified on each x-ray film (Fig. 1): sella turcica (S), pituitary point (P), sphenoidal wing point (W), anteriormost point on occipital condyle (O), nasion (N), point A (A), menton (Me), anterior nasal spine (Ans), anterior nasal spine prime (Ans') (which is the point at which a perpendicular line from the anterior nasal spine intersects N-Me),

point B (B), pogonion (Pog), gnathion (Gn), gonion (Go), articulare (Ar), articulare prime (Ar') (which is the point at which a perpendicular line from articulare intersects S-Go), porion (Po), orbital (OR), soft-tissue glabella (Gl'), pronasale or tip of the soft-tissue nose (PR), superior labial sulcus (SLS), labrale superius (LS), labrale inferius (LI), and soft-tissue pogonion (Pog').

The definition of the various landmarks has been published elsewhere.²⁴⁻³⁰ From these landmarks, various linear and angular measurements have been derived. These measurements have been previously described by Bishara,²⁷ Jacobson,²⁸ Hession,²⁹ Knott,³⁰ Riedel,³¹ and Wylie.³²

To describe the normal range of variation in addition

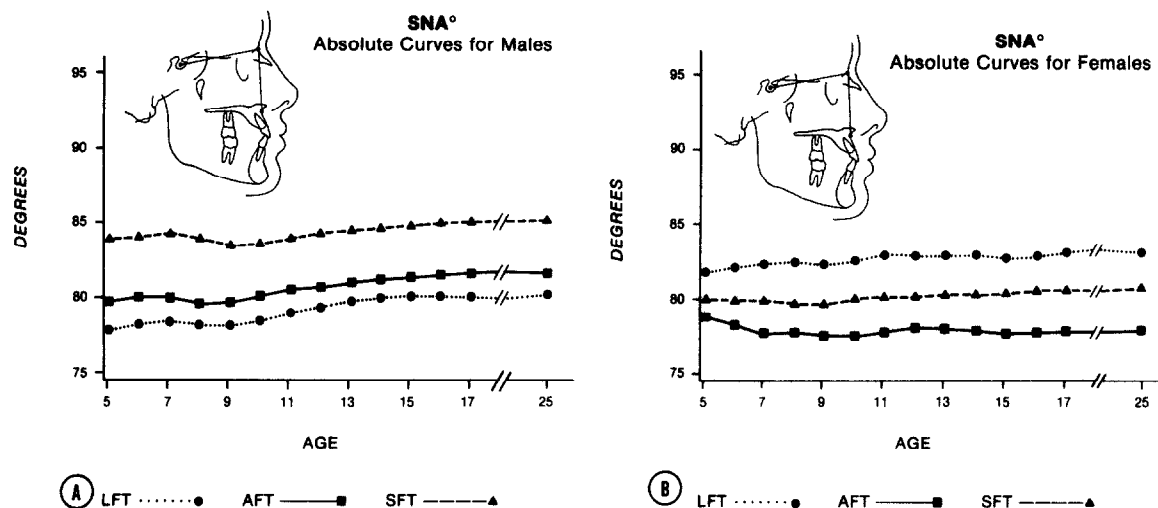


Fig. 5, A and B.

Table IV. Results of Analysis of Variance General Linear Models procedure for the **cross-sectional** comparisons of the absolute data of the **cranial base** parameters for three facial types at 5, 10, 15, and 25 years of age

Facial type parameter		Age period investigated					
		5 years			10 years		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
NSO°	M	S	NS	S	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
NSAr°	M	NS	NS	NS	NS	NS	NS
	F	S	NS	S	S	NS	S
S-N mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
S-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
N-O mm	M	NS	NS	S	S	NS	S
	F	NS	NS	NS	NS	NS	NS
		15 years			25 years		
NSO°	M	NS	NS	NS	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
NSAr°	M	NS	NS	NS	NS	NS	NS
	F	S	NS	S	NS	NS	NS
S-N mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
S-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
N-O mm	M	NS	NS	S	NS	NS	S
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type.
NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

Table V. Descriptive statistics on the **absolute** changes for six **maxillary** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age periods investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
SNA°	M	77.8	4.2	79.7	1.9	83.8	4.4	78.4	4.0	80.1	1.9	83.5	4.4
	F	81.8	4.0	78.7	2.5	80.0	2.9	82.5	4.0	77.5	3.1	80.0	2.5
SNAns°	M	83.0	4.2	83.4	1.9	82.1	12.8	84.6	3.3	85.0	1.8	87.6	4.9
	F	87.0	4.2	81.6	3.5	83.8	3.3	88.3	4.1	81.5	3.4	85.0	2.0
A-O mm	M	81.5	4.3	78.2	2.7	74.1	9.3	87.6	5.0	84.2	4.0	84.6	3.5
	F	77.6	4.6	77.2	3.9	77.5	1.4	83.5	4.5	84.4	4.1	82.1	2.6
Ans-O mm	M	85.1	3.8	80.6	3.0	75.7	10.3	92.6	3.9	87.7	3.9	87.0	3.5
	F	80.7	4.1	79.6	4.0	80.2	2.2	87.6	4.5	87.4	4.7	85.9	3.5
A-Ptm mm	M	45.3	2.7	44.6	1.2	42.7	5.3	48.3	3.4	48.2	1.5	47.9	2.2
	F	43.5	1.6	42.8	2.1	42.4	1.2	47.6	1.4	46.0	2.4	45.7	2.0
Ans-Ptm mm	M	47.5	2.2	46.0	1.4	43.2	6.1	52.0	2.4	50.4	2.0	49.2	2.3
	F	45.9	0.9	44.2	2.2	44.4	1.8	50.8	1.4	47.8	2.8	48.5	2.3
		15 years						Adults					
SNA°	M	80.1	3.5	81.2	1.8	84.5	4.4	80.2	3.4	81.6	2.2	85.1	4.2
	F	82.8	4.4	77.7	3.4	80.4	2.0	83.1	4.5	77.9	3.0	80.8	1.3
SNAns°	M	85.9	2.6	86.3	1.5	89.0	4.5	84.4	3.7	86.2	2.6	88.2	3.6
	F	88.9	4.0	82.1	3.4	85.6	1.5	88.2	5.2	81.8	2.8	85.2	1.3
A-O mm	M	96.5	4.9	92.6	5.7	92.1	4.2	99.8	6.4	95.5	5.4	96.0	4.6
	F	88.3	4.4	88.7	3.9	88.3	1.6	90.1	4.0	89.8	4.2	89.9	2.2
Ans-O mm	M	101.1	3.8	96.5	5.2	94.9	4.5	102.7	5.6	99.0	5.7	98.2	4.7
	F	92.7	4.2	91.6	4.3	92.1	2.5	93.9	4.4	92.5	4.6	93.1	2.7
A-Ptm mm	M	53.3	3.5	53.2	2.8	51.2	2.4	56.0	4.3	55.2	3.4	53.4	1.9
	F	50.4	8.9	47.7	2.5	48.4	1.5	52.0	1.6	48.3	3.2	50.1	2.1
Ans-Ptm mm	M	57.0	2.3	56.0	3.1	53.5	2.5	57.8	3.5	57.7	3.7	54.9	2.4
	F	54.3	6.2	49.9	2.3	51.4	1.5	54.7	1.7	50.2	2.4	52.4	2.3

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

to standing height (which is an indicator of general body change), the 47 dentofacial parameters evaluated were grouped as follows:

CRANIAL BASE PARAMETERS

Angular: NSO and NSAr

Linear: S-N, S-O, and N-O

MAXILLARY PARAMETERS

Angular: SNA and SNAns

Linear: A-O, Ans-O, A-Ptm, and Ans-Ptm

MANDIBULAR PARAMETERS

Angular: PWPog, SNPog, SNB, and FH:NPog

PWPog expresses more accurately the changes at Pog because it minimizes the effects of the normal remodeling changes at S and N and substitutes them with more stable landmarks—P and W on the sphenoid bone.

Linear: Ar-Pog and O-Pog

MAXILLARY-MANDIBULAR ANTEROPOSTERIOR PARAMETERS

Angular: ANB and NAPog

Linear: Wits and overjet

Ratio: Ans-Ptm/Ar-Pog%

The Wits appraisal²⁸ is measured by constructing perpendicular lines from points A and B on the occlusal plane. The distance between the two perpendicular lines is measured in millimeters. When the perpendicular line from point A is anterior, the value is positive; when the perpendicular line is posterior, the value is negative.

The overjet is measured from the cephalogram as the distance between the incisal edge of the most labially placed maxillary central incisor to the labial surface of the most labially placed mandibular central incisor. To standardize the measurement, the overjet

Table VI. Descriptive statistics on the **incremental** changes for six **maxillary** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
SNA°	M	0.6	1.2	0.4	0.4	-0.3	0.6	1.6	1.1	1.3	1.2	1.2	0.6
	F	0.7	1.4	-1.2	1.7	0	0.8	0.3	1.1	0.2	0.7	0.4	1.6
SNAns°	M	1.7	1.7	1.6	0.9	5.5	13.3	1.2	1.5	1.3	0.8	1.5	1.0
	F	1.3	1.6	-0.2	1.6	1.2	1.6	0.6	0.8	0.6	0.6	0.7	1.8
A-O mm	M	6.2	2.4	6.1	1.7	10.6	11.6	8.8	2.7	8.4	2.9	7.5	1.7
	F	5.9	0.5	7.1	3.7	4.6	3.0	4.8	1.9	4.4	1.8	6.2	2.5
Ans-O mm	M	7.5	2.2	7.1	1.6	11.4	12.4	8.5	3.2	8.8	2.5	7.9	2.1
	F	6.9	0.8	7.8	4.0	5.7	3.7	5.2	1.5	4.3	1.8	6.2	2.4
A-Ptm mm	M	3.0	1.5	3.6	0.7	5.2	7.0	5.0	1.2	5.1	2.5	3.4	1.6
	F	4.1	0.7	3.2	0.8	3.3	2.0	2.8	1.4	1.7	1.3	2.7	2.0
Ans-Ptm mm	M	4.5	1.5	4.6	0.8	6.0	7.7	5.0	1.8	5.6	2.0	4.2	1.0
	F	4.9	0.8	3.6	1.8	4.1	2.8	3.4	1.2	2.1	0.7	2.9	1.8
		15 to 25 years						5 to 25 years					
SNA°	M	0.1	0.5	0.2	0.8	0.3	0.7	2.4	1.7	1.9	1.9	1.3	0.6
	F	0.3	0.8	0.2	0.7	0.4	1.1	1.3	1.7	-0.8	1.3	0.8	2.0
SNAns°	M	-1.5	1.8	—	1.8	-0.8	1.3	1.4	3.5	2.8	1.8	6.2	13.4
	F	-0.7	2.0	-0.3	0.6	-0.5	0.6	1.2	1.5	0.2	1.4	1.4	3.3
A-O mm	M	3.3	2.4	2.9	1.4	3.8	1.0	18.3	4.9	17.3	3.7	21.9	12.6
	F	1.8	1.1	1.1	0.6	1.6	0.9	12.6	2.5	12.6	3.1	12.4	2.0
Ans-O mm	M	1.6	2.3	2.6	1.7	3.3	1.5	17.6	6.0	18.5	3.5	22.6	13.6
	F	1.2	1.9	0.9	0.3	1.0	0.9	13.2	2.4	12.9	3.7	12.9	2.2
A-Ptm mm	M	2.6	1.2	1.9	1.3	2.2	1.8	10.6	2.5	10.6	3.6	10.7	6.6
	F	1.6	0.9	0.6	1.6	1.7	1.4	8.5	2.2	5.5	1.6	7.7	1.4
Ans-Ptm mm	M	0.8	1.5	1.7	1.7	1.4	1.3	10.3	4.2	11.8	3.2	11.7	7.7
	F	0.5	1.7	0.2	0.6	1.0	1.0	8.8	2.0	6.0	0.9	8.0	2.1

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

was measured along the perpendicular line from the maxillary incisal edge to N-Me.

VERTICAL FACIAL PARAMETERS

Angular: MP:SN, FH:MP, NSGn, and FH:SGn

Linear: N-Ans', N-Me, Ar'-Go, S-Go, and overbite

The overbite is measured as the distance in millimeters between perpendicular lines from the incisal edges of the most labially inclined maxillary and mandibular central incisors on N-Me.

Ratios: N-Ans'/N-Me%, Ar'-Go/S-Go%, and S-Go/N-Me%

DENTAL PARAMETERS

Angular: $\bar{1}$: \bar{I} , $\bar{1}$:SN, \bar{I} :MP, and \bar{I} :FH

Linear: $\bar{1}$:A-Pog, \bar{I} :NB, and Pog:NB (the latter is not a dental parameter but traditionally has been related to \bar{I} :NB)

SOFT-TISSUE PROFILE PARAMETERS

Angular: Gl'-PR-Pog', Gl'SLS-Pog', LS-Pog':NB (holdaway soft-tissue angle), and FH:Pog-LS or FH:Pog-LI (Z-angle)

Linear: PR-Pog:LS and PR-Pog:LI

For each of these parameters, the recorded value for a specific age was derived from the average of the measurements recorded before, at, and after the age in question. For example, the value of SNB at age 7 years was actually an average of the value at 6 years 6 months, 7 years, and 7 years 6 months.

All linear measurements were corrected for magnification and the true size reported in the findings.

Reliability

The landmarks on each cephalogram were picked by one investigator and checked by another. When possible, the set of cephalograms belonging to an individual

Table VII. Longitudinal comparisons of the absolute and incremental changes in the maxillary parameters between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>						
SNA° M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
F	NS	NS	NS	S(LFT)	S(SFT)	S(LFT)
SNAns° M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
F	NS	NS	NS	S(LFT)	S(SFT)	S(LFT)
A-O mm M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	NS	NS	NS
Ans-O mm M	NS	NS	NS	S(LFT)	NS	S(LFT)
F	NS	NS	NS	NS	NS	NS
A-Ptm mm M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(LFT)	NS	S(LFT)
Ans-Ptm mm M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(LFT)	S(SFT)	S(LFT)
<i>Incremental changes</i>						
SNA° M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	S(LFT)	NS	NS
SNAns° M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
A-O mm M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
Ans-O mm M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
A-Ptm mm M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	S(LFT)	NS	NS
Ans-Ptm mm M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	S(LFT)	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

subject were pricked at the same sitting. Two investigators independently measured each parameter on each cephalogram twice.

Permissible intra- and inter-investigator disagreements were predetermined at 0.5° and 0.2 mm. When disagreements were greater than these limits, two new measurements were taken and the three in closest agreements were averaged.

Statistical analysis

Longitudinal comparisons. The yearly individual values were used to calculate individual absolute and incremental growth curves. The mean growth profile curve for each facial parameter was compared among the three facial types by means of the Analysis of Variance General Linear Models procedure. The sum of squares of the variation was partitioned into those at-

tributable to age, parameter measured, and the interaction between age and parameter.

The first step in the statistical analysis is to determine whether significant differences are present between males and females for each of the three facial types. The presence of statistical differences necessitates that male and female growth profile curves be examined separately.

In the statistical analysis of the growth curves, there were two aspects to be evaluated—the *shape* or *profile* of the curves and the *magnitude* of the curves. The *shape* or *profile* is the slope that describes growth direction. In this respect, the curves might show a parallel relationship indicating that the growth trends are the same. On the other hand, lack of parallelism among curve profiles indicates differences in growth trends. The *magnitude* of the curves is the height of the curves

Table VIII. Results of Analysis of Variance General Linear Models procedure comparing the absolute data of the **maxillary** parameters for three facial types **cross-sectionally** at 5, 10, 15, and 25 years of age

Facial type parameter		Age period investigated					
		5 years			10 years		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
SNA°	M	NS	NS	S	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
SNAns°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	S	NS	NS
A-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Ans-O mm	M	NS	NS	NS	S	NS	S
	F	NS	NS	NS	NS	NS	NS
A-Ptm mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Ans-Ptm mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
		15 years			25 years		
SNA°	M	NS	NS	NS	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
SNAns°	M	NS	NS	NS	NS	NS	NS
	F	S	NS	NS	S	NS	NS
A-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Ans-O mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
A-Ptm mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Ans-Ptm mm	M	NS	NS	NS	NS	NS	NS
	F	S	NS	S	S	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

with age held constant. The method of analysis used to compare the growth curves was described in detail by Kleinbaum and Kupper.³³

The level of statistical significance was predetermined at the 0.01 level of confidence for the comparisons of the curve parallelism and at the 0.05 level of confidence for the comparisons of curve magnitude. This variation in the level of significance is suggested by Bonferroni. The Bonferroni method³⁴ takes into consideration all tests of significance to be examined in one analysis. Because the test for parallelism was part of an analysis that included three variables, the 0.01 level of significance was chosen to keep the overall level of significance relatively high.

Regression analysis. To determine which of the 48 variables examined could help differentiate the three facial types, a stepwise regression analysis was per-

formed. Stepwise regression analysis was used to ascertain which variables should be included in a regression model. Such an analysis gives insight into the relationship between the independent variables and the dependent response variables.³⁵ This procedure was therefore employed to isolate a subset of predictor variables that best explained the variation between or within groups.

Discriminant analysis. To determine whether the variables identified by the regression model could significantly help differentiate the three facial types, a discriminant analysis was performed.³⁶ This procedure, DISCRIM, develops a discriminant model that attempts to classify each observation into one of the three facial types.

Cross-sectional analysis. The Analysis of Variance General Linear Models procedure was used to compare

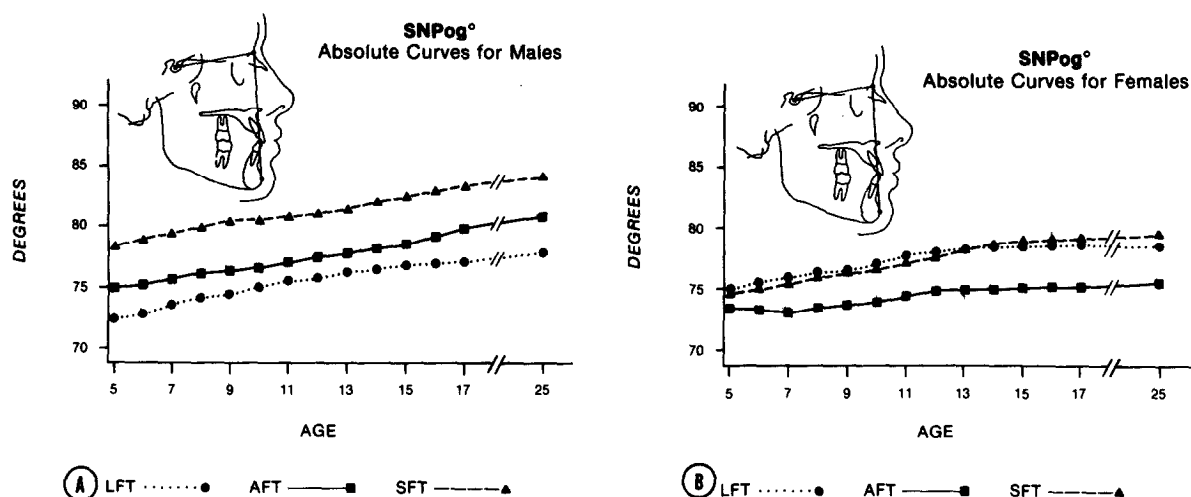


Fig. 6, A and B.

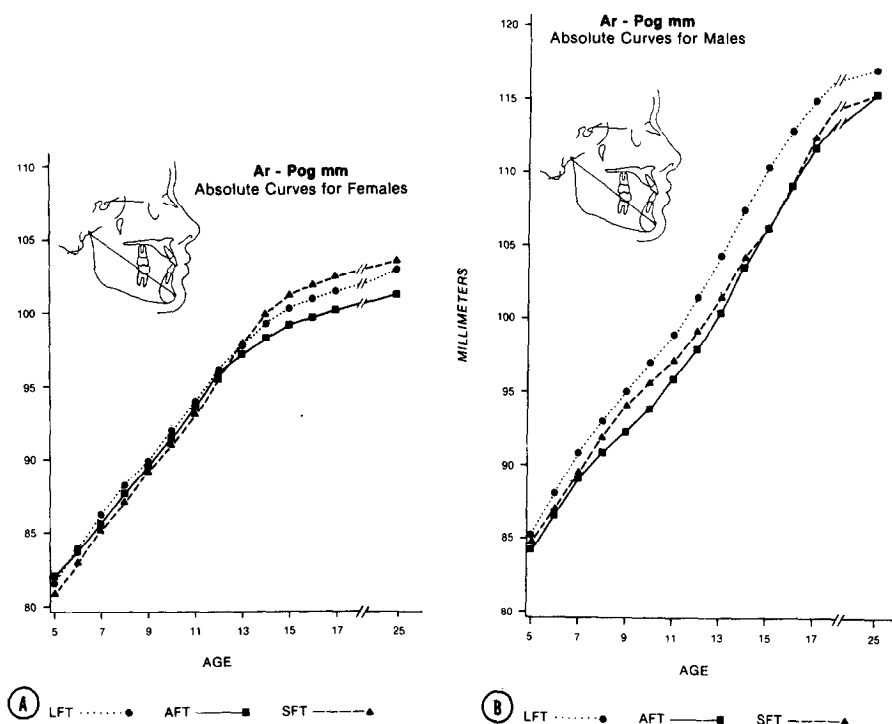


Fig. 7, A and B.

the dentofacial parameters among the three facial types. The level of significance was predetermined at the 0.05 level of confidence. The absolute data were compared at 5, 10, 15, and 25.5 years of age. The incremental changes were compared among the four growth periods examined—5 to 10, 10 to 15, 15 to 25.5, and 5 to 25.5 years of age. These periods roughly corresponded to the times for “early,” “adolescent,” and “adult” treatment.

FINDINGS

Changes in facial type between 5 and 25.5 years

As described previously, the male and female subjects were grouped separately into three different facial types by ranking the cephalograms obtained at adulthood according to the FH:MP angle, the ratio of S-Go/N-Me, and the clinical evaluation of the cephalogram. Björk's¹² structural signs were used for the clinical evaluation.

Table IX. Descriptive statistics on the **absolute** values of six **mandibular** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
PWPog°	M	101.1	3.1	100.7	3.2	107.7	6.8	105.4	4.6	104.5	3.5	113.1	5.5
	F	102.0	3.9	100.8	4.0	106.2	4.5	107.9	4.6	102.9	3.4	110.1	1.9
SNPog°	M	72.3	3.9	74.9	2.8	78.2	3.8	75.0	3.9	76.6	2.3	80.5	4.0
	F	75.0	3.5	73.4	3.0	74.8	2.0	77.1	3.6	74.0	1.9	76.6	2.8
SNB°	M	73.6	3.7	75.7	3.1	78.8	3.4	75.2	3.4	76.2	2.6	79.9	3.2
	F	76.6	3.6	74.5	3.0	75.2	1.3	77.8	3.6	74.0	2.3	76.4	2.1
FH : NPog°	M	80.8	3.4	84.6	2.1	79.2	11.8	81.0	3.9	83.4	2.6	85.4	3.4
	F	82.4	1.7	84.2	1.4	83.8	3.9	83.1	1.5	83.6	1.3	83.2	4.2
Ar-Pog mm	M	85.2	6.8	84.2	3.0	84.8	3.9	97.0	7.3	93.9	3.1	95.6	4.5
	F	81.5	5.4	82.0	2.4	80.9	3.5	91.9	5.8	91.4	3.0	90.9	5.3
O-Pog mm	M	87.7	6.8	86.1	2.7	86.4	4.1	99.4	7.4	95.5	2.4	97.2	5.3
	F	83.9	5.9	84.3	2.4	83.2	2.5	94.0	6.4	93.6	3.9	93.0	4.4
		15 years						25 years					
PWPog°	M	107.3	5.2	109.1	4.5	116.9	3.2	106.9	4.4	109.9	5.5	117.0	3.2
	F	110.6	7.2	103.4	3.5	112.3	2.8	111.6	7.8	103.2	3.1	113.3	1.9
SNPog°	M	76.7	3.8	78.5	2.6	82.4	3.3	77.8	4.1	80.8	3.6	84.1	3.1
	F	78.5	3.7	75.1	2.2	79.0	2.9	78.6	3.7	75.5	1.9	79.5	3.0
SNB°	M	76.8	3.4	77.8	2.6	81.1	3.0	77.6	3.5	79.4	3.6	82.2	2.8
	F	78.8	3.6	74.8	2.9	78.4	2.1	78.4	4.0	74.8	2.6	78.5	2.3
FH : NPog°	M	80.6	3.9	83.7	2.5	85.2	3.9	81.8	2.3	87.0	4.3	87.3	4.7
	F	82.7	2.6	83.7	1.5	84.1	3.5	82.3	2.4	83.1	2.4	85.1	3.6
Ar-Pog mm	M	110.3	8.0	106.2	3.4	106.3	6.0	117.0	9.2	115.3	4.4	115.4	6.8
	F	100.2	5.3	99.1	3.9	101.2	6.1	102.8	3.6	101.1	4.0	103.4	6.1
O-Pog mm	M	112.7	7.9	107.5	3.3	107.7	6.4	118.9	8.9	116.5	4.5	116.2	7.7
	F	102.9	6.1	101.3	5.0	103.2	4.9	105.2	4.2	102.9	4.7	105.2	4.9

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

The same approach was used to categorize the same subjects at 5 years of age. Fig. 2, A-C illustrates the changes in facial type between 5 and 25.5 years of age. It is apparent that the majority of cases (27 or 77%) were typed similarly at 5 and at 25.5 years. Of the eight subjects that changed categories, only one person moved two categories—that is, from a short (SFT) to a long (LFT) facial type.

Male-female comparisons

Comparisons of the growth profiles of males and females within each facial type indicated the presence of significant sex differences both in curve parallelism and in curve magnitude. Differences in curve parallelism were observed predominantly in the comparisons of the average facial type (AFT). The differences were observed primarily in standing height and the various

facial heights. On the other hand, differences in curve magnitude between males and females were present among the three facial types in all the areas compared—namely, cranial base, maxillary, mandibular, dental, and soft-tissue parameters.

As a result of these findings, comparisons among the various facial types were conducted separately for males and females.

CHANGES IN THE VARIOUS PARTS OF THE CRANIOFACIAL COMPLEX

Cranial base parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables I and II. These data were analyzed both longitudinally and cross-sectionally.

Table X. Descriptive statistics on the **incremental** values for six **mandibular** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
PWPog°	M	4.3	2.0	3.8	2.6	5.4	2.2	1.9	2.5	4.6	2.5	3.8	2.8
	F	6.0	2.1	2.1	3.1	4.0	3.3	2.6	4.0	0.6	1.4	2.1	2.4
SNPog°	M	2.6	1.5	1.7	0.8	2.3	0.6	1.8	0.7	2.0	1.5	2.0	1.1
	F	2.0	1.1	0.5	1.7	1.8	1.4	1.5	0.9	1.2	1.1	2.4	0.5
SNB°	M	1.6	1.5	0.6	1.1	1.1	0.8	1.6	0.8	1.5	1.6	1.2	0.8
	F	1.2	0.9	-0.4	1.5	1.2	0.9	1.0	0.8	0.8	1.2	2.0	0.6
FH : NPog°	M	0.2	2.1	-1.2	2.6	6.1	10.8	-0.4	1.5	0.4	2.7	-0.2	1.6
	F	0.7	1.4	-0.6	2.1	-0.6	3.1	-0.4	2.0	0.1	0.5	0.8	1.2
Ar-Pog mm	M	11.8	2.6	9.7	2.0	10.9	1.4	13.4	2.5	12.4	1.8	10.6	3.2
	F	10.4	1.1	9.4	1.6	10.1	2.1	8.3	1.0	7.7	1.7	10.2	0.8
O-Pog mm	M	11.7	3.1	9.4	1.8	10.9	2.0	13.3	2.5	12.0	1.6	10.5	2.9
	F	10.1	1.1	9.3	2.0	9.8	2.2	8.9	1.0	7.7	1.8	10.2	0.8
		15 to 25 years						5 to 25 years					
PWPog°	M	-0.4	2.9	0.9	2.2	0	1.8	5.8	3.8	9.2	5.0	9.3	4.6
	F	1.1	0.9	-0.3	0.7	1.0	1.8	9.7	6.2	2.4	3.9	7.1	4.2
SNPog°	M	1.1	0.6	2.3	1.8	1.7	1.4	5.5	1.5	5.9	3.2	5.9	2.0
	F	0.1	0.6	0.4	0.6	0.5	0.9	3.6	1.5	2.1	2.3	4.7	2.2
SNB°	M	0.8	0.6	1.6	1.6	1.0	1.3	4.0	1.5	3.7	3.4	3.3	1.7
	F	-0.4	0.6	0	0.7	0.1	0.6	1.8	1.6	0.3	2.0	3.3	1.5
FH : NPog°	M	1.2	2.7	3.2	2.5	2.3	1.3	1.1	2.4	2.3	3.8	8.1	9.7
	F	-0.5	0.9	-0.6	1.6	1.1	0.8	-0.2	2.7	-1.1	2.6	1.3	3.7
Ar-Pog mm	M	6.7	2.4	9.1	4.5	9.1	4.1	31.8	3.6	31.1	5.6	30.6	5.5
	F	2.6	2.1	2.0	1.3	2.2	0.4	21.3	2.4	19.1	2.5	22.5	3.1
O-Pog mm	M	6.2	2.5	9.1	4.7	8.4	4.4	31.2	3.5	30.4	5.6	29.8	5.6
	F	2.3	2.3	1.6	1.4	2.0	1.2	21.3	1.9	18.6	3.1	22.0	2.8

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

Longitudinal comparisons of the absolute data (Table III)

a. CURVE PARALLELISM. The growth profiles for each of the five cranial base parameters for males and females were compared among the three facial types. There were no statistically significant differences among the overall shapes of the three curves in any of these comparisons.

The absolute curves for NSO and N-O are presented in Figs. 3 and 4. These figures serve as a pictorial summary of the changes that occurred in the parameters with age.

b. CURVE MAGNITUDE. For each of the cranial base parameters compared, the magnitude of the curves was significantly different among the three facial types (that is, the overall sizes of the parameters were different). It is of interest to note that the differences in curve

magnitude among the 3 facial types expressed different trends in males and females (Table III).

Longitudinal comparisons of the incremental data

The comparisons of curve parallelism and magnitude for the incremental data indicated that no significant differences were present among the three facial types.

Cross-sectional comparisons of the absolute data (Table IV)

Cross-sectional comparisons of the three facial types at 5, 10, 15, and 25 years of age indicated that, in general, the greatest differences were between the LFT and SFT—that is, the cranial base angle (NSO) and the total cranial base length (N-O) were significantly larger in the LFT in males. The saddle angle (NSAr) was significantly larger in females with LFT.

Table XI. Longitudinal comparisons of the absolute and incremental changes in the mandibular parameters between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>						
PWPog° M	NS	NS	NS	NS	S(SFT)	S(SFT)
PWPog° F	NS	NS	NS	S(LFT)	S(SFT)	S(SFT)
SNPog° M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
SNPog° F	NS	NS	NS	S(LFT)	S(LFT)	NS
SNB° M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
SNB° F	NS	NS	NS	S(LFT)	S(SFT)	S(LFT)
FH : NPog° M	NS	NS	NS	S(AFT)	NS	S(SFT)
FH : NPog° F	NS	NS	NS	S(AFT)	NS	S(SFT)
Ar-Pog mm M	NS	NS	NS	S(LFT)	NS	S(LFT)
Ar-Pog mm F	NS	NS	NS	NS	NS	NS
O-Pog mm M	NS	NS	NS	S(LFT)	NS	S(LFT)
O-Pog mm F	NS	NS	NS	NS	NS	NS
<i>Incremental changes</i>						
PWPog° M	NS	NS	NS	NS	NS	NS
PWPog° F	NS	NS	NS	S(LFT)	S(SFT)	S(LFT)
SNPog° M	NS	NS	NS	NS	NS	NS
SNPog° F	NS	NS	NS	S(LFT)	S(SFT)	NS
SNB° mm M	NS	NS	NS	NS	NS	NS
SNB° mm F	NS	NS	NS	NS	S(SFT)	NS
FH : NPog° M	NS	NS	NS	NS	NS	S(SFT)
FH : NPog° F	NS	NS	NS	NS	NS	NS
Ar-Pog mm M	NS	NS	NS	NS	NS	NS
Ar-Pog mm F	NS	NS	NS	NS	S(SFT)	NS
O-Pog mm M	NS	NS	NS	NS	NS	NS
O-Pog mm F	NS	NS	NS	NS	S(SFT)	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

Cross-sectional comparisons of the incremental data

The comparisons of the incremental changes for the four growth periods examined (5 to 10 years, 10 to 15 years, 15 to 25 years, and 5 to 25 years) indicated no significant differences among the three facial types for any of the cranial base parameters.

Maxillary anteroposterior parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables V and VI.

Longitudinal comparisons of the absolute data (Table VII)

a. CURVE PARALLELISM. There were no statistically

significant differences among the growth profiles of the three facial types. The absolute curves for the SNA angles are presented in Fig. 5, A and B.

b. CURVE MAGNITUDE. Significant differences were present among the three facial types in the comparisons of all the maxillary parameters evaluated with the exception of A-O and Ans-O in females. In general, the curve magnitudes of the various maxillary parameters were greater in both the SFT and LFT as compared to the AFT.

Longitudinal comparisons of the incremental data (Table VII)

a. CURVE PARALLELISM. No statistically significant differences were present.

b. CURVE MAGNITUDE. There were few significant differences present in the comparisons among the three

Table XII. Results of Analysis of Variance General Linear Models procedure comparing the absolute data of the **mandibular** parameters of three facial types **cross-sectionally** at 5, 10, 15, and 25 years of age

Facial type parameter		Age period investigated					
		5 years			10 years		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
PWPog°	M	NS	S	S	NS	S	S
	F	NS	NS	NS	S	S	NS
SNPog°	M	NS	NS	S	NS	S	S
	F	NS	NS	NS	NS	NS	NS
SNB°	M	NS	NS	S	NS	S	S
	F	NS	NS	NS	NS	NS	NS
FH : NPog°	M	NS	NS	NS	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
Ar-Pog mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
O-Pog mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
		15 years			25 years		
PWPog°	M	NS	S	S	NS	S	S
	F	S	S	NS	S	S	NS
SNPog°	M	NS	S	S	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
SNB°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
FH : NPog°	M	NS	NS	NS	S	NS	S
	F	NS	NS	NS	NS	NS	NS
Ar-Pog mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
O-Pog mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type.
NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

facial types. Females with LFT had a greater curve magnitude for SNA, A-Ptm, and Ans-Ptm.

Cross-sectional comparisons of the absolute data (Table VIII)

Contrary to the findings on the curve magnitude in the longitudinal comparisons, few significant differences were present among the three facial types at 5, 10, 15, and 25 years of age.

Cross-sectional comparisons of the incremental data

No significant differences were present.

Mandibular anteroposterior parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables IX and X.

Longitudinal comparisons of the absolute data (Table XI)

a. CURVE PARALLELISM. No significant differences were present among the three facial types. The absolute curves for SNPog and Ar-Pog are presented in Figs. 6 and 7.

b. CURVE MAGNITUDE. Both male and female comparisons of the various mandibular parameters indicated significant differences among the three facial types. In general, SFT males had a tendency for a relatively greater mandibular protrusion; males with LFT had a greater mandibular length.

Longitudinal comparisons of the incremental data (Table XI)

a. CURVE PARALLELISM. No statistically significant differences were present.

b. CURVE MAGNITUDE. The significant differences

Table XIII. Descriptive statistics on the **absolute** values for five **anteroposterior maxillary-mandibular** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameters		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
ANB°	M	4.2	1.5	4.0	2.0	4.2	2.8	3.2	1.8	3.8	1.8	3.6	2.1
	F	5.2	0.6	4.2	1.5	4.7	2.6	4.7	1.2	3.5	1.3	3.6	2.8
NAPog°	M	12.2	4.6	9.7	4.9	10.7	2.3	7.4	4.6	7.1	4.5	6.2	3.9
	F	14.3	2.1	10.0	3.6	10.0	3.6	11.1	3.8	7.2	3.6	6.7	5.4
Wits mm	M	—	1.7	0.4	1.9	-0.7	1.5	-0.8	1.7	0	2.0	0.1	1.2
	F	0.2	1.1	-0.2	2.7	-0.5	1.2	0.3	1.8	-0.9	1.9	-0.4	1.6
Overjet mm	M	2.9	0.6	3.3	1.8	2.6	0.8	3.8	1.0	3.5	1.8	3.0	0.7
	F	2.0	0.5	3.1	1.5	2.3	0.5	3.0	0.8	3.6	0.5	3.7	0.9
Ans-Ptm%	M	55.9	2.6	54.6	2.1	51.1	7.7	53.7	1.7	53.7	2.6	51.5	1.8
Ar-Pog	F	56.5	3.1	53.9	2.1	54.9	2.2	55.4	2.4	52.3	2.3	53.6	5.0
		15 years						25 years					
ANB°	M	3.3	1.2	3.6	2.5	3.6	1.8	2.6	1.2	2.2	3.2	3.0	2.1
	F	4.0	1.9	2.9	1.1	2.0	3.2	4.6	1.2	3.1	1.2	2.3	2.8
NAPog°	M	7.1	3.3	5.6	6.3	5.0	5.5	5.5	2.7	1.8	7.9	2.0	6.0
	F	8.5	5.6	5.7	2.8	2.7	7.3	9.4	4.7	5.3	3.0	2.7	7.1
Wits mm	M	-1.5	2.0	0.3	3.1	0	1.1	-2.2	2.6	0.1	4.1	-0.1	1.2
	F	0.3	2.1	0.2	2.1	-1.5	2.5	1.0	2.0	0.8	2.1	-0.6	2.9
Overjet mm	M	2.8	0.7	3.2	1.4	2.6	0.5	2.8	0.3	2.8	1.2	2.7	0.6
	F	2.9	0.7	3.5	0.7	3.3	0.9	2.9	0.7	3.4	0.7	3.3	1.0
Ans-Ptm%	M	51.7	2.7	52.5	2.5	50.2	2.1	49.6	3.5	50.1	3.5	47.7	2.2
Ar-Pog	F	54.3	3.0	50.5	2.2	51.1	3.6	53.3	2.2	49.6	2.3	50.8	3.9

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

in curve magnitude indicated that, in general, the AFT had the smallest overall relative change in mandibular parameters as compared to the other two facial types.

Cross-sectional comparisons of the absolute data (Table XII)

The results of the analysis of variance comparing the three facial types indicated that only one mandibular parameter (PWPog) was significantly different at 5, 10, 15, and 25 years of age with the SFT having the largest PWPog angle in both males and females.

Cross-sectional comparisons of the incremental data

The only significant finding in the comparisons among the various facial types was in mandibular lengths (O-Pog and Ar-Pog), which demonstrated greater increments of change in females during the 10 to 15-year period in persons with SFT.

Maxillary-mandibular anteroposterior parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years

of age for the three facial types are presented in Tables XIII and XIV.

Longitudinal comparisons of the absolute data (Table XV)

a. CURVE PARALLELISM. No significant differences were present among the three facial types. The absolute curves for the Wits appraisal are presented in Fig. 8, A and B.

b. CURVE MAGNITUDE. There were a number of significant differences in the curve magnitude in the maxillary-mandibular parameters of the three facial types. In general, persons with LFT had, on the average, the largest ANB and Wits measurements.

Longitudinal comparisons of the incremental data (Table XV)

There were no significant differences among the three facial types in either the curve parallelism or magnitude with the exception of the Wits appraisal and Ans-Ptm/Ar-Pog% in males.

Cross-sectional comparisons of the absolute and incremental data

Table XIV. Descriptive statistics on the incremental values for five anteroposterior maxillary-mandibular parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
ANB°	M	-1.0	0.8	-0.2	1.2	-0.5	2.1	0.7	1.1	-0.2	1.0	—	0.6
	F	-0.5	0.7	-0.8	0.9	-1.2	1.1	-0.7	1.1	-0.5	1.0	-1.6	1.2
NAPog°	M	-4.7	2.2	-2.7	2.3	-4.4	3.1	-0.3	2.6	-1.5	2.6	-1.3	1.9
	F	-3.2	2.3	-2.7	1.2	-3.3	3.0	-2.6	2.6	-1.6	2.2	-4.0	2.3
Wits mm	M	-0.7	1.1	-0.3	1.4	-0.6	0.8	-0.8	1.2	0.2	2.1	-0.1	0.9
	F	0.1	1.3	-0.8	1.6	0.2	2.0	0	1.1	1.1	1.7	-1.1	1.4
Overjet mm	M	-0.9	0.5	-0.2	2.0	-0.4	0.7	-1.0	0.9	-0.2	1.2	-0.4	0.6
	F	1.0	1.0	0.5	1.1	1.3	1.2	-0.1	0.4	—	0.2	-0.3	0.7
Ans-Ptm %	M	-2.2	1.3	0.9	1.1	0.4	8.9	-2.0	1.4	-1.3	2.2	-1.3	0.5
Ar-Pog	F	-1.1	1.1	-1.6	1.8	-1.4	3.6	-1.2	0.9	-1.8	0.3	-2.5	2.1
		15 to 25 years						5 to 25 years					
ANB°	M	-0.7	0.6	-1.4	1.0	-0.7	0.7	-1.0	1.0	-1.8	2.7	-1.2	1.8
	F	0.7	0.8	0.2	0.4	0.3	0.7	-0.6	0.7	-1.1	1.4	-2.5	1.9
NAPog°	M	-1.6	1.0	-3.8	2.6	-3.0	1.7	-6.7	2.5	-8.0	6.0	-8.8	5.3
	F	0.9	1.4	-0.4	0.8	0.1	0.8	-11.9	2.7	-4.6	3.2	-7.2	5.4
Wits mm	M	-0.6	1.1	-0.2	1.3	-0.1	0.8	-2.1	1.9	-0.3	2.7	-0.8	1.1
	F	0.7	0.4	0.6	1.1	0.9	0.6	0.8	1.7	0.9	2.0	—	2.6
Overjet mm	M	—	0.5	-0.5	0.9	0.1	0.5	-0.1	0.6	-0.5	2.0	—	0.9
	F	—	0.4	-0.1	0.4	—	0.7	0.9	1.1	0.4	1.1	1.0	1.1
Ans-Ptm %	M	-2.2	1.9	-2.4	1.9	-2.5	2.2	-6.4	3.0	-4.5	3.7	-3.5	8.5
Ar-Pog	F	-1.0	1.8	-0.8	0.6	-0.2	1.1	-3.2	2.8	-4.3	1.7	-4.1	2.3

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

No significant differences were found in the comparisons among the three face types.

Dental parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables XVI and XVII.

Longitudinal comparisons of the absolute data (Table XVIII)

a. CURVE PARALLELISM. The growth profiles for each of the seven dental parameters were not significantly different for the three facial types. The absolute curves for \bar{I} :SN and Pog:NB are presented in Figs. 9 and 10.

b. CURVE MAGNITUDE. There were significant differences in the curve magnitude of the different dental parameters in the three facial types. These differences indicated that, on the average, the maxillary and mandibular incisors are more labially inclined in the SFT and more upright in the LFT. In addition, the SFT

persons had the most pronounced effective bony chins (Pog:NB), LFT persons the least pronounced chins.

Longitudinal comparisons of the incremental data (Table XVIII)

a. CURVE PARALLELISM. Of the seven parameters compared, the growth profile of Pog:NB was significantly different in the three facial types.

This finding is the *only* significant difference of all the comparisons of curve parallelism in either the absolute or incremental data.

b. CURVE MAGNITUDE. There were few significant differences in curve magnitude indicating that persons with SFT have greater increments of change in Pog:NB in females and \bar{I} :MP in males.

Cross-sectional comparisons of the absolute data

Of the comparisons performed on the various parameters at the different ages, only 2 were significantly different— \bar{I} :MP and Pog:NB were greater in females with SFT at 5 years of age.

Cross-sectional comparisons of the incremental data

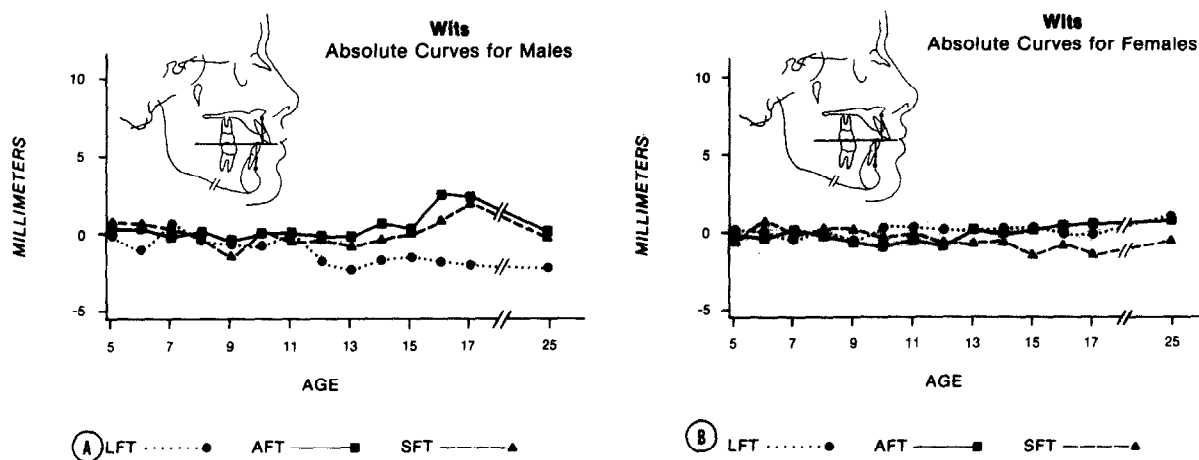


Fig. 8, A and B.

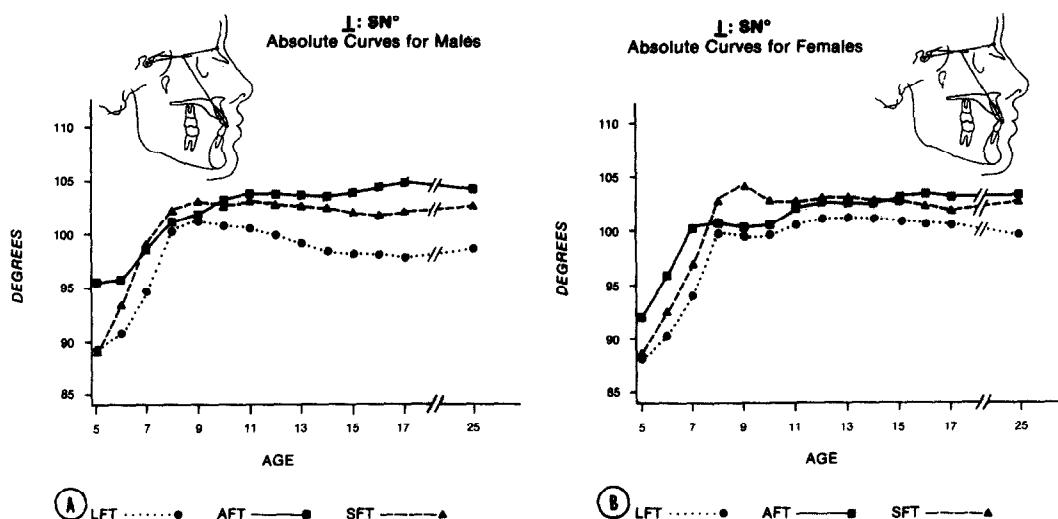


Fig. 9, A and B.

No significant differences were present among the three facial types.

Soft-tissue profile parameters

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables XIX and XX.

Longitudinal comparisons of the absolute data (Table XXI)

a. CURVE PARALLELISM. No significant differences were present in the growth profile comparisons of the various soft-tissue parameters in the three facial types. The absolute curves for the Holdaway soft-tissue angle and the Z-angle are presented in Figs. 11 and 12.

b. CURVE MAGNITUDE. The differences in the curve magnitude for the different parameters of the soft-tissue profile indicated that persons with SFT had less of a facial convexity than either the AFT or LFT facial types.

Longitudinal comparisons of the incremental data (Table XXI)

The comparisons of curve parallelism and magnitude of the incremental data indicated that no significant differences among the three facial types were present.

Cross-sectional comparisons of the absolute and incremental data

No significant differences among the three cleft types were present at any of the growth periods evaluated.

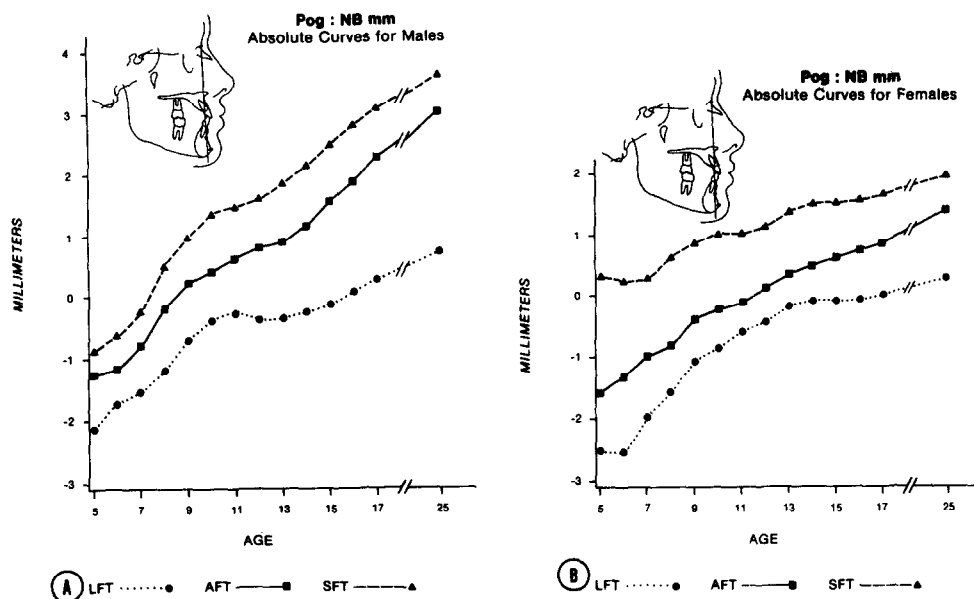


Fig. 10, A and B.

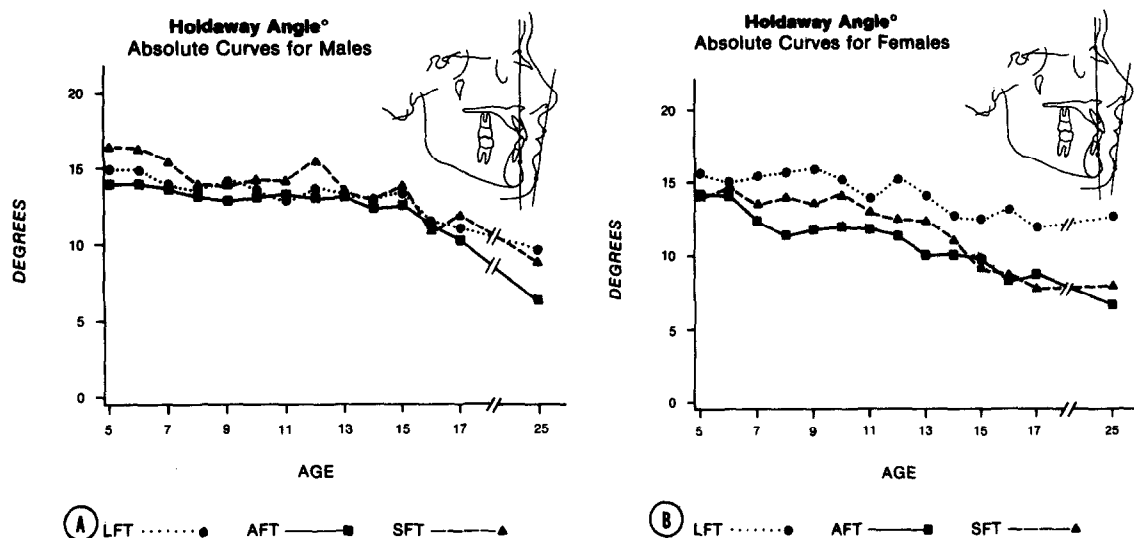


Fig. 11, A and B.

Vertical facial parameters

1. ANGULAR MEASUREMENTS

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Tables XXII and XXIII.

Longitudinal comparisons of the absolute data (Table XXIV)

a. CURVE PARALLELISM. There were no statistically significant differences in the overall shape of the three curves in any of these comparisons. The absolute

curves for FH:MP angle are presented in Fig. 13, A and B.

b. CURVE MAGNITUDE. For each of the four angular parameters compared, the magnitudes of the curves were significantly different in the three facial types; the LFT had the largest mandibular diversion (steeper mandibular plane) and the SFT presented the smallest mandibular diversion.

Longitudinal comparisons of the incremental data (Table XXIV)

a. CURVE PARALLELISM. With the exception of

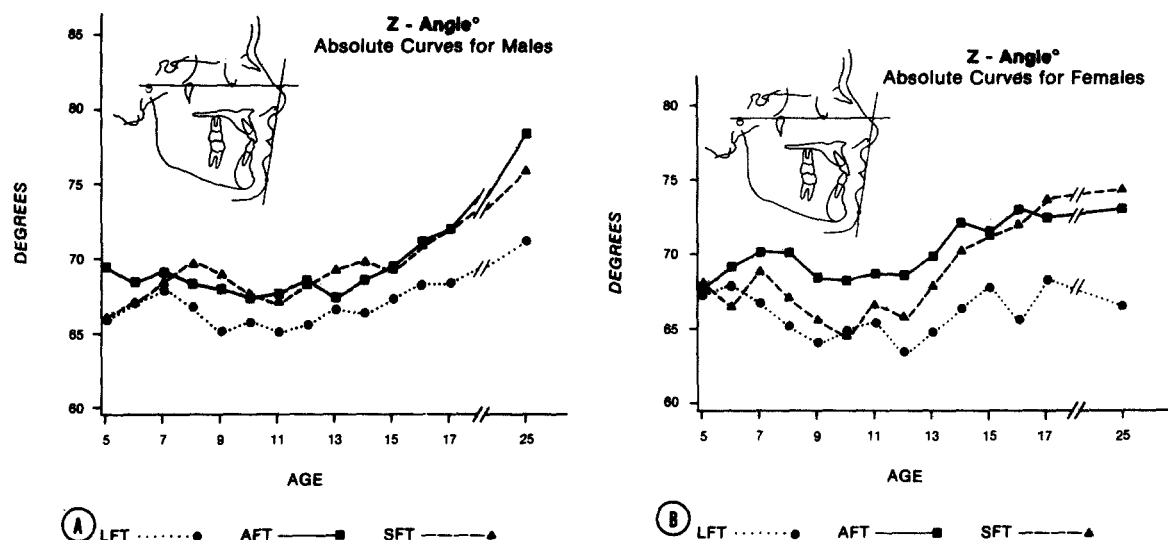


Fig. 12, A and B.

Table XV. Longitudinal comparisons of the absolute and incremental changes in the anteroposterior maxillary-mandibular parameters between 5 and 25 years of age for the three facial types*

Facial type parameter		Type of comparison					
		Curve parallelism comparison			Curve magnitude comparison		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>							
ANB°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	S(LFT)	NS	S(LFT)
NAPog°	M	NS	NS	NS	S(LFT)	NS	S(LFT)
	F	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
Wits mm	M	NS	NS	NS	S(AFT)	NS	S(SFT)
	F	NS	NS	NS	NS	NS	NS
Overjet mm	M	NS	NS	NS	NS	S(AFT)	S(LFT)
	F	NS	NS	NS	S(AFT)	NS	S(SFT)
Ans-Ptm Ar-Pog %	M	NS	NS	NS	S(AFT)	NS	S(SFT)
	F	NS	NS	NS	S(LFT)	NS	S(LFT)
<i>Incremental changes</i>							
ANB°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
NAPog°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Wits mm	M	S(AFT)	S(AFT)	S(LFT)	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Overjet mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Ans-Ptm Ar-Pog %	M	NS	NS	NS	NS	S(AFT)	S(LFT)
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

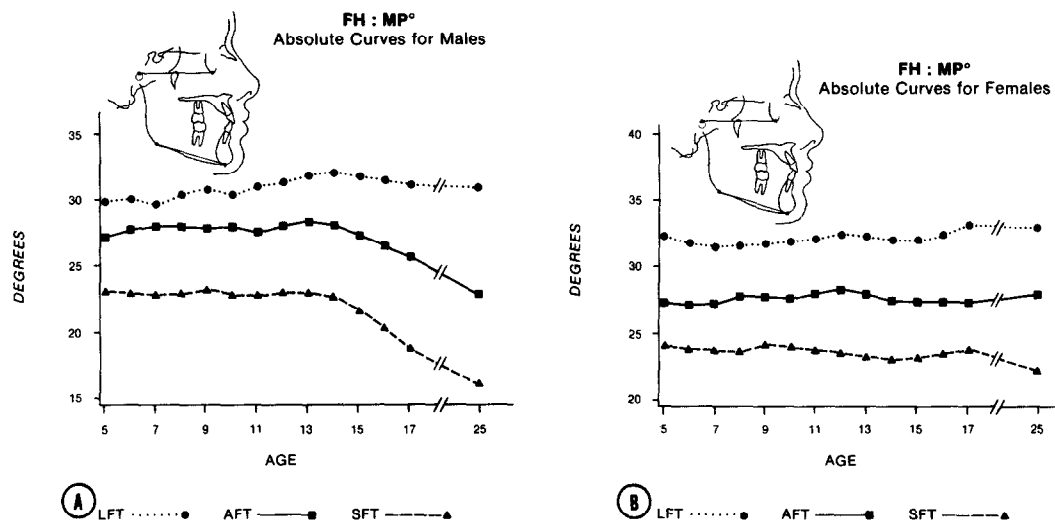


Fig. 13, A and B.

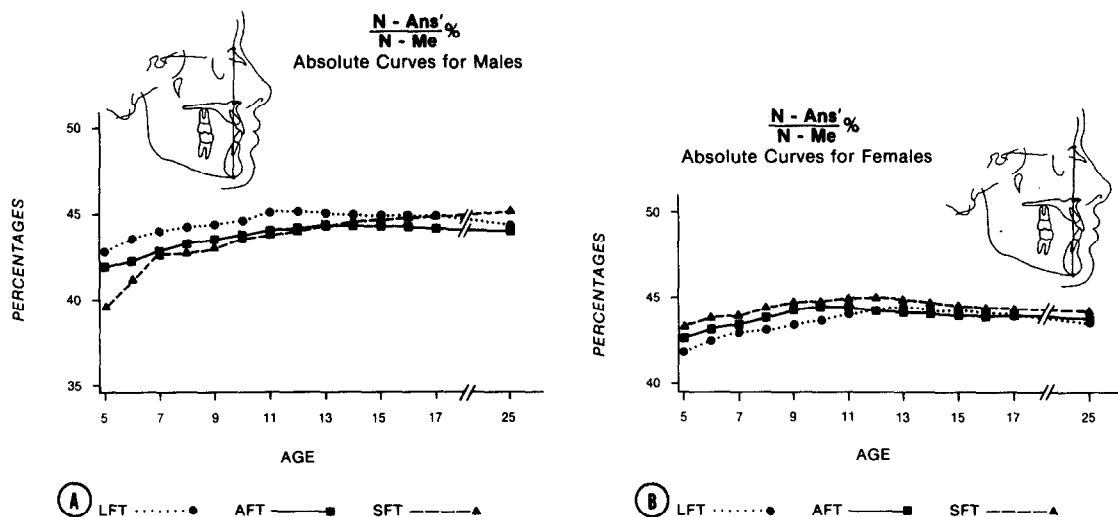


Fig. 14, A and B.

MP:SN in males, the growth profiles of the incremental changes in all other parameters were not significantly different.

b. CURVE MAGNITUDE. The magnitude of the incremental changes was significantly greater in the SFT—that is, the greatest reductions in the MP:SN and FH:MP angles were in the SFT.

Cross-sectional comparisons of the absolute data (Table XXV)

As expected, a large number of significant differences were present when the various parameters were compared among the three facial types. These differences indicated that the SFT had significantly smaller vertical angular dimensions—that is, flatter mandibular

plane with the least facial divergence. In general, the differences were more frequent at the older ages.

These differences indicate that the method used in this study to differentiate among facial types was appropriate.

Cross-sectional comparisons of the incremental data

The only significant differences present were in the 15 to 25-year growth period between the LFT and the SFT, indicating a significantly greater decrease in the FH:MP and MP:SN angles in the SFT.

II. FACE HEIGHTS AND OVERBITE

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years

Table XVI. Descriptive statistics on the **absolute** changes for seven **dental** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter	Age period investigated											
	5 years						10 years					
	LFT		AFT		SFT		LFT		AFT		SFT	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
<i>Dental angular</i>												
$\bar{I} : \bar{I}^\circ$												
M	144.2	5.0	138.9	10.4	134.9	20.8	129.5	7.8	125.9	9.2	130.1	3.7
F	150.2	8.8	142.9	7.7	146.8	15.7	131.8	7.7	125.7	4.6	127.0	6.7
$\bar{I} : \text{SN}^\circ$												
M	89.3	5.6	95.6	6.2	89.0	12.9	100.7	7.0	103.1	5.0	102.7	3.5
F	88.0	7.2	92.0	5.1	88.6	7.2	99.6	5.2	100.6	3.1	102.8	4.7
$\bar{I} : \text{MP}^\circ$												
M	87.7	4.3	88.7	8.3	87.7	13.8	93.7	5.6	96.8	5.1	98.8	1.8
F	81.9	4.8	86.9	5.0	91.3	9.1	91.2	4.6	97.5	2.1	99.6	4.9
$\bar{I} : \text{FH}^\circ$												
M	62.4	4.4	64.0	8.9	59.5	8.5	56.0	4.7	55.4	5.0	58.4	5.0
F	65.8	4.7	65.3	6.5	64.8	11.6	57.1	3.1	55.0	4.0	56.5	7.3
<i>Dental linear</i>												
$\bar{I} : \text{A-Pog mm}$												
M	3.0	0.4	3.3	1.8	2.7	0.7	5.8	1.4	5.6	2.0	4.2	0.9
F	2.7	1.0	3.7	1.2	2.7	2.2	5.4	1.3	6.0	1.2	5.6	2.4
$\bar{I} : \text{NB mm}$												
M	1.8	0.5	2.3	1.6	2.1	0.8	3.8	1.5	4.2	1.5	4.0	0.7
F	2.6	0.8	1.9	1.4	2.2	2.2	4.8	1.0	4.3	1.2	3.7	1.9
$\text{Pog} : \text{NB mm}$												
M	-2.1	0.7	-1.2	1.5	-0.9	0.7	-0.4	1.4	0.4	2.2	1.4	1.1
F	-2.5	0.4	-1.6	0.7	0.3	1.9	-0.9	0.7	-0.2	1.2	1.0	1.6
Facial type parameter	15 years						25 years					
	LFT		AFT		SFT		LFT		AFT		SFT	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
<i>Dental angular</i>												
$\bar{I} : \bar{I}^\circ$												
M	133.4	7.8	128.0	10.3	133.0	6.5	135.9	8.7	132.2	11.3	136.3	10.0
F	132.4	8.1	122.8	10.6	133.4	5.9	132.6	9.9	122.0	11.6	133.9	6.4
$\bar{I} : \text{SN}^\circ$												
M	98.0	7.1	103.8	6.5	101.8	3.3	98.5	6.5	104.0	7.2	102.6	3.7
F	100.8	5.6	103.1	5.8	102.7	5.8	99.6	6.0	103.2	6.1	102.8	6.9
$\bar{I} : \text{MP}^\circ$												
M	93.0	6.9	96.3	7.7	101.0	4.6	90.8	8.4	94.7	9.9	101.2	6.6
F	90.9	4.8	98.7	4.3	96.2	5.7	91.0	6.6	98.9	5.2	95.7	5.9
$\bar{I} : \text{FH}^\circ$												
M	55.3	5.5	56.5	8.0	58.0	8.0	58.8	5.6	62.6	12.6	62.7	11.2
F	57.3	4.4	55.0	7.0	60.7	7.0	55.9	7.7	52.7	7.9	62.5	6.0
<i>Dental linear</i>												
$\bar{I} : \text{A-Pog mm}$												
M	5.1	1.3	5.2	2.0	3.8	1.4	4.4	1.8	4.3	2.0	3.0	1.9
F	5.6	1.4	6.7	1.7	5.2	1.8	5.4	1.6	7.0	2.1	4.8	1.5
$\bar{I} : \text{NB mm}$												
M	4.4	1.2	4.8	1.8	4.2	1.7	3.8	1.9	4.0	2.9	3.4	2.8
F	5.0	1.2	5.0	2.2	3.2	2.2	5.3	1.7	5.7	2.2	3.3	1.8
$\text{Pog} : \text{NB mm}$												
M	-0.2	1.0	1.6	2.4	2.5	1.8	0.7	1.2	3.0	2.4	3.6	2.0
F	-0.1	1.2	0.6	1.2	1.5	2.0	0.3	1.2	1.4	1.4	1.9	2.1

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

of age for the three facial types are presented in Tables XXVI and XXVII.

Longitudinal comparisons of the absolute data (Table XXVIII)

a. CURVE PARALLELISM. The comparisons of the growth profiles of the different vertical linear parameters indicated no significant differences among the three facial types. The absolute curves of the ratios N-Ans'/N-Me% and S-Go/N-Me% are presented in Figs. 14 and 15.

b. CURVE MAGNITUDE. A number of significant differences were present in the comparisons among the

three facial types. The differences were present in comparisons of both linear dimensions and ratios of the different face heights—namely, anterior, posterior, and anterior-posterior face heights. From the LFT to the SFT, there was a progressive relative decrease in the anterior face height and an increase in the posterior face height.

Longitudinal comparisons of the incremental data (Table XXVIII)

a. CURVE PARALLELISM. With the exception of overbite in females, there were no significant differences in the growth profiles of the incremental curves of the three facial types.

Table XVII. Descriptive statistics on the **incremental** values for seven **dental** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
<i>Dental angular</i>													
\perp : \bar{I}°	M	-14.7	6.9	-12.9	9.1	-4.8	19.5	3.8	5.2	2.1	5.0	2.9	5.4
	F	-18.4	10.0	-17.2	7.9	-19.7	10.8	0.6	1.5	-2.9	7.0	6.4	4.9
\perp : SN $^\circ$	M	11.4	6.3	7.5	7.3	13.8	14.7	-2.6	1.1	0.7	3.5	-0.8	2.8
	F	11.6	4.1	8.6	4.4	14.2	4.1	1.2	1.5	2.5	3.0	0	2.8
\bar{I} : MP $^\circ$	M	6.0	3.1	8.1	6.6	11.1	14.0	-0.6	4.7	-0.5	3.1	2.2	3.7
	F	9.3	7.2	10.6	5.0	8.4	7.1	-0.4	0.4	1.2	4.6	-3.5	2.3
\bar{I} : FH $^\circ$	M	-6.4	4.0	-8.6	6.5	-1.1	9.0	-0.7	3.4	1.0	4.1	-0.4	4.2
	F	-8.6	5.8	-10.2	5.1	-8.3	6.9	0.2	2.8	0	4.3	4.2	1.1
<i>Dental linear</i>													
\perp : A-Pog mm	M	2.7	1.2	2.3	1.5	1.5	1.5	-0.7	0.5	-0.4	0.7	-0.4	0.8
	F	2.8	0.8	2.2	1.4	2.8	1.7	0.2	0.2	0.7	1.0	-0.4	0.8
\bar{I} : NB mm	M	2.0	1.2	2.2	1.2	1.9	1.4	0.6	1.0	0.2	1.1	0.2	1.1
	F	2.2	0.6	2.3	1.0	1.5	0.8	0.2	0.5	0.8	1.6	-0.5	0.8
Pog : NB mm	M	1.7	0.9	1.7	1.1	2.2	0.9	0.2	0.7	1.1	0.9	1.1	0.8
	F	1.7	0.5	1.3	0.6	0.7	1.0	0.8	0.6	0.9	0.3	0.5	0.9
15 to 25 years							5 to 25 years						
<i>Dental angular</i>													
\perp : \bar{I}°	M	2.6	2.1	4.2	3.2	3.3	4.0	-8.3	7.1	-6.7	10.0	1.4	20.9
	F	0.2	3.0	-0.7	3.1	-0.5	3.3	-17.6	12.5	-20.1	9.1	-12.8	11.8
\perp : SN $^\circ$	M	0.4	1.2	0.2	2.9	0.7	2.6	9.2	5.9	8.4	9.5	13.6	15.9
	F	-1.2	0.7	0.1	2.3	0.1	2.1	11.6	4.5	11.2	3.4	14.2	2.0
\bar{I} : MP $^\circ$	M	-2.2	2.4	-1.6	2.8	0.1	2.3	3.1	6.2	6.0	8.2	13.5	18.5
	F	0.1	3.1	0.2	1.8	-0.5	3.0	9.0	9.6	12.0	6.3	4.4	10.2
\bar{I} : FH $^\circ$	M	3.5	3.2	6.1	5.6	4.7	3.4	-3.6	2.2	-1.4	9.5	3.2	12.4
	F	-1.4	4.2	-2.3	3.4	1.8	3.0	-9.8	11.0	-12.6	8.3	-2.4	8.7
<i>Dental linear</i>													
\perp : A-Pog mm	M	-0.7	0.6	-0.9	0.6	-0.8	0.7	1.4	1.6	1.1	1.2	0.3	2.6
	F	-0.2	0.3	0.3	0.7	-0.4	0.4	2.7	1.0	3.2	1.6	2.1	1.0
\bar{I} : NB mm	M	-0.6	0.8	-0.7	1.3	-0.8	1.2	2.0	1.4	1.7	2.2	1.3	3.6
	F	0.3	0.7	0.7	0.7	0.1	0.7	2.7	1.6	3.7	2.6	1.1	0.8
Pog : NB mm	M	0.9	0.5	1.5	0.8	1.1	0.4	2.8	0.9	4.3	1.4	4.5	1.8
	F	0.4	0.3	0.8	0.4	0.4	0.6	2.8	1.0	3.0	0.9	1.6	2.2

LFT = Long face type. AFT = Average face type. SFT = Short face type.

\bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

b. CURVE MAGNITUDE. In general, the SFT subjects exhibited a significantly greater change than the other two facial types.

Cross-sectional comparisons of the absolute data

The analysis of variance indicated that at 25 years of age the anterior face height (N-Me) in males was significantly larger in the LFT subjects; the lower posterior face height (Ar-Go) in females was significantly larger in the SFT subjects.

Cross-sectional comparisons of the incremental data

No significant differences were present among the

three facial types in any of the incremental changes in the various growth periods.

Standing height

Descriptive statistics on males and females for the absolute and incremental data at 5, 10, 15, and 25 years of age for the three facial types are presented in Table XXIX.

Longitudinal comparisons of the absolute data (Table XXX)

a. CURVE PARALLELISM. There were no differences in the growth profiles of the three facial types in males

Table XVIII. Longitudinal comparisons of the absolute and incremental changes in the dental parameters between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Dental angular parameters—Absolute</i>						
$\underline{1} : \overline{1}^\circ$ M	NS	NS	NS	S(LFT)	S(SFT)	NS
F	NS	NS	NS	NS	S(SFT)	NS
$\underline{1} : \text{SN}^\circ$ M	NS	NS	NS	S(AFT)	NS	S(SFT)
F	NS	NS	NS	S(AFT)	NS	S(SFT)
$\overline{1} : \text{MP}^\circ$ M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
F	NS	NS	NS	S(AFT)	NS	S(SFT)
$\overline{1} : \text{FH}^\circ$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	S(SFT)	NS
<i>Dental linear parameters—Absolute</i>						
$\underline{1} : \text{A-Pog mm}$ M	NS	NS	NS	NS	S(AFT)	S(LFT)
F	NS	NS	NS	S(AFT)	S(AFT)	NS
$\overline{1} : \text{NB mm}$ M	NS	NS	NS	S(AFT)	S(AFT)	NS
F	NS	NS	NS	NS	S(AFT)	S(LFT)
Pog : NB mm M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
F	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
<i>Dental angular parameters—Incremental changes</i>						
$\underline{1} : \overline{1}^\circ$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
$\underline{1} : \text{SN}^\circ$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
$\overline{1} : \text{MP}^\circ$ M	NS	NS	NS	S(AFT)	NS	S(SFT)
F	NS	NS	NS	NS	NS	NS
$\overline{1} : \text{FH}^\circ$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	S(SFT)	NS
<i>Dental linear parameters—Incremental changes</i>						
$\underline{1} : \text{A-Pog mm}$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
$\overline{1} : \text{NB mm}$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	S(AFT)	NS
Pog : NB mm M	S	S	S	NS	NS	S(SFT)
F	NS	NS	NS	NS	S(SFT)	S(SFT)

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

or females. The absolute curves for standing height are presented in Fig. 16, A and B.

b. CURVE MAGNITUDE. Significant differences were present in the curve magnitude of standing height for the different facial types. In males the magnitude of the curves was significantly larger in the LFT and AFT than in the SFT subjects. In females the curve magnitude of the AFT was significantly greater than in the other two facial types.

Longitudinal comparisons of the incremental data (Table XXX)

There were no significant differences in the curve parallelism or curve magnitude of the incremental changes in the three facial types.

Cross-sectional comparisons of the absolute and incremental data

No significant differences were present in any of the comparisons among the three facial types.

Results of regression analysis

A step-wise regression analysis was performed on all 48 variables to determine which of the variables

Table XIX. Descriptive statistics on the **absolute** values of six **facial profile** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
Gl'-Pr-Pog°	M	144.7	3.8	147.8	2.8	149.6	1.8	142.3	3.9	144.0	2.8	146.6	1.6
	F	145.4	3.3	149.1	4.1	149.7	4.4	139.6	4.1	144.5	3.9	145.4	4.6
Gl'-SLS-Pog°	M	166.7	5.7	170.7	3.0	171.5	2.1	166.8	3.7	167.9	3.4	169.7	2.5
	F	168.2	2.0	169.5	4.1	173.2	4.2	165.1	3.0	167.8	3.0	169.4	5.6
LS-Pog' : NB°	M	14.9	3.1	14.0	5.2	16.4	2.5	13.6	2.8	13.2	4.6	14.3	4.0
	F	15.6	4.7	14.0	4.7	14.0	6.5	15.2	4.2	12.0	4.4	14.1	6.9
Z angle°	M	65.9	4.6	69.5	7.4	66.0	3.4	65.8	4.1	67.4	6.4	67.7	8.1
	F	67.3	3.9	67.8	8.4	68.1	10.4	64.8	3.4	68.2	5.2	64.5	13.6
Pr-Pog : LS mm	M	0.3	1.2	-0.1	2.6	-1.1	1.2	1.1	0.8	0.9	2.1	—	2.0
	F	0.6	1.1	—	2.0	-0.7	1.0	0.3	1.0	0.1	2.0	-0.5	2.0
Pr-Pog : LI mm	M	0.6	1.1	—	2.0	-0.7	1.0	0.3	1.0	0.1	2.0	-0.5	2.0
	F	—	1.3	-0.3	1.7	-0.2	2.4	-0.1	1.4	0.1	1.8	-0.7	3.1
		15 years						25 years					
Gl'-Pr-Pog°	M	137.1	4.1	139.1	4.4	141.2	4.3	139.1	4.1	140.6	6.1	140.6	4.4
	F	134.4	5.9	140.8	4.6	141.5	6.1	134.4	5.9	140.8	4.6	141.5	6.2
Gl'-SLS-Pog°	M	165.6	3.1	167.0	6.1	168.0	4.2	170.5	5.7	174.0	6.6	174.0	5.4
	F	166.4	4.6	172.6	2.8	174.8	8.5	166.4	4.6	172.6	2.8	174.8	8.5
LS-Pog' : NB°	M	13.4	2.5	12.7	6.6	13.9	4.1	9.6	3.8	6.4	6.4	8.8	5.7
	F	12.8	4.3	6.7	4.4	8.0	7.8	12.8	4.3	6.7	4.4	8.0	7.8
Z angle°	M	67.3	3.7	69.5	8.2	69.3	6.4	71.2	2.7	78.4	9.3	75.9	9.9
	F	66.5	4.8	73.1	5.3	74.3	10.6	66.5	4.8	73.1	5.2	74.3	10.6
Pr-Pog : LS mm	M	2.6	2.5	2.1	2.9	1.4	2.2	4.9	2.3	5.9	3.5	4.5	2.4
	F	4.0	0.6	5.7	2.6	5.0	3.0	4.0	0.6	5.7	2.6	5.0	3.0
Pr-Pog : LI mm	M	1.8	1.0	1.6	2.0	1.7	2.7	3.8	0.9	3.8	1.9	4.3	3.5
	F	1.4	1.4	2.5	2.5	1.7	2.7	1.4	1.4	2.5	2.5	2.3	2.7

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

could best explain the difference—that is, the variation among the three normal facial types.

For *males* step I in the regression model indicated that MP:SN explained approximately 48% of the variation; step II indicated that MP:SN and O-Pog explained 63% of the variation among the three facial types. The addition of more variables gradually increased the efficiency of the regression model, but in much smaller increments.

For *females* step I in the regression model indicated that FH:MP explained approximately 58% of the variation among the three facial types; step III indicated that three variables—namely, FH:MP, N:Me, and FH:SGn—explained 81% of the variation. In the subsequent steps, the addition of new variables gradually increased the efficiency of the regression model.

Discriminant analysis techniques using two variables further supported the findings of the stepwise

regression analysis—73% of the males and 68% of the females were correctly classified.

DISCUSSION

In spite of the many advances in orthodontic sciences in the past half century, a cephalometric analysis that can readily diagnose every person within a population still needs to be developed.

A result of many studies is the generally accepted conclusion regarding the wide range of variation in both the size and relationship of the cranio-facial-dental complex. Thus, cephalometric standards presently used in orthodontic diagnosis are of benefit as "reference lines" by which a person is compared. Standards that are specific for age, sex, race, and face-type attempt to bring that "reference line" closer to the individual patient. Therefore, in our cephalometric diagnosis we must depend on our ability to identify specific standards

Table XX. Descriptive statistics on the **incremental** changes for six **facial profile** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
GI'-Pr-Pog' ^o	M	-2.4	2.7	-3.7	2.1	-3.1	1.9	-5.1	3.7	-4.9	2.8	-5.4	2.9
	F	-5.7	1.7	-4.6	0.9	-4.3	1.5	-4.6	3.3	-3.5	1.7	-1.9	1.3
GI'-SLS-Pog' ^o	M	—	4.2	-2.8	2.0	-1.8	3.2	-1.2	2.3	-0.9	4.3	-1.7	2.4
	F	-3.1	1.2	-1.7	2.4	-3.8	2.6	1.7	3.1	1.2	1.9	3.4	2.6
LS-Pog' : NB ^o	M	-1.3	3.4	-0.8	1.5	-2.1	3.1	-0.2	3.8	-0.5	2.7	-0.4	1.0
	F	-0.4	1.8	-2.1	3.2	0.1	1.7	-2.7	2.7	-2.2	2.1	-5.0	2.7
Z angle ^o	M	-0.1	6.0	-2.0	4.7	1.7	5.4	1.6	4.7	2.1	5.6	1.7	2.5
	F	-2.5	1.4	0.4	8.0	-3.6	5.6	2.9	3.5	3.2	4.4	6.6	5.1
Pr-Pog : LS mm	M	0.8	1.2	1.0	0.8	-1.1	1.4	1.3	1.7	1.2	1.0	1.4	0.8
	F	1.0	0.9	1.9	1.5	0.5	0.8	3.1	1.2	2.2	0.9	3.1	1.3
Pr-Pog : LI mm	M	-0.3	1.8	0.1	1.0	0.2	1.2	1.5	1.5	1.5	0.8	2.2	1.0
	F	-0.1	0.5	0.5	1.6	-0.4	1.0	2.1	1.6	1.6	1.1	2.2	1.6
		15 to 25 years						5 to 25 years					
GI'-Pr-Pog' ^o	M	2.0	0.9	1.4	3.7	-0.6	1.8	-5.3	1.1	-7.2	5.9	-9.0	4.2
	F	0.5	1.4	-0.3	0.4	-2.0	1.1	-10.9	4.2	-8.3	2.6	-8.2	3.2
GI'-SLS-Pog' ^o	M	4.9	3.1	7.0	2.0	6.1	2.3	3.8	1.9	3.4	5.7	2.6	5.8
	F	-0.4	1.2	3.6	2.2	1.9	1.5	-1.8	2.8	3.1	4.8	1.6	5.4
LS-Pog' : NB ^o	M	-3.8	3.0	-6.3	2.1	-5.0	2.6	-5.4	1.8	-7.6	3.0	-7.5	4.8
	F	0.2	2.4	-3.1	1.8	-1.2	2.3	-2.8	2.7	-7.4	4.6	-6.1	2.4
Z angle ^o	M	3.9	3.3	8.9	3.9	6.6	4.0	5.3	2.1	8.9	5.9	9.9	7.0
	F	-1.2	1.1	1.6	2.7	3.1	3.0	-0.8	4.6	5.2	9.0	6.2	4.4
Pr-Pog : LS mm	M	2.3	1.5	3.8	1.4	3.0	1.4	4.5	1.7	6.0	2.2	5.6	2.0
	F	-0.5	1.4	1.7	1.0	1.2	0.8	3.6	1.5	5.8	2.2	4.8	1.3
Pr-Pog : LI mm	M	2.0	0.6	2.3	0.9	2.6	1.4	3.5	1.4	3.9	1.2	5.0	3.0
	F	-0.6	1.3	0.8	0.9	0.8	0.9	1.4	1.1	2.9	2.6	2.5	1.4

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

for each patient with regard to age, sex, and overall facial type. Superimposed on these factors are the unique characteristics of the individual dentofacial relationships. Finally, clinicians should be able to combine all this knowledge with their own clinical experience and their own concepts of facial esthetics.

Therefore, as an integral part of the systematic evaluation of dentofacial discrepancies, it is important to define the differences among the various facial types. The findings from this study identify these differences and indicate at what stages of development they are expressed.

A number of points will be discussed that outline some of the differences among the three facial types.

1. *The original relationships of the different parts of the craniofacial complex.* The present findings indicate that most persons (77%) are categorized as hav-

ing the same facial type at 5 years and at 25 years of age. This means that there is a strong tendency to maintain the overall facial type as facial growth progresses with age. On the other hand, cross-sectional comparisons in this study indicated that the differences between the three facial types, particularly in the vertical relationships, were more pronounced at adulthood as compared with childhood. This could be partly attributed to the method by which the various groups were selected. It could also indicate that the facial pattern becomes more pronounced with age and/or that other epigenetic factors interplay to promote or inhibit the earlier growth trends.

In 23% of the subjects there was a change in the categorization of the facial type between 5 years and 25 years of age. One can speculate that the majority of these cases were "borderline" between two facial types

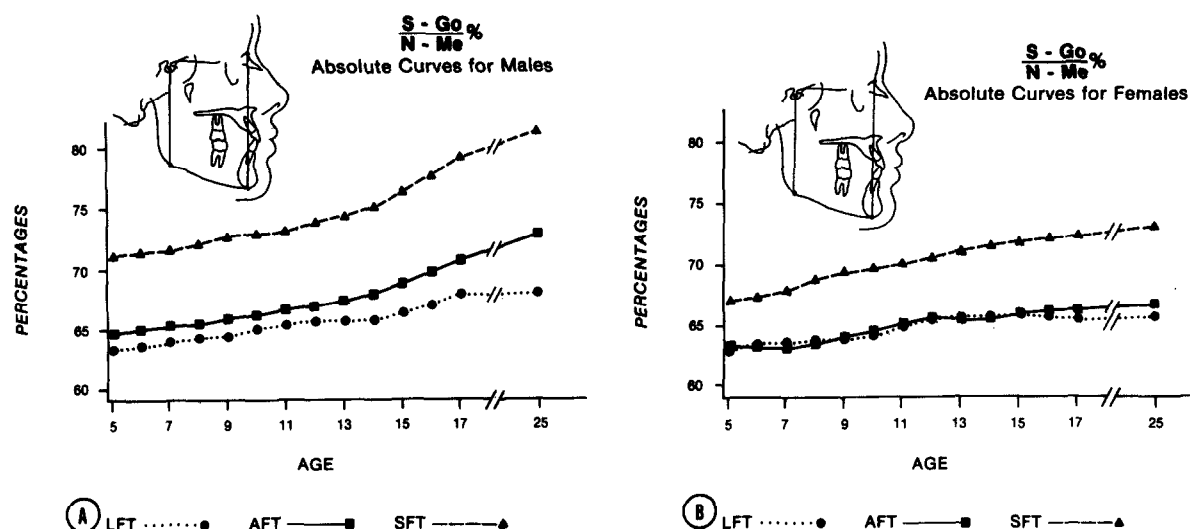


Fig. 15, A and B.

Table XXI. Longitudinal comparisons of the absolute and incremental changes in the facial profile parameters between 5 and 25 years of age for the three facial types*

Facial type parameter		Type of comparison					
		Curve parallelism comparison			Curve magnitude comparison		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>							
GI'-Pr-Pog'°	M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
	F	NS	NS	NS	S(AFT)	NS	S(SFT)
GI'-SLS-Pog'°	M	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
	F	NS	NS	NS	S(AFT)	S(SFT)	S(SFT)
LS-Pog' : NB°	M	NS	NS	NS	NS	S(SFT)	NS
	F	NS	NS	NS	S(LFT)	NS	S(LFT)
Z angle°	M	NS	NS	NS	S(AFT)	NS	S(SFT)
	F	NS	NS	NS	S(AFT)	NS	S(SFT)
Pr-Pog : LS mm	M	NS	NS	NS	NS	S(AFT)	S(LFT)
	F	NS	NS	NS	NS	NS	NS
Pr-Pog : LI mm	M	NS	NS	NS	NS	NS	S(LFT)
	F	NS	NS	NS	NS	NS	NS
<i>Incremental changes</i>							
GI'-Pr-Pog'°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
GI'-SLS-Pog'°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
LS-Pog' : NB°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Z angle°	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Pr-Pog : LS mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS
Pr-Pog : LI mm	M	NS	NS	NS	NS	NS	NS
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

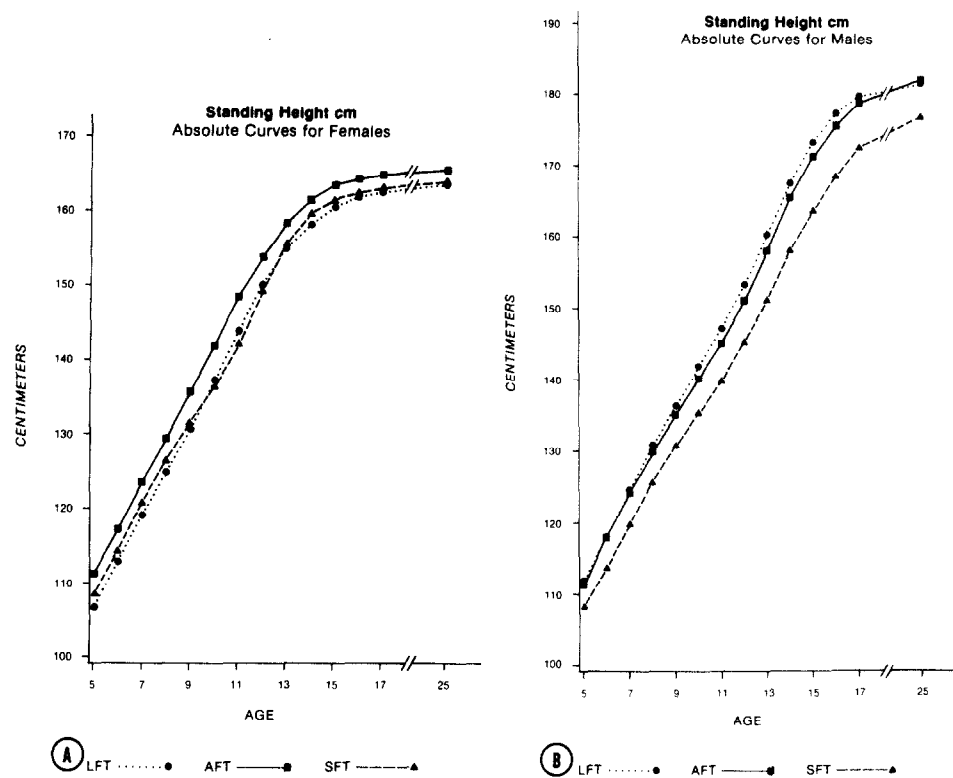


Fig. 16, A and B.

Table XXII. Descriptive statistics on the **absolute** values for four **vertical angular** parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
MP:SN	M	38.2	4.2	36.5	3.0	28.1	6.1	36.5	4.1	34.6	2.9	27.7	4.0
	F	39.7	2.6	38.0	2.0	33.1	2.4	37.7	2.1	37.2	1.0	30.6	2.7
FH:MP°	M	29.9	3.6	27.2	3.2	23.2	5.1	30.4	3.9	27.9	3.6	22.8	4.1
	F	32.3	1.8	27.3	1.4	24.1	4.0	31.9	2.2	27.6	3.9	24.0	3.7
NSGn°	M	70.4	2.2	68.3	2.0	65.4	3.2	70.0	2.6	68.2	1.5	65.3	3.6
	F	67.9	2.1	69.9	3.1	66.8	1.5	67.7	2.2	71.1	1.6	67.0	2.0
FH:SGn°	M	62.2	2.8	58.8	1.7	56.7	8.9	63.9	2.6	61.4	2.3	60.4	3.3
	F	60.6	2.3	58.4	2.5	57.8	3.8	61.8	2.0	61.5	3.3	60.5	3.5
		15 years						25 years					
MP:SN	M	35.6	4.9	32.1	2.2	24.4	3.1	34.4	5.7	28.9	2.2	19.6	4.6
	F	35.9	2.3	35.9	1.5	28.3	3.1	36.5	2.3	35.8	1.0	28.0	3.7
FH:MP°	M	31.2	4.5	27.3	2.6	21.7	4.7	30.9	5.8	22.8	3.1	16.2	5.7
	F	31.9	3.3	27.3	3.7	23.2	3.7	32.9	3.6	27.8	3.3	22.1	3.8
NSGn°	M	70.2	2.9	67.9	1.9	64.3	2.9	69.9	3.3	66.6	2.9	63.3	2.8
	F	67.4	2.5	71.3	1.7	66.4	2.2	67.9	2.6	71.1	1.2	66.3	2.3
FH:SGn°	M	66.4	3.1	62.7	2.1	61.7	4.2	65.8	2.3	60.2	3.8	59.9	4.6
	F	63.1	2.7	62.6	3.6	61.2	2.9	64.0	2.9	63.5	4.1	60.6	3.0

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.



Fig. 17, A and B.

Table XXIII. Descriptive statistics on the **incremental** changes for four **vertical angular** parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
MP:SN°	M	-1.7	2.7	-1.8	1.0	-0.4	4.8	-0.9	1.8	-2.6	1.2	-3.4	1.2
	F	-2.1	1.1	-0.9	2.1	-2.6	2.0	-1.7	1.5	-1.3	1.6	-2.2	0.7
FH:MP°	M	-0.5	3.2	-0.7	1.9	-0.3	5.2	1.4	2.3	-0.6	1.9	-1.2	1.6
	F	-0.4	2.0	0.3	3.1	-0.1	3.9	—	2.6	-0.3	1.0	-0.8	1.8
NSGn°	M	-0.5	1.7	-0.1	0.7	-0.1	0.7	0.2	1.0	-0.3	1.5	-1.0	0.9
	F	-0.2	0.4	1.3	1.9	0.2	1.1	-0.4	0.8	0.2	1.4	-0.7	0.3
FH:SGn°	M	1.7	2.9	2.5	2.1	3.6	9.1	2.4	2.1	1.4	2.6	1.3	1.7
	F	1.3	1.0	3.0	2.5	2.7	3.1	1.2	2.3	1.1	0.8	0.7	1.2
		15 to 25 years						5 to 25 years					
MP:SN	M	-1.2	1.0	-3.2	1.5	-4.8	2.7	-3.8	4.2	-7.6	2.4	-8.5	6.5
	F	0.6	0.5	-0.1	1.2	-0.3	0.7	-3.2	2.2	-2.2	2.5	-5.1	2.8
FH:MP°	M	-0.9	3.7	-4.5	2.8	-5.5	1.1	1.1	5.9	-4.4	3.7	-7.0	6.6
	F	0.9	1.2	0.5	1.2	-1.0	0.3	0.6	2.6	0.5	2.4	-2.0	5.1
NSGn°	M	-0.3	0.6	-1.3	1.5	-1.0	1.3	-5.3	2.2	-1.7	2.8	-2.1	1.8
	F	0.5	1.6	-0.2	0.9	-0.1	0.5	0	1.1	1.3	2.6	-0.6	1.4
FH:SGn°	M	-0.5	2.7	-2.5	2.2	-1.8	1.3	3.6	3.4	1.4	3.6	3.2	10.0
	F	0.9	1.2	0.9	1.7	-0.6	0.8	3.4	2.6	5.1	3.9	2.8	3.5

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

Table XXIV. Longitudinal comparisons of the absolute and incremental changes in the vertical angular parameters between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>						
MP:SN° M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	NS	S(AFT)	S(LFT)
FH:MP° M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
NSGn° M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
FH:SGn° M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	NS	S(AFT)	S(LFT)
<i>Incremental changes</i>						
MP:SN M	S	S	S	S(AFT)	NS	S(SFT)
F	NS	NS	NS	S(AFT)	NS	S(LFT)
FH:MP° M	NS	NS	NS	S(AFT)	NS	S(SFT)
F	NS	NS	NS	NS	NS	NS
NSGn° M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
FH:SGn° M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

and that epigenetic factors tipped the balance from one type to the other.

2. *Direction of growth vs. magnitude of growth.* One of the most significant aspects of this study is that the longitudinal comparisons of the 3 facial types have consistently demonstrated the lack of significant differences in the profile of the absolute growth curves for all the 48 parameters compared. This indicates that, regardless of facial type, the curves demonstrate a parallel relationship—that is, similar growth behavior or direction. As interesting as this finding might seem in the context of facial growth, such a phenomenon is readily observed in the well-publicized standards for standing height (Fig. 17) for tall, average, and short persons.⁴⁰

This consistency in curve parallelism observed in the present findings was matched by a consistent presence of significant differences among the three facial types in the curve magnitude for most of the parameters examined including standing height.

It seems that the outcome of facial growth is influenced, at least in part, by the original size and relationship of the different parts of the face. Superimposed

on that are the differences in the magnitude of change between successive ages. For example, the comparisons of the curves for SNA (Table VII, Fig. 5) indicate that the three facial types have parallel growth curves. Yet the overall magnitudes of the absolute and incremental curves for the three facial types were significantly different.

3. *Variation within each facial type.* Even within a relatively homogenous small sample, each facial type expressed a considerable amount of variation. The persons *within* each facial type were neither of similar size nor had similar dentofacial relationships. In other words, there is more than one combination in the size and relationships of the different parts of the dentofacial complex that could produce a certain facial type.

4. *Interaction among parameters.* Subtle changes in more than one parameter can together have an additive effect that can influence the overall direction of growth as well as the ultimate relationships of the face.

5. *Male and female differences.* The analysis of the data indicated that there were a number of significant differences between males and females in each of the

Table XXV. Results of Analysis of Variance General Linear Models procedure for the **cross-sectional** comparisons of the absolute data of the **vertical angular** parameters for three facial types at 5, 10, 15, and 25 years of age

Facial type parameter		Age period investigated					
		5 years			10 years		
		LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
MP:SN	M	NS	S	S	NS	S	S
	F	NS	S	S	NS	S	S
FH:MP°	M	NS	NS	S	NS	S	S
	F	S	NS	S	NS	NS	S
NSGn°	M	NS	NS	S	NS	NS	S
	F	NS	NS	NS	S	S	NS
FH:SGn°	M	NS	NS	NS	NS	NS	S
	F	NS	NS	NS	NS	NS	NS
		15 years			25 years		
MP:SN°	M	NS	S	S	S	S	S
	F	NS	S	S	NS	S	S
FH:MP°	M	NS	S	S	S	S	S
	F	NS	NS	S	S	S	S
NSGn°	M	NS	S	S	NS	NS	S
	F	S	S	NS	S	S	NS
FH:SGn°	M	NS	NS	S	S	NS	S
	F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type.
NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

three facial types. Furthermore, the differences among the three facial types were not identical in males and females.

6. *Differences between the results of longitudinal and cross-sectional comparison.* An important finding of this investigation was the presence of a large number of significant differences in the longitudinal comparisons of curve magnitude for both the absolute and incremental data. Similar results were not observed in the cross-sectional comparisons at the different ages.

It should be noted that the longitudinal comparisons of curve magnitude take into consideration the weight of the curve over the whole period of growth. The cross-sectional analysis of the data is only a comparison between points on the continuum of the growth curve. Thus the lack of significance in the cross-sectional comparisons could be related to the magnitude of change among the successive ages (relatively small) and/or to the variation within each facial type (relatively large).

Another point that has been observed in this study is the lack of consistent findings in the cross-sectional

comparisons. For example, the NSO angle was significantly different between the LFT and SFT subjects at ages 5, 10, and 25 years—but not at 15 years of age (Table IV). These findings could explain why cross-sectional studies on facial growth can produce conflicting results depending upon which points (ages) on the growth curves the comparisons are made. Investigators might examine the same data at different ages and come to different conclusions regarding the presence or absence of significant differences. These discrepancies between the longitudinal and cross-sectional comparisons can be attributed to the obvious differences in the statistical approach, one of which provides a more sensitive instrument to detect changes in the overall growth period for each facial type.

These findings point to the limitations of the cross-sectional comparisons in explaining the longitudinal changes in the face and to the fact that differences among the normal facial types might be of a magnitude that is not consistently observed at every point on the growth curve. It is the cumulative, yet subtle, differences along the span of the growth period that are more readily measured with the longitudinal analysis. The

Table XXVI. Descriptive statistics on the **absolute** values for seven **vertical linear** facial parameters at 5, 10, 15, and 25 years of age for three normal facial types

Facial type parameter		Age period investigated											
		5 years						10 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
N-Ans' mm	M	41.1	2.1	39.3	1.2	35.8	5.9	48.2	1.8	45.6	0.8	44.4	3.2
	F	37.8	1.4	39.1	1.5	37.6	1.4	44.2	2.1	46.0	1.0	42.9	2.8
N-Me mm	M	96.2	3.9	93.9	1.8	85.5	13.8	108.1	3.5	104.2	2.4	101.8	4.9
	F	90.5	4.7	91.7	2.5	87.0	1.7	101.5	5.8	103.5	2.0	95.7	3.3
N-Ans' %	M	42.8	3.0	41.9	1.0	39.6	5.7	44.6	2.2	43.7	0.8	43.6	1.4
	F	41.9	2.0	42.7	1.3	43.3	1.8	43.6	2.1	44.5	1.1	44.8	1.6
Ar'-Go mm	M	40.4	4.4	40.3	2.2	39.7	5.9	45.8	4.5	44.1	2.2	47.8	3.2
	F	37.7	3.6	37.8	0.7	39.5	2.1	41.5	2.9	42.1	1.1	43.8	3.2
S-Go mm	M	61.0	5.9	60.8	2.5	60.7	9.8	70.4	6.0	69.0	3.7	74.2	4.4
	F	56.9	4.2	58.1	1.0	58.3	2.2	65.1	4.6	66.8	1.0	66.6	1.2
Ar'-Go %	M	66.2	2.2	66.3	2.6	65.5	2.6	65.0	2.6	64.0	2.8	64.4	2.2
	F	66.1	1.8	65.0	1.8	67.8	2.7	63.8	1.0	63.0	1.6	65.7	3.9
Overbite mm	M	1.2	0.7	0.5	1.3	1.7	1.0	3.8	1.3	2.7	1.8	3.3	1.0
	F	1.6	0.8	1.2	1.1	1.9	1.5	3.1	1.3	2.4	2.0	3.4	0.5
		15 years						25 years					
N-Ans' mm	M	54.5	2.5	51.4	1.4	49.8	3.0	56.5	3.0	53.3	2.0	53.0	2.8
	F	48.2	2.0	48.7	1.1	46.7	1.9	49.1	2.5	49.7	1.0	47.6	2.1
N-Me mm	M	121.5	4.4	116.0	4.1	111.3	5.4	127.6	4.9	121.0	4.6	117.5	4.6
	F	109.3	6.7	111.0	2.2	105.1	2.0	113.0	5.1	113.9	2.7	108.1	2.4
N-Ans' %	M	44.9	2.2	44.3	1.3	44.7	1.4	44.3	2.8	44.1	1.6	45.1	1.5
	F	44.2	3.6	43.9	1.3	44.5	1.6	43.6	3.6	43.6	1.3	44.1	1.4
Ar'-Go mm	M	52.9	6.1	51.5	3.3	56.3	5.1	58.0	8.2	58.9	3.6	65.2	5.5
	F	46.1	3.5	46.1	1.7	51.0	4.3	47.7	3.6	48.4	1.9	53.7	4.8
S-Go mm	M	80.6	6.0	79.8	4.8	84.9	4.8	86.8	8.0	88.1	4.8	95.4	5.0
	F	72.0	5.1	73.2	1.2	75.5	2.4	74.2	4.5	75.8	1.9	78.6	2.8
Ar'-Go %	M	65.5	3.4	64.5	2.3	66.2	3.6	66.6	3.7	66.8	2.9	68.3	3.8
	F	64.0	2.0	63.0	2.0	67.5	4.3	64.3	3.2	63.8	2.1	68.2	4.8
Overbite mm	M	3.4	1.2	3.3	1.3	4.1	1.3	2.8	1.1	3.0	1.5	3.5	1.6
	F	3.8	1.1	2.0	1.8	3.2	1.5	3.5	1.6	3.1	1.5	3.3	2.0

LFT = Long face type. AFT = Average face type. SFT = Short face type.

 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

present findings emphasize the need for proper evaluation of longitudinal growth data to better comprehend the growth of the face.

The longitudinal comparisons provide a better understanding and a clearer description of the extent of the differences in the dentofacial relationships among the three normal facial types evaluated. It also indicates that, on the average, each facial type has certain dentofacial characteristics that need to be considered during the diagnosis and treatment planning of persons with malocclusions.

7. *Normal vs. extreme variation.* It should be emphasized that the present sample was composed of per-

sons with normal occlusion and skeletal relationship. The variation presented in this study therefore describes the range of normal relationships within such a population. Persons with more severe discrepancies (abnormally long or short faces) present with a more accentuated facial morphology that is easier to describe and even predict. In a recent study on the prediction of mandibular growth rotation on the basis of 4 morphologic variables, Skieller, Björk, and Linde-Hansen⁴¹ successfully predicted the mandibular rotation in 86% of their cases. But they stated that "As pointed out before, our statistical analysis was based on a sample that included several extreme cases. In a normal sample

Table XXVII. Descriptive statistics on the **incremental** changes for seven **vertical linear** facial parameters between 5 to 10, 10 to 15, 15 to 25, and 5 to 25 years of age for three facial types

Facial type parameter		Age period investigated											
		5 to 10 years						10 to 15 years					
		LFT		AFT		SFT		LFT		AFT		SFT	
		\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
N-Ans' mm	M	7.1	1.1	6.3	0.9	8.5	4.6	6.3	1.9	5.8	1.5	5.4	1.4
	F	6.4	0.8	6.7	1.6	5.2	1.6	4.0	1.5	2.7	0.8	3.9	1.1
N-Me mm	M	11.9	1.5	10.3	1.4	16.3	11.2	13.4	3.3	11.8	2.2	9.5	3.5
	F	11.0	1.6	11.8	2.1	8.7	4.1	7.8	1.6	7.5	1.9	9.4	3.1
N-Ans' %	M	1.8	1.0	1.8	0.9	4.0	5.7	0.3	0.8	0.6	1.0	1.1	0.8
	F	1.8	0.9	1.8	0.9	1.5	0.8	0.6	1.7	-0.5	0.6	-0.3	0.3
Ar'-Go mm	M	5.4	2.7	3.8	1.2	8.1	5.7	7.1	2.6	7.4	2.0	8.5	3.2
	F	3.9	2.0	4.3	1.0	4.3	1.3	4.6	1.8	4.0	1.1	7.2	1.3
S-Go mm	M	9.3	1.9	8.3	1.9	13.5	7.2	10.2	2.5	10.8	2.2	10.7	3.1
	F	8.2	2.5	8.7	1.6	8.3	1.2	6.8	1.6	6.4	0.6	8.9	1.7
Ar'-Go %	M	-1.1	2.5	-2.4	1.5	-1.1	2.9	-0.5	1.8	0.6	1.7	1.8	1.6
	F	-2.3	1.5	-2.0	0.8	-2.0	3.0	0.3	1.4	0	1.6	1.8	0.8
S-Go	M	2.7	1.1	2.2	1.5	1.6	0.7	-0.4	1.1	0.6	1.6	0.8	0.9
	F	1.5	1.3	1.2	2.8	1.5	1.2	0.7	0.6	-0.4	0.5	-0.2	1.1
		15 to 25 years						5 to 25 years					
N-Ans' mm	M	2.0	1.3	2.0	1.3	3.2	1.0	15.4	1.4	14.0	2.2	17.2	5.2
	F	0.9	1.0	0.9	0.2	0.9	0.5	11.3	2.3	10.5	2.0	10.0	1.0
N-Me mm	M	6.1	1.9	5.0	2.1	6.2	2.4	31.4	4.1	27.0	3.4	32.0	11.4
	F	3.7	1.9	2.9	0.8	3.0	0.5	22.5	0.9	22.1	2.6	21.1	1.9
N-Ans' %	M	-0.6	1.0	-0.2	0.6	0.4	0.5	1.6	0.8	2.2	1.9	5.5	6.1
	F	-0.7	0.3	-0.3	0.2	-0.4	0.4	1.7	1.9	1.0	1.7	0.8	0.6
Ar'-Go mm	M	5.0	2.8	7.4	3.2	8.9	3.7	17.5	5.4	18.6	3.5	25.5	7.9
	F	1.6	1.8	2.2	1.4	2.7	0.6	10.1	4.6	10.6	2.4	14.2	3.1
S-Go mm	M	6.2	2.4	8.3	3.2	10.5	3.6	25.7	3.5	27.4	3.8	34.7	6.9
	F	2.2	1.2	2.7	1.6	3.2	0.7	17.3	3.6	17.8	1.7	20.3	1.4
Ar'-Go %	M	1.1	1.3	2.3	1.7	2.0	1.4	0.4	3.9	0.5	2.3	2.7	4.8
	F	0.3	1.4	0.7	0.8	0.7	0.9	-1.6	3.8	-1.2	2.8	0.4	3.2
S-Go	M	-0.6	0.8	-0.3	0.6	-0.6	0.8	1.7	1.0	2.5	1.1	1.8	1.1
	F	-0.3	0.6	1.1	0.9	0	0.6	1.8	1.9	1.9	2.0	1.4	1.3

LFT = Long face type. AFT = Average face type. SFT = Short face type.
 \bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

moderate rotation may be difficult to classify according to the discussed features for prediction of mandibular growth. However, if one or more of these features are strongly developed in individual cases, they indicate that an extreme growth rotation of the mandible is going on."

With these facts in mind, the results of the stepwise regression and the discriminant analysis in this study compare favorably with those of Skieller et al.⁴¹

SUMMARY AND CONCLUSIONS

The findings in this investigation indicated the following:

1. Most persons (77%) have been categorized as having the same facial type at 5 years and 25.5 years of age—there is a strong tendency to maintain the original facial type with age.

2. Comparisons of the growth curves of the different parameters showed that the curves consistently demonstrated parallelism regardless of the facial type. On the other hand, comparisons of curve magnitudes revealed significant differences within the three facial types.

3. The persons within each facial type expressed a relatively large variation in the size and relationships of the various dentofacial structures.

Table XXVIII. Longitudinal comparisons of the absolute and incremental vertical linear facial parameters between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>						
N-Ans' mm M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(AFT)	S(AFT)	S(LFT)
N-Me mm M	NS	NS	NS	S(LFT)	S(AFT)	S(LFT)
F	NS	NS	NS	S(AFT)	S(AFT)	S(LFT)
$\frac{N-Ans'}{N-Me}\%$ M	NS	NS	NS	S(LFT)	NS	S(LFT)
F	NS	NS	NS	NS	NS	S(SFT)
Ar'-Go mm M	NS	NS	NS	S(LFT)	S(SFT)	S(SFT)
F	NS	NS	NS	NS	S(SFT)	S(SFT)
S-Go mm M	NS	NS	NS	NS	S(SFT)	S(SFT)
F	NS	NS	NS	S(AFT)	NS	S(SFT)
$\frac{Ar'-Go}{S-Go}\%$ M	NS	NS	NS	S(LFT)	S(SFT)	S(SFT)
F	NS	NS	NS	S(LFT)	S(SFT)	S(SFT)
Overbite mm M	NS	NS	NS	S(LFT)	S(SFT)	NS
F	NS	NS	NS	S(LFT)	S(SFT)	NS
<i>Incremental changes</i>						
N-Ans' mm M	NS	NS	NS	NS	S(SFT)	NS
F	NS	NS	NS	NS	NS	NS
N-Me mm M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
$\frac{N-Ans'}{N-Me}\%$ M	NS	NS	NS	NS	S(SFT)	S(SFT)
F	NS	NS	NS	NS	NS	NS
Ar'-Go mm M	NS	NS	NS	NS	S(SFT)	S(SFT)
F	NS	NS	NS	NS	S(SFT)	S(SFT)
S-Go mm M	NS	NS	NS	NS	S(SFT)	S(SFT)
F	NS	NS	NS	NS	NS	NS
$\frac{Ar'-Go}{S-Go}\%$ M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS
Overbite mm M	NS	NS	NS	NS	NS	NS
F	S	S	S	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

*Two aspects of the growth profile curves are presented—comparisons of growth parallelism and growth magnitude.

4. Significant differences in the dentofacial parameters were present between males and females with the same facial type. In addition, the differences within facial types were not identical in males and females.

5. Longitudinal analysis of the data lent more consistent and therefore more meaningful results than cross-sectional comparisons when facial growth trends required evaluation. This occurred because growth changes are often subtle and of magnitudes not readily observed when the data are evaluated cross-sectionally.

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Table XXIX. Descriptive statistics on the **absolute** and **incremental** data on **standing height** in centimeters for the four age periods investigated

Facial type parameter	Age period investigated											
	5 years						10 years					
	LFT		AFT		SFT		LFT		AFT		SFT	
	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD	\bar{x}	SD
<i>Absolute data</i>												
M	111.9	3.2	111.4	4.2	108.2	6.1	141.8	3.4	140.0	5.4	135.2	6.4
F	106.6	5.7	111.3	4.4	108.5	4.9	137.2	10.2	141.8	6.2	136.4	4.7
<i>15 years</i>												
<i>Absolute data</i>												
M	173.3	2.9	171.2	9.0	163.6	5.4	181.4	3.4	181.7	8.0	176.6	6.5
F	160.5	7.8	163.4	5.9	161.4	6.1	163.5	5.4	165.4	6.4	163.9	6.7
<i>5 to 10 years</i>												
<i>Incremental data</i>												
M	29.9	2.0	28.5	1.9	27.0	0.9	31.5	2.5	31.2	4.0	28.4	3.1
F	30.5	5.1	30.5	5.0	27.9	1.0	23.3	4.1	21.6	4.4	25.0	2.6
<i>15 to 25 years</i>												
<i>Incremental data</i>												
M	8.2	3.8	10.5	5.4	13.0	4.2	69.6	2.6	70.3	4.6	68.4	2.1
F	3.1	3.6	2.0	1.6	2.5	1.1	56.9	2.4	54.0	3.5	55.5	3.5

LFT = Long face type. AFT = Average face type. SFT = Short face type.

\bar{x} = Mean. SD = Standard deviation. M = Males. F = Females.

Table XXX. Longitudinal comparisons of the absolute and incremental data on **standing height** between 5 and 25 years of age for the three facial types*

Facial type parameter	Type of comparison					
	Curve parallelism comparison			Curve magnitude comparison		
	LFT vs AFT	AFT vs SFT	LFT vs SFT	LFT vs AFT	AFT vs SFT	LFT vs SFT
<i>Absolute changes</i>						
Height (cm) M	NS	NS	NS	NS	S(AFT)	S(LFT)
F	NS	NS	NS	S(AFT)	S(AFT)	NS
<i>Incremental changes</i>						
Height (cm) M	NS	NS	NS	NS	NS	NS
F	NS	NS	NS	NS	NS	NS

LFT = Long face type. AFT = Average face type. SFT = Short face type. Letters in brackets indicate which facial group is significantly larger.

NS = Not significant. S = Significant at $P \leq 0.05$. M = Males. F = Females.

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