A SERIAL CEPHALOMETRIC STUDY OF THE LONG AXES OF THE MANDIBULAR BICUSPID TEETH OF CHILDREN FROM EIGHT TO ELEVEN YEARS OF AGE

by

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Dentistry

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INTRODUCTION

During the period of the mixed dentition no single test or observation should be expected to provide sufficient evidence to justify the initiation of orthodontic treatment. A knowledge of the significance of the various angular relationships between the long axes of adjacent erupting bicuspid teeth, when used in conjunction with other predictive criteria, could be of value to the clinician who is interested in the early detection of developing malocclusions.

The purpose of this study was to observe and to compare the angular relationships of the long axes of the mandibular bicuspid teeth to each other in a group of elementary school children. Changes in the angular relationships of the bicuspid teeth between sexes and between right and left sides were studied at four different ages. Comparisons were made of the angular relationships in children with different types of dental occlusions. Skeletal and dental classification of the thirty-five children studied was based upon evaluations of lateral cephalograms and plaster record casts of the dentitions obtained when the children were approximately twelve years of age. The control and experimental groups had similar skeletal characteristics but different types of dental occlusions. The angles formed by the long axes of the mandibular bicuspid teeth were noted annually from eight to eleven years of age from tracings of oblique cephalograms.

An analysis of the data was made to determine if there were statistically significant differences in the angular measurements between children in the control and the experimental groups. Frequency and percentage distributions of the various angular arrangements were noted for age, sex, experimental and control groups.

REVIEW OF THE LITERATURE

Many reports of studies related to the development of the teeth and to the establishment of dental occlusion are found in the literature. The studies generally fall into two classes: those which deal with the development of the teeth themselves and those which are concerned with changes in the positions of the teeth relative to other structures. Only the literature pertaining to the active eruptive movements of the teeth will be considered here.

Reports of studies of the movements of the teeth during intrabony and intraoral eruption may be divided into the following types: those which deal with rates of eruption; those which deal with times of eruption and those concerned with sequences and paths or courses of eruption. This review is limited to reports of studies of the paths or courses of eruption of the teeth.

Sicher (1) has classified the movements of the developing teeth into several types, any combination of which may occur simultaneously.

I	Axial movement	A progressive movement in the direction of the long axis of the tooth.
II	Drifting movement	Bodily movement of a tooth parallel to itself.
III	Tilting movement	Rotation of a tooth around any one of its transverse axes.

IV Rotational movement Rotation of a tooth around its long axis.

The study to be reported here involves observations of the long axes of the mandibular bicuspid teeth in relation to each other, thus, it is concerned with the tilting movements noted by Sicher.

Massler and Schour (2) state that in using the term eruption, "we should confine ourselves strictly to migrations of the tooth." Weinman (3) agrees and elaborates by including all movements of the teeth prior to their appearance in the oral cavity; those movements associated with emergence of the teeth into the oral cavity, and those movements which occur after the teeth have reached the occlusal plane.

Broadbent (4) noted the, "tipping and shifting of the teeth as the face expands." He later described the eruptive movements of the mandibular third molar teeth and refers to measurements made to one-half degree, although his method of assigning long axes to the molar teeth is unclear.(5). Broadbent has related tooth movements to the cranial base area by orienting tracings of cephalograms with Bolton planes parallel and "r" points registered. He uses the term wiggle to describe the eruptive movements of the developing teeth as they are seen in animated motion pictures constructed from oriented tracings of lateral cephalograms (6).

Brodie (7) has presented a description of the eruptive courses of the mandibular molar teeth which differs from Broadbent's (5) concept. He states that, "If we dislocate the maxilla and the mandible from the cranium and study only tooth-jaw relations, we find

that eruption is in an almost vertical direction." In Brodie's study lines were established which represented the posterior and inferior borders of the mandible. From these lines perpendiculars were erected which intersected at the distal contact point of the mandibular first permanent molars.

Orban (8) wrote of the " . . . illusion of axial movement" of the mandibular first permanent molar teeth. He attributed the illusion to the growth of the mandible at its posterior border and to resorption at the anterior margin of the ramus which, ". . . allowed the molar to be uncovered."

Moss (9) recorded the mesial migration of the mandibular teeth by noting changes in the position of the apices of the roots relative to the center of the mental foramen. Estrada (10) and Murray (11) have also studied mesial and distal migrations of the teeth. Estrada described distal movements of the mandibular bicuspid teeth while Murray noted a variety of movements of the entire maxillary and mandibular dentitions.

Deinstein (11) has described the buccolingual angle of eruption of the mandibular molars in the rat. His study was based upon histological sections of rat mandibles.

The axial inclinations of the maxillary and mandibular permanent incisor teeth were studied by Noyes, Rushing and Sims (13). Several cephalometric analyses utilize measurements of axial inclinations of the incisor teeth relative to each other and to adjacent structures (14, 15, 16, 17). In such analyses long axes are assigned to the teeth by connecting the tips of the incisal edges and the apices

of the roots with a lines. The long axis line is later transferred to other tracings of cephalograms of the same child by superimposing the outlines of the teeth to be studied on each other. Through the use of various orientations and registrations of records, movements of the teeth may be demonstrated.

Kim, Shiere, and Fogels (18) have noted the variability between the axial inclinations of the mandibular bicuspid teeth relative to the occlusal plane in the following groups of children:

I Normal

II Those with asymmetric patterns of resorption of the roots of the primary molars

III Those with periapical pathological involvement of the primary teeth

IV Those with loss of mandibular first permanent molars prior to the eruption of the bicuspid teeth

The study was based upon periapical radiographs. It was noted that in children in Group IV the axial inclinations of the mandibular bicuspid teeth were markedly more distal than in the normal group. Groups I, II and III had inclinations of the first bicuspid teeth of eighty-eight degrees, indicating a slightly distal inclination in relation to the occlusal plane. The second bicuspid teeth were inclined at ninety-two degrees or slightly mesially. Rotations of the mandibular teeth were greater in Groups II, III and IV than in the control group.

A comparison of the findings of various investigators who have studied the migrations of the teeth reveals confusing and often

contradictory evidence. A wide range of materials have been used in studying the movements of the developing teeth. An even greater number of reference points, orientation-registrations of records and methods of measuring have been employed. A search of the literature has revealed no reports of serial studies in which the axial inclinations of the mandibular bicuspid teeth were related to each other in children with different types of dental occlusions. The study reported here represents an attempt to describe the changes in angular relationships between the long axes of the mandibular bicuspid teeth in males and females, on the right and left sides, at four different ages. The angular changes are also compared between children with different types of dental occlusions.

METHODS AND MATERIALS

All of the children studied were enrolled in the University of Michigan Elementary School Growth Study* which is based upon an Ann Arbor, Michigan elementary school population. The sample selected included only white children.

Sample selection was based upon an examination of the lateral cephalometric records made at approximately twelve years of age of all children enrolled in the Growth Study for whom the following records were available:

I Lateral cephalograms taken in occlusion at twelve years of age.

II Right and left oblique cephalograms at eight, nine, ten and eleven years of age.

III Plaster record casts of the dentition made from alginate impressions taken at approximately twelve years of age.

Lateral cephalograms and record casts made at ages later than twelve years were also studied when they were available.

Tables 1 and 2 in the Appendix contain the ages of the children when the various records were obtained.

The University of Michigan Cephalometric Templates (19) were used to estimate the skeletal status of each subject for whom appropriate records were available. The templates are specific for sex

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and for age and include means and one standard deviation limits for ages four through sixteen years in two year increments. The lateral cephalograms recorded at approximately twelve years of age were examined with the aid of the templates. The anteroposterior positions of A and B points were noted relative to the various age and sex standards. (Fig. 1).

To be included in the investigation all subjects were required to have A and B points fall within plus or minus one standard deviation of the mean for the same age standards, without regard for the chronological age of the child. It was thus possible for a twelve year old male to be included in the study when his A and B points fell within the limits stated for ten year old males on the template.

All of the children selected for study by this method were considered to have acceptable skeletal relations when compared to statistical norms which were derived from the same population of children (19). Children whose skeletal relations were beyond the one standard deviation limits in either direction were excluded from the study since it was desired to study children with malocclusions which were essentially dental in origin.

Tracings were made of the lateral cephalograms recorded at twelve years of age for those children who remained after the initial screening process was completed. The template analysis was repeated using tracings of the cephalograms instead of by direct observation of the cephalograms (Fig. 1).

Twenty females and sixteen males met the skeletal requirements established for the investigation.

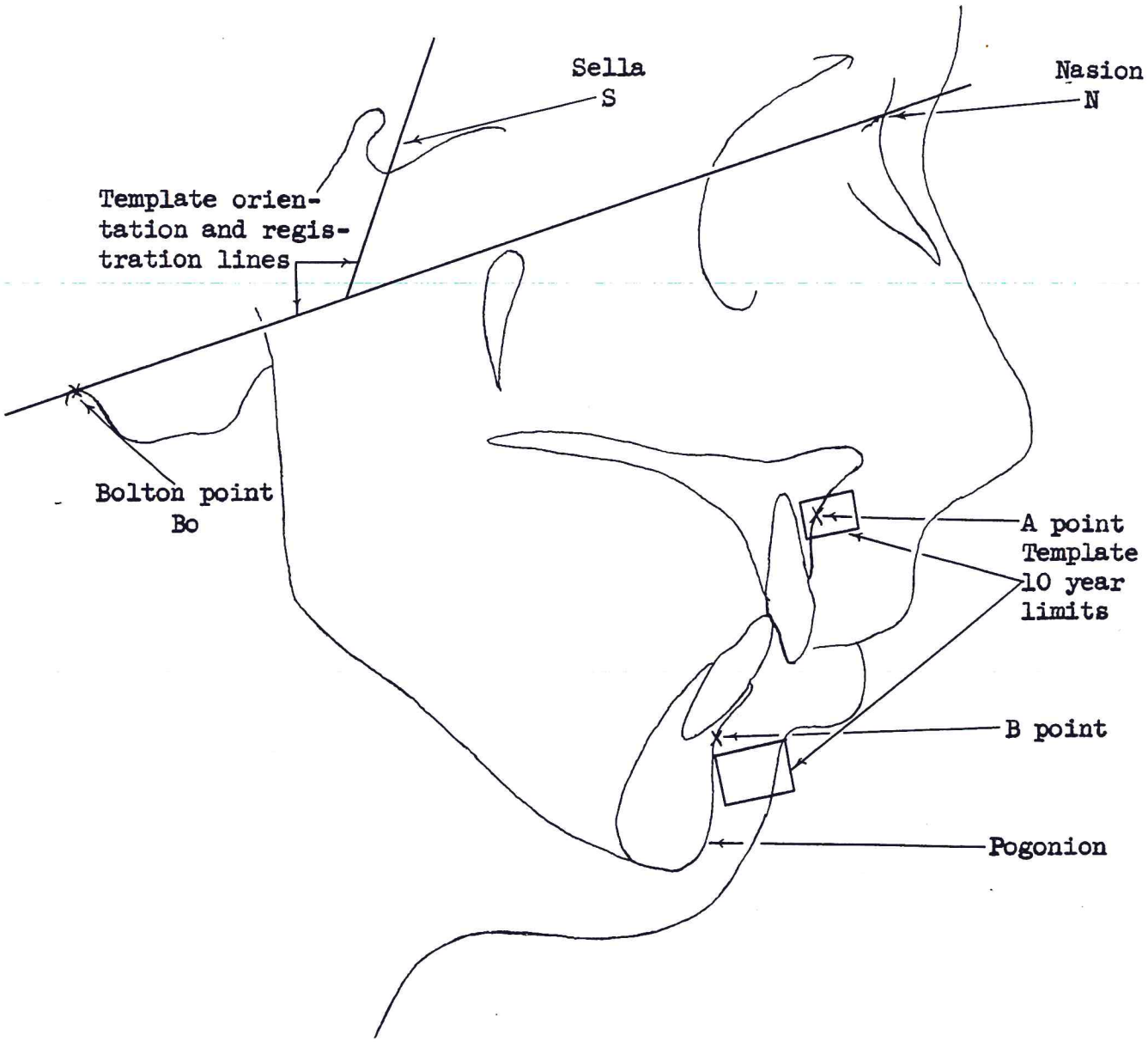


Fig. 1.--The rectangles adjacent to the maxillary and mandibular incisor teeth represent the plus or minus one standard deviation limits for A and B points for a specific chronological age. The subject illustrated would not be included in the study since B point does not fall within the required limits.

Additional measures of craniofacial skeletal relations were made using SNA, SNB, ANB, and NAP angular measurements. The land marks utilized for the angular measurements are illustrated by capital letters in Figure 1. The findings are presented in Table 2 in the Appendix.

Classification of the thirty-six children into control and experimental groups was based upon the dental characteristics of each child. Record casts of the dentition obtained at approximately twelve years of age were used for evaluating the dental occlusion.

A modification of the code method used at the Burlington Centre for Orthodontic Research (20) to classify dental characteristics, was employed in recording various features of the dental occlusion.

Code one is used to designate anterposterior denture relations as determined by the positions of the maxillary and the mandibular first permanent molar and cuspids teeth.

N Dental neutrocclusion

D Dental distocclusion, half cusp displacement

D+ Dental distocclusion, full cusp displacement

M Dental mesiocclusion, half cusp displacement

M+ Dental mesiocclusion, full cusp displacement

U Unilateral

Code two is used to indicate malpositions of the teeth which are not considered to be acceptable in good dental occlusions.

P1 Anterior crossbite

P2 Posterior crossbite with maxillary teeth to the lingual

P3 Upper incisor to lower incisor overjet exceeding four millimeters

P4 Overbite exceeding one-half the lower incisor crown

P5 Openbite exceeding one millimeter

P6 Open contacts between upper permanent teeth exceeding three millimeters

P7 Open contacts between lower teeth exceeding three millimeters

P8 Midline diastema exceeding two millimeters

P9 Crowding out of position one or more upper teeth where three millimeters or more of space is required for correction

P10 Crowding out of position of one or more mandibular teeth where three millimeters or more of space is required for correction

Code I-N, dental neutrocclusion, was the only characteristic of those noted which was permitted in the control group of children. Subjects whose record casts indicated that additional Code I or Code II characteristics were present were placed into the experimental group.

All subjects whose records indicated that there had been mutilation of the dentition due to caries or to extraction were eliminated from the study.

Verification of the skeletal and dental status of each child was made from records obtained at ages later than twelve years whenever such records were available. No modification of the original classification was indicated after examination of the later records.

The control group selected was composed of five females and five males. Fifteen females and eleven males were included in the experimental group.

Tracings of the mandibular first and second bicuspid teeth were obtained from right and left oblique cephalograms which were recorded at ages eight, nine, ten and eleven years.

The method used in this investigation for assigning long axis lines to tracings of the bicuspid teeth was selected after a preliminary study of the replication errors produced by using two different procedures.

Method A, in which long axis lines were assigned to each tracing of a bicuspid tooth independently, required the use of the template illustrated in Figure 2. The template was oriented over the tracing of each tooth so that line X was tangent to the most superior contour of the tooth when the long axis line, LA, approximately bisected the tooth into mesial and distal halves. The rulings at the ends of lines Y and Z were then used to further register the template so that the long axis line was equidistant from the mesial and distal contours at the levels of lines Y and Z. A sharpened instrument was then placed into the holes at each end of line LA and the marks produced on the tracing paper connected by a fine pencil line.

The resulting long axis line was considered to represent the long axis of the crown of each tooth.

In Method B long axis lines were assigned to the tracings of the bicuspid teeth at eight years of age as in Method A. The lines

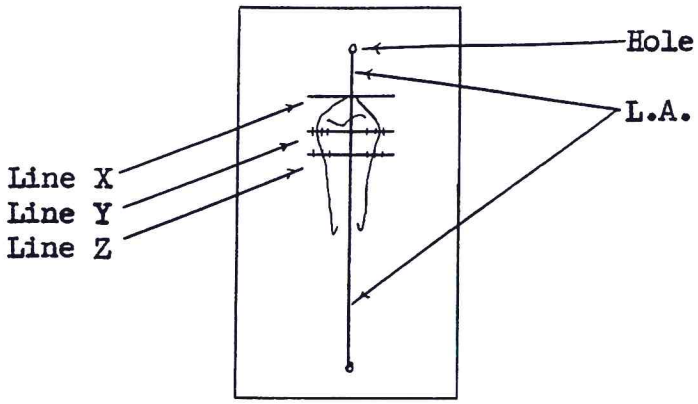


Fig. 2.--Template in place over tracing of an oblique cephalogram.

were then transferred to tracings of the teeth which were obtained at later ages by superimposing maximally the outlines of the crowns and drawing the axes assigned to the initial outlines on the later tracings.

A series of twenty-four tracings of oblique cephalograms were used to study replication errors with the two methods. Overlay tracing paper was placed over each of the original tracings and Method A was used to assign long axes to the bicuspid teeth. The procedure was repeated with Method B on a different day. After an interval of several days both procedures were repeated. The angles formed by the long axes of adjacent mandibular first and second bicuspid teeth were measured to the nearest one-half degree with a three inch protractor. Measurements obtained from the first and second trials with each method were compared. The differences were tested statistically to determine the magnitude of errors produced by the two methods and to determine if the differences between the errors produced by the two methods were statistically significant. The findings of the

statistical analyses are presented in Table 1.

TABLE 1

FINDINGS OF F TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN FIRST AND SECOND TRIALS WITH METHODS A AND B BETWEEN ERRORS AT 96 MONTHS OF AGE AND LATER AGES GROUPED

Groups	Method A Std. Dev. t_1-t_2	Method B Std. Dev. t_1-t_2	P
Between first and second trials at 96 months of age	5.46°	4.87°	>.05
Between first and second trials in the remaining ages grouped	2.37°	2.36°	>.05
P	<.01	<.02	

No statistically significant differences were noted between the errors produced by the two methods. The differences between the errors at age 96 months of age and those at the remaining age groups were statistically significant at the .01 and .02 levels of confidence for both methods. No statistically significant differences were noted between the errors on the right and left sides or between the sexes using F tests and the .05 level of confidence.

Method A was selected for use in the study since independent observations of angular relationships could be made without reference to serial records with accuracy comparable to that obtained with Method B.

An attempt was made to estimate the amounts of error which were contributed by the tracing procedure, by the method of assigning long axis lines to the teeth, and by the method of measuring angles.

The right and left oblique cephalograms which were recorded at 96, 108, 120 and 132 months of age were traced twice for three females and for three males. There were eight oblique cephalograms for each child in the error study. Long axis lines were assigned to the tracings of the bicuspid teeth twice for each tracing. Overlay tracing paper was used for the first long axis assignment. The second long axis assignment was made directly on the original tracings. Each angular measurement was made twice. Comparisons were made between:

1. The angular measurements on the two tracings of the same cephalogram
2. The first and second long axis assignments on the same tracing
3. First and second measurements of the same angles

TABLE 2

SUMMARY OF ERROR CONTROL STUDY

Source of error	Estimate of Error variance S^2
Measurement of angles	.027 degrees
Assignment of long axis lines	2.875 degrees
Tracing procedures	8.758 degrees
One standard deviation = 3.41°	(s^2_{m+a+t} = 11.66)

The findings of the error study indicate that the absolute

values of the angular measurements are accurate only within plus or minus 6.82 degrees, or within plus or minus two standard deviations. The findings of this error study are in agreement with those summarized in Table 1, which were obtained from a smaller sample. In the error study summarized in Table 2, forty-eight cephalograms were used. Since the ages were not considered separately in the second error study one would expect one standard deviation to fall between 2.37 and 5.46 degrees. The one standard deviation error, when all known sources of error in the study were considered, was 3.41 degrees.

In consideration of the experimental errors the data were grouped in the following manner:

I. DIVERGENT PATTERNS were those in which the long axis lines of adjacent bicuspid teeth intersected towards the apices of the teeth. To be included in the divergent group the absolute angular measurement was required to exceed 6.82 degrees. Such patterns were identified by the code letter d. When absolute measurements were used for statistical analyses the divergent angles were preceeded by a plus sign.

II. CONVERGENT PATTERNS were those in which the long axes of adjacent bicuspid teeth intersected towards the crowns of the teeth. To be included in the convergent group the absolute angular measurements were required to be greater than 6.82 degrees. Such patterns were identified by the code letter c. When absolute measurements were used for statistical analyses the convergent angles were preceeded by a minus sign.

III. PARALLEL PATTERNS were those in which the long axis lines of

adjacent bicuspid teeth intersected either apically or crownward of the teeth and the angular measurements were less than 6.82 degrees. Parallel patterns were identified by the code letter p. When absolute measurements were used for statistical procedures the appropriate plus or minus sign was prefixed, depending upon the direction of the intersection of the long axes. When absolute measurements of angles were zero, i.e., parallel long axis lines, no signs were used.

The coding procedure is illustrated in Figure 3.

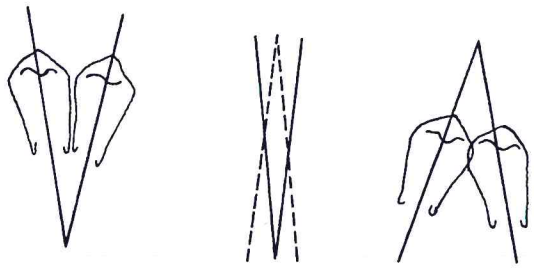


Fig. 3.--Illustration of the method used in assigning code letters to the patterns formed by the long axes of the bicuspid teeth.

FINDINGS

The data are presented in two ways: (1) in coded form, taking into account the experimental errors which were estimated, and (2) in terms of the values of the absolute angular measurements. The discussion of the coded data is descriptive while the values of the absolute measurements have been utilized in statistical analyses.

Data in Code Form

The angles formed by the long axes of adjacent mandibular bicuspid teeth are listed in coded form in Table 3. The frequencies of convergent, divergent and parallel patterns in the male and female groups are listed in Table 4. The same frequencies are expressed in percentage form in Table 5.

The percentage distribution of c, d and p patterns in males and females are illustrated in figure 4. A higher percentage of parallel patterns was observed in males than in females at all ages except on the left sides at 120 months of age. A higher percentage of divergent patterns was noted in females than in males at all ages and on both the right and left sides. Convergent patterns were observed more frequently in females than in males at all ages except 120 months.

The line graphs in figure 5 illustrate the differences between the percentage distribution of c, d and p patterns on the right and left sides.

The patterns for males and females, right and left sides were

TABLE 3

ANGULAR PATTERNS FORMED BY THE LONG AXES OF THE MANDIBULAR BICUSPID TEETH IN CHILDREN FROM EIGHT TO ELEVEN YEARS OF AGE

	Identification Number	Age in months: 96 R	96 L	108 R	108 L	120 R	120 L	132 R	132 L
		CONTROL GROUP							
	FEMALE								
	118	d	d	d	d	d	d	d	d
	119	d	p	d	p	d	p	p	p
N=5	111	d	p	d	c	p	p	c	c
	112	p	c	p	p	d	c	p	c
	125	c	c	c	c	c	c	c	c
	MALE								
	217	p	p	p	p	p	c	p	c
	210	p	p	p	p	p	p	p	p
N=5	212	c	p	c	c	c	c	c	c
	203	p	p	p	p	p	p	c	p
	220	p	p	p	p	c	p	c	p
		EXPERIMENTAL GROUP							
	FEMALE								
	120	p	c	c	c	c	p	p	d
	107	c	c	c	c	c	c	c	c
	114	p	p	p	c	p	p	c	p
	105	p	c	p	c	p	c	p	p
	103	p	c	p	c	p	c	p	c
	104	d	d	d	d	d	d	d	d
	109	c	c	c	c	c	p	c	c
N=15	108	c	p	c	c	c	p	c	p
	117	d	d	d	d	d	d	d	p
	102	p	d	c	c	c	p	c	c
	110	p	d	p	c	p	c	c	c
	101	p	p	p	p	p	p	p	p
	123	p	c	c	p	c	c	c	c
	122	p	c	c	c	p	c	p	c
	121	p	c	p	c	p	c	p	c
	MALE								
	215	c	p	p	p	c	c	p	c
	219	p	c	c	c	p	c	p	p
	204	c	p	p	c	c	c	c	c
	208	d	p	d	p	p	p	d	p
	207	p	p	d	p	p	p	p	p
N=11	206	p	p	p	p	c	c	c	c
	205	p	p	p	p	p	c	p	p
	213	d	d	d	d	p	d	p	p
	209	p	p	p	p	p	c	d	p
	214	c	c	p	p	c	c	c	c
	201	p	p	p	c	d	p	p	p

TABLE 4

NUMERICAL FREQUENCIES OF c, d AND p PATTERNS

Age in Months	Right			Left		
	c	d	p	c	d	p
			Females			
96	4	5	11	10	5	5
108	8	5	7	13	3	4
120	8	5	7	8	3	9
132	10	3	7	10	3	7
			Males			
96	4	2	10	2	1	13
108	2	3	11	4	1	11
120	6	1	9	9	1	6
132	6	2	8	6	0	10

TABLE 5

PERCENTAGE DISTRIBUTION OF c, d and p PATTERNS

Age in Months	Right			Left		
	c	d	p	c	d	p
			Females			
96	20.0	25.0	55.0	50.0	25.0	25.0
108	40.0	25.0	35.0	65.0	15.0	20.0
120	40.0	25.0	35.0	40.0	15.0	45.0
132	50.0	15.0	35.0	50.0	15.0	35.0
Total	37.5	22.5	40.0	51.2	17.5	31.2
			Males			
96	25.0	12.5	62.5	12.5	6.3	81.2
108	12.5	18.7	68.7	25.0	6.3	68.7
120	37.5	6.3	56.2	56.2	6.3	37.5
132	37.5	12.5	50.0	27.5	0.0	62.5
Total	28.1	12.5	59.3	32.8	4.6	62.5

pooled. The numerical and percentage distributions are listed in Table 6. The percentages are plotted for all subjects with right and left sides pooled in figure 6.

Convergent patterns accounted for thirty-eight per cent of all of the coded patterns while parallel patterns were noted in forty-seven

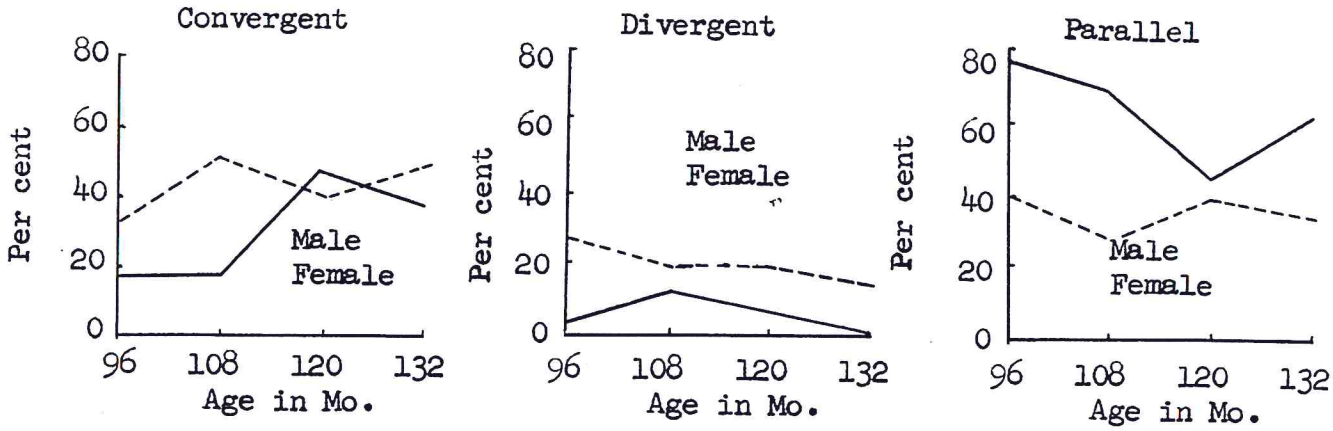


Fig. 4.--Percentage distributions of c, d and p patterns in males and females.

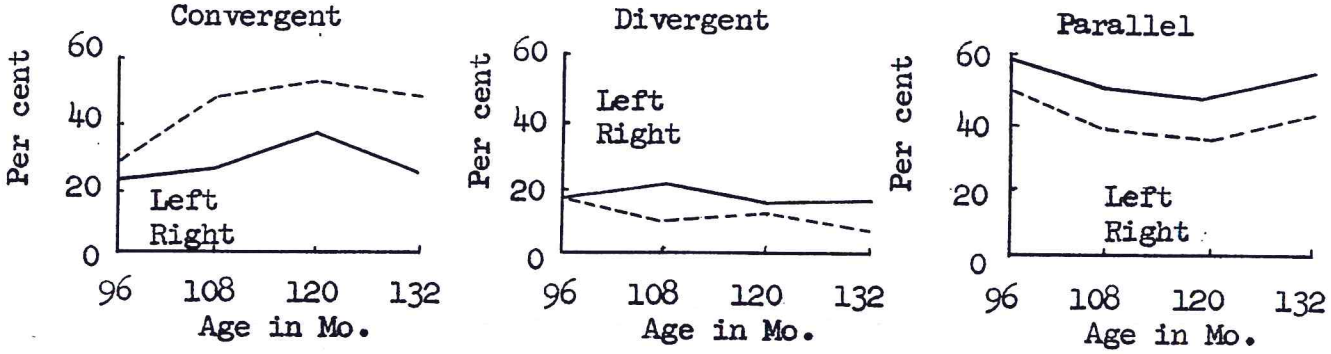


Fig. 5.--Percentages of c, d and p patterns on the right and left sides. Males and females have been grouped. The right-left differences, illustrated in figure 5, indicate that there were no great differences in the frequency of c, d and p patterns between the right and the left sides.

TABLE 6

FREQUENCIES OF ALL ANGULAR PATTERNS

Age in Months	Angular Patterns					
	c	c%	d	d%	p	p%
96	20	28	13	18	39	54
108	27	37	12	17	33	46
120	31	43	10	14	31	43
132	32	44	88	11	32	45
Total	110	38%	43	15%	136	47%

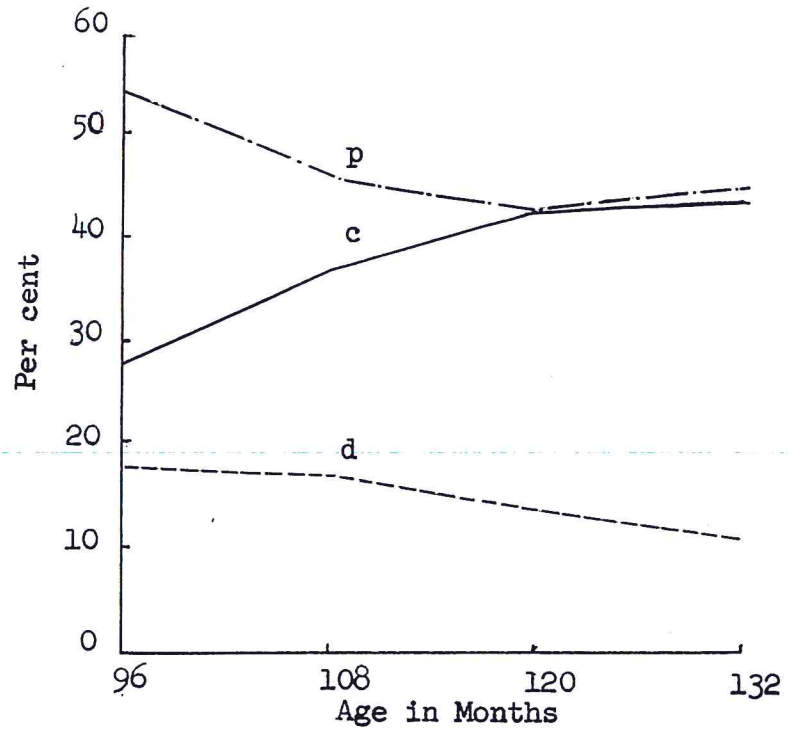


Fig. 6.--Percentage distribution of all patterns. Males and females, right and left sides pooled.

per cent of the observations. Convergent patterns tended to increase in number through time. Parallel patterns and divergent patterns were observed less frequently as age increased. Only fifteen per cent of all patterns observed were classified as divergent.

The data (Table 7) were examined to determine the frequency of right-left symmetry and asymmetry of patterns using the c, d and p code designations. The percentage distributions of symmetry and of asymmetry are summarized in Table 8. The percentage distribution of right-left symmetry of angular patterns in males and females are illustrated in figure 7. The data indicate that there was more right-left symmetry of patterns in males than in females. Approximately one-half of the female subjects had right-left symmetry of patterns while approximately sixty-six per cent of the males had right-left symmetry. In the male group there was slightly greater percentage of symmetry at 96 and 108

TABLE 7

FREQUENCY OF R-L SYMMETRY AND ASYMMETRY OF c, d AND p PATTERNS IN MALES AND FEMALES

Age in Months	R-L Symmetry				R-L Asymmetry			
	c c	d d	p p	Total	c c	d d	p p	Total
				FEMALES				
96	3	3	2	8	0	4	8	12
108	7	3	2	12	1	1	6	8
120	3	3	3	9	1	1	9	11
132	7	3	2	12	0	2	6	8
Total	20	11	10	41	2	8	29	39
				MALES				
96	1	1	9	11	0	1	4	5
108	2	1	9	12	0	2	2	4
120	5	0	4	9	0	2	5	7
132	4	0	6	10	0	2	4	6
Total	12	2	28	42	0	7	15	22

TABLE 8

PERCENTAGE DISTRIBUTION OF RIGHT-LEFT SYMMETRY OF ANGULAR PATTERNS

Age in Months	Males		Females	
	Symmetry	Asymmetry	Symmetry	Asymmetry
96	68%	32%	40%	60%
108	75	25	60	40
120	56	44	45	55
132	62	38	60	40
Total	66%	34%	51%	49%

months of age than at 120 and 132 months of age. In the female group the percentages of symmetry at 96 and 108 months of age were essentially the same as at ages 120 and 132 months.

The frequency of right-left symmetry of angular patterns in the experimental and control groups is summarized in Table 9.

The differences between the frequencies of right-left symmetry

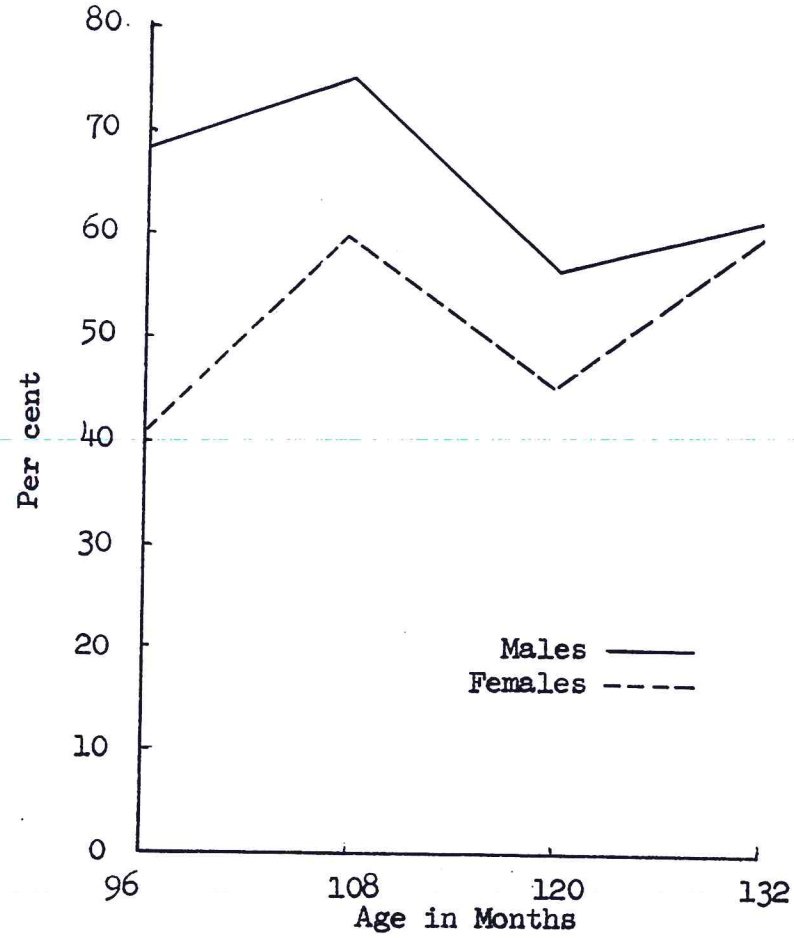


Fig. 7.--Percentage distribution of right-left symmetry of angular patterns in males and females.

TABLE 9

FREQUENCY OF RIGHT-LEFT SYMMETRY IN EXPERIMENTAL AND CONTROL GROUPS

Age in Months	Symmetric Patterns				Asymmetric Patterns			
	c c	d d	p p	Total	c c	d d	p p	Total
				Control				
96	1	1	4	6	0	2	2	4
108	2	1	5	8	1	1	0	2
120	2	1	3	6	1	1	2	4
132	3	1	2	6	0	0	4	4
Total	8	4	14	26	2	4	8	14
				Experimental				
96	3	3	7	13	0	3	10	13
108	7	3	6	16	0	2	8	10
120	6	2	4	12	0	2	12	14
132	8	1	7	16	0	4	6	10
Total	24	9	24	57	0	11	36	47

of angular patterns in the experimental and control groups are presented graphically in figure 8. It may be noted that, in general, there was a higher percentage of right-left symmetry in the control group than in the experimental group. The greatest difference between the two groups was noted at 108 months of age.

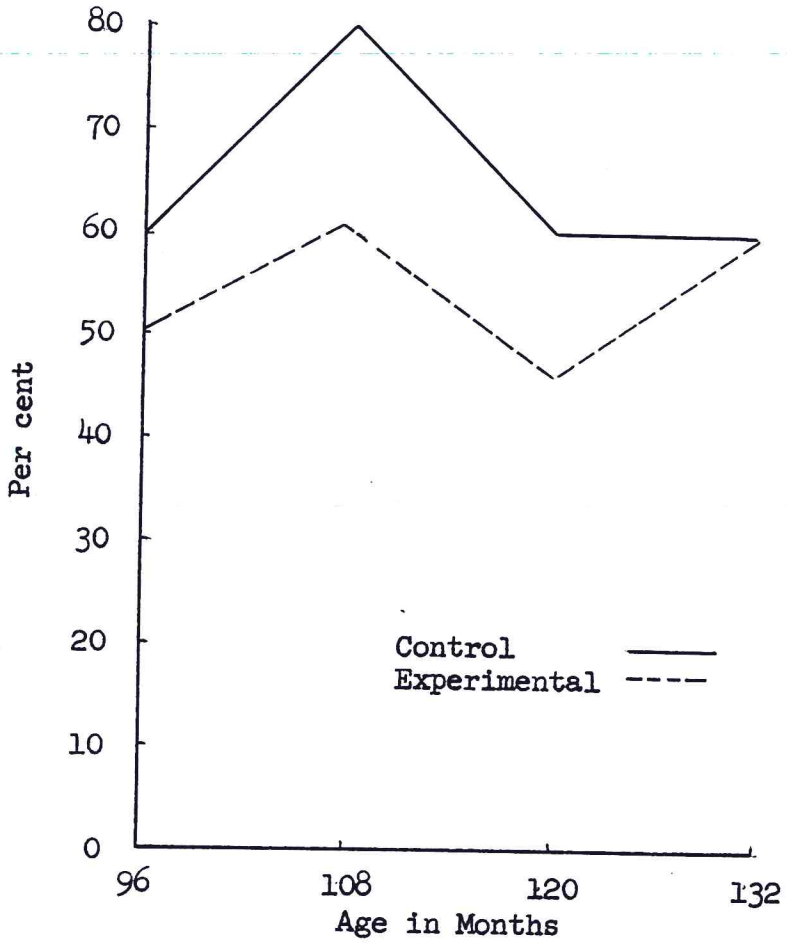


Fig. 8.--Percentages of right-left symmetry in the experimental and control groups.

Since the sample sizes are small and unequal for the various groups and sub-groups, the percentage distributions and their line plots should be interpreted with caution. Examination of Table 3 reveals that subjects number 118, 119, 111, 104, 117 and 213 contributed approximately seventy-five per cent of all of the divergent patterns

noted throughout the study. Male subject number 213 contributed forty-five per cent of the divergent patterns noted in the male group.

Absolute Angular Measurements

The line graphs in figures 9 through 24 are based upon means which were derived from the absolute angular measurements of the angles between the long axes of adjacent mandibular first and second bicuspid teeth. Students' "t" tests were used to determine whether or not the differences in angular measurements between the various groups of children were statistically significant. Probability levels greater than .05 were considered to indicate that no statistically significant difference existed between the measurements in the groups tested.

Each graph line is followed by a table which contains a summary of the findings of the statistical tests. Sample means, "t" values, the number of degrees of freedom and the probability levels are included for each statistical test. Significant differences between groups are indicated on the line graphs by asterisks (*). The asterisks appear above the age designation and between the two line plots between which there is a statistically significant difference.

The data for males and for females were pooled and the angular measurements from the right sides were compared to those from the left sides. There was a statistically significant difference between the angular measurements on the right and left sides at ninety-six months of age. No statistically significant differences were noted between the right and left angular measurements in the remaining age groups. Figure 9 and Table 10 indicate that the mean angular measurements tend to become more convergent with increasing age of the subjects.

The angular measurements from the male subjects were compared to those from the female subjects. The data from the right and left sides were pooled. No statistically significant differences were noted between the angular measurements from the male and the female groups at any of the four ages studied. (Figure 10 and Table 11).

Mean angular measurements from the left sides were compared between males and females. Similarly, mean angular measurements from the right sides were compared between males and females. The information in Tables 12 and 13 indicate that there were no statistically significant differences between any of the groups at any of the ages studied.

The right-left differences between the angular measurements within each sex was considered. No statistically significant differences were noted in the male group (Table 14, figure 13). A statistically significant difference was noted between the angular measurements from the right and left sides in the female group at ninety-six months of age (Table 15, figure 14).

The data for children in the experimental group were separated from those of children in the control group. Subgroups were composed of males and females, right and left sides and the four ages at which observations were made. The means of the angular measurements for the various groups and subgroups are included in Tables 17 through 26. The line plots in figures 15 through 24 are also based upon the means of the angular measurements for the various groups. Ten intergroup and intragroup tests were made for statistically significant differences between the angular measurements of each group. Table 16 contains a list of the groups between which analyses were made.

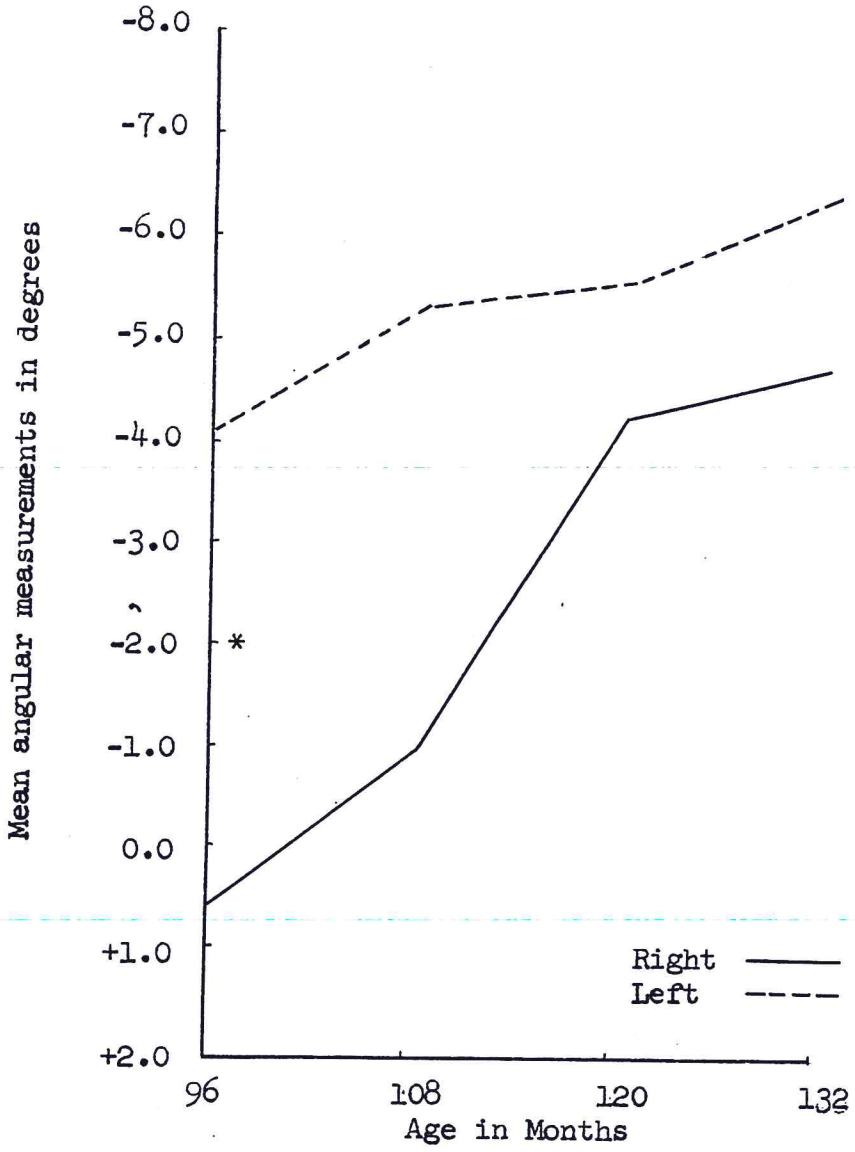


Fig. 9.--Mean angular measurements on the right and left sides.

TABLE 10

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT AND LEFT SIDES

Age in Months	Right $\bar{X}$ N=36	Left $\bar{X}$ N=36	"t" Value	d.f.	P
96	+0.500	-4.08	2.002	70	<.05
108	-0.916	-5.305	1.755	70	>.05
120	-4.18	-5.527	.547	70	>.05
132	-4.690	-6.375	.678	70	>.05

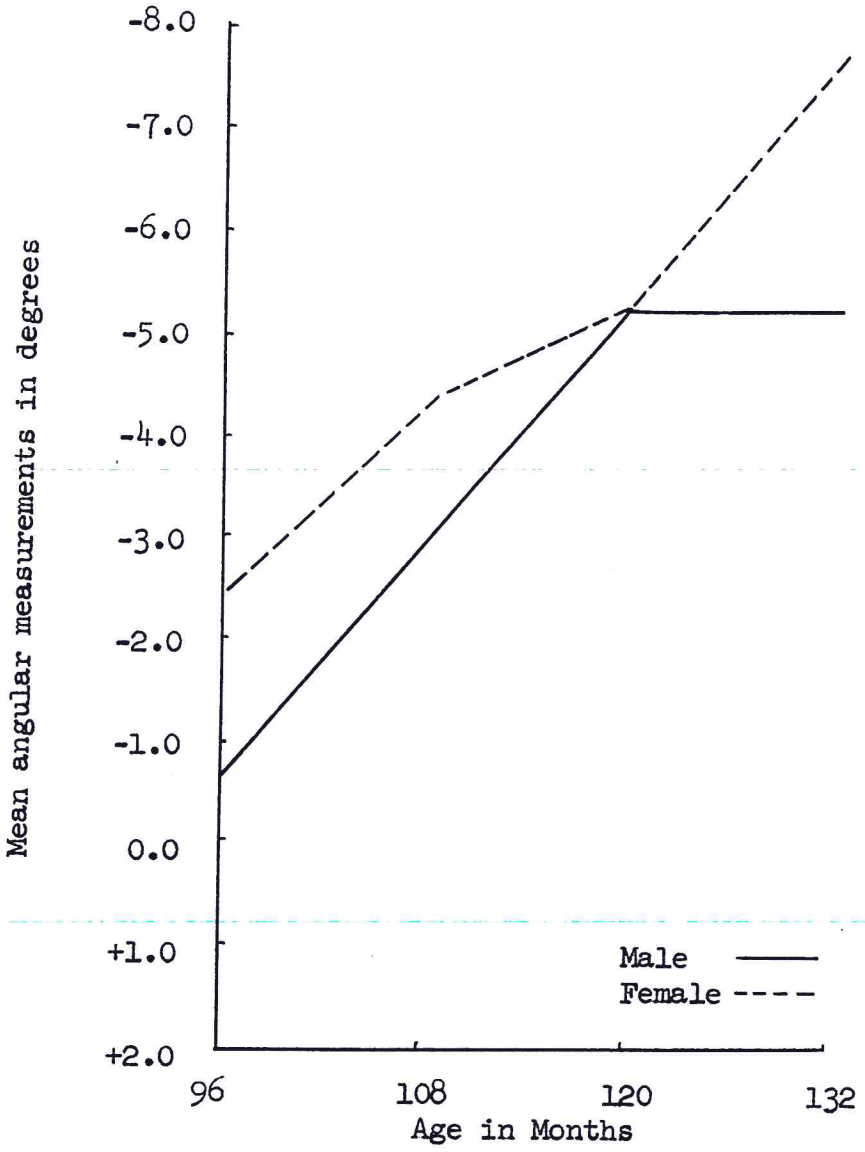


Fig. 10.--Mean angular measurements in males and females

TABLE 11

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES FOR MALES AND FEMALES

Age in Months	Male $\bar{X}$ N=32	Female $\bar{X}$ N=40	"t" Value	d.f.	P
96	-2.450	-0.560	.739	70	>.05
108	-4.240	-2.810	.806	70	>.05
120	-5.130	-5.220	.021	70	>.05
132	-7.560	-5.125	.675	70	>.05

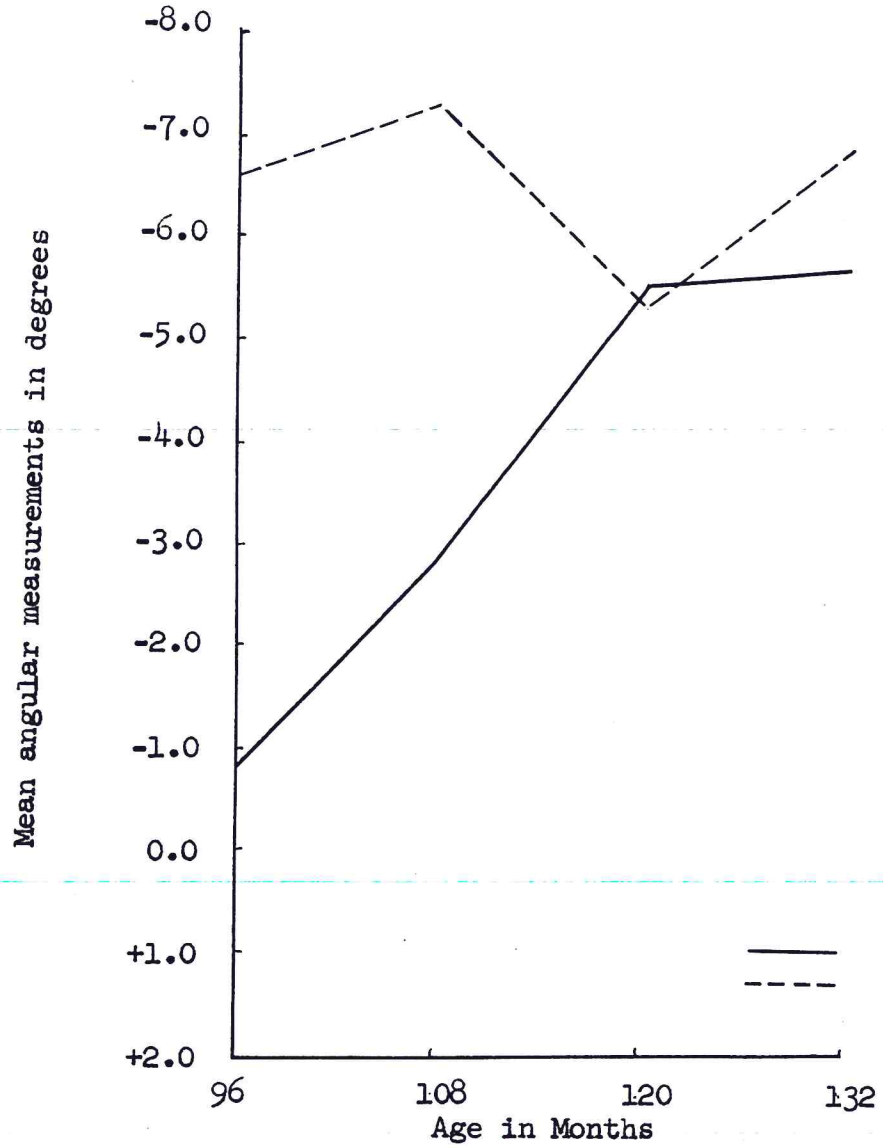


Fig. 11.--Mean angular measurements on the left sides in males and females.

TABLE 12

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE LEFT SIDES IN MALES AND FEMALES

Age in Months	Female $\bar{X}$ N=20	Male $\bar{X}$ N=16	"t" value	d.f.	P
96	-6.700	-0.812	1.854	34	>.05
108	-7.350	-2.750	1.455	34	>.05
120	-5.380	-5.750	.107	34	>.05
132	-6.85	-5.781	.337	34	>.05

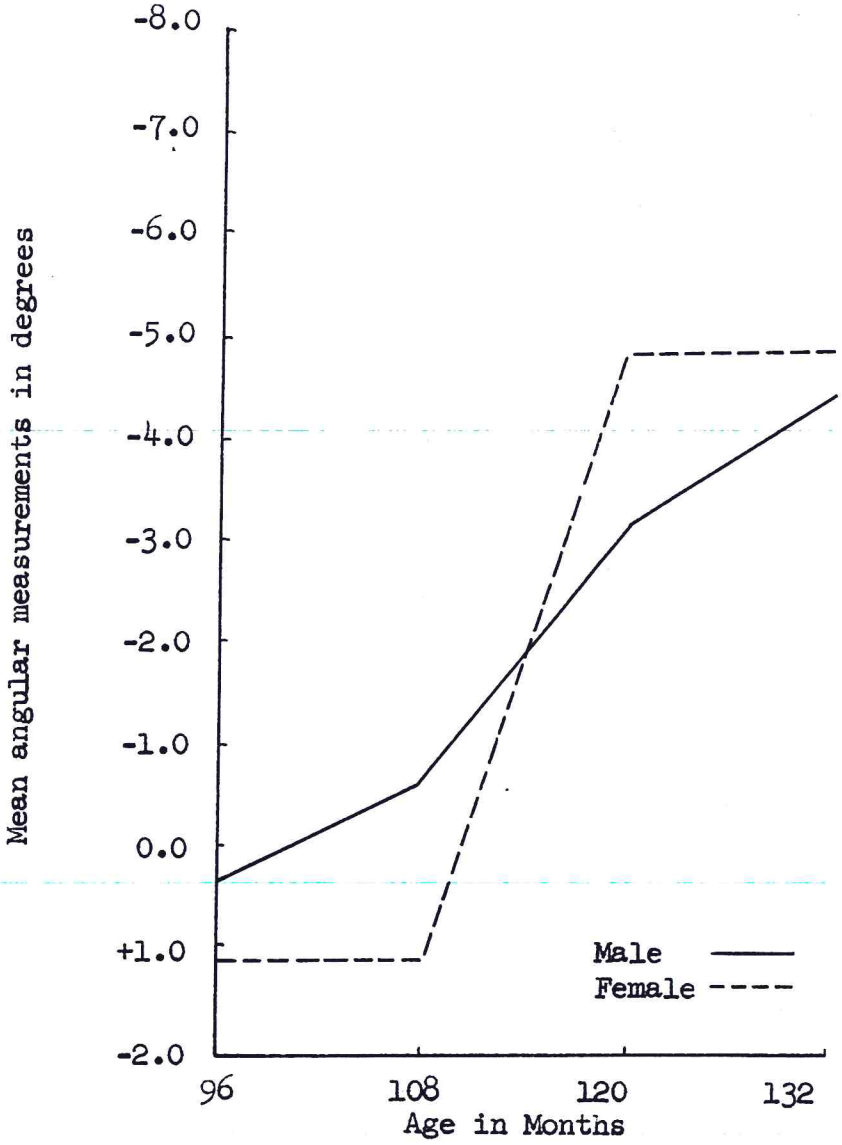


Figure 12.--Mean angular measurements on the right sides in males and females.

TABLE 13

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT SIDES IN MALES AND FEMALES

Age in Months	Female $\bar{X}$ N=20	Male $\bar{X}$ N=16	"t" value	d.f.	P
96	+1.125	-0.312	.438	34	>.05
108	-1,125	-0.677	.100	34	>.05
120	-4.900	-3.218	.459	34	>.05
132	-4.875	-4.468	.101	34	>.05

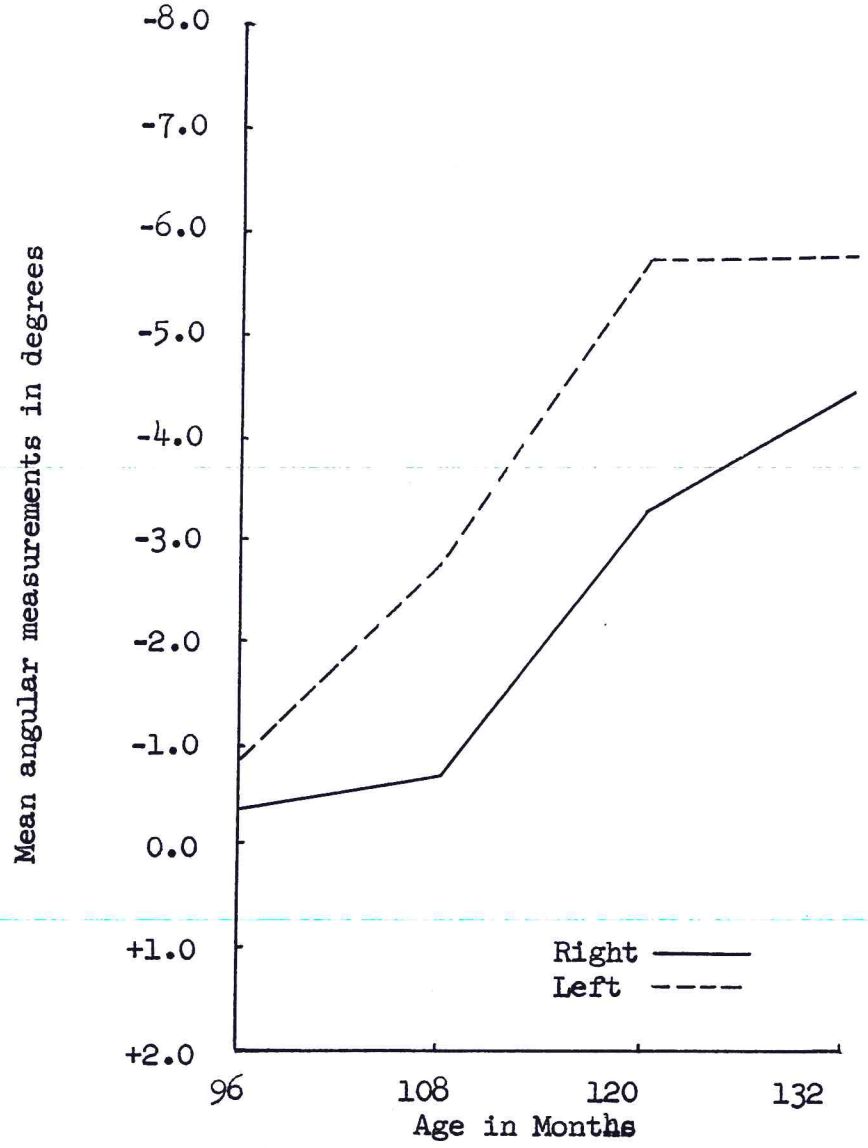


Fig. 13.--Mean angular measurements on the right and left sides in males.

TABLE 14

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT AND LEFT SIDES IN MALES

Age in Months	Right $\bar{X}$	Left $\bar{X}$	Male "t"	d.f.	P
96	-.312	-.812	.204	30	>.05
108	-.687	-2.750	.787	30	>.05
120	-3.218	-5.750	.948	30	>.05
132	-4.468	-5.781	.473	30	>.05

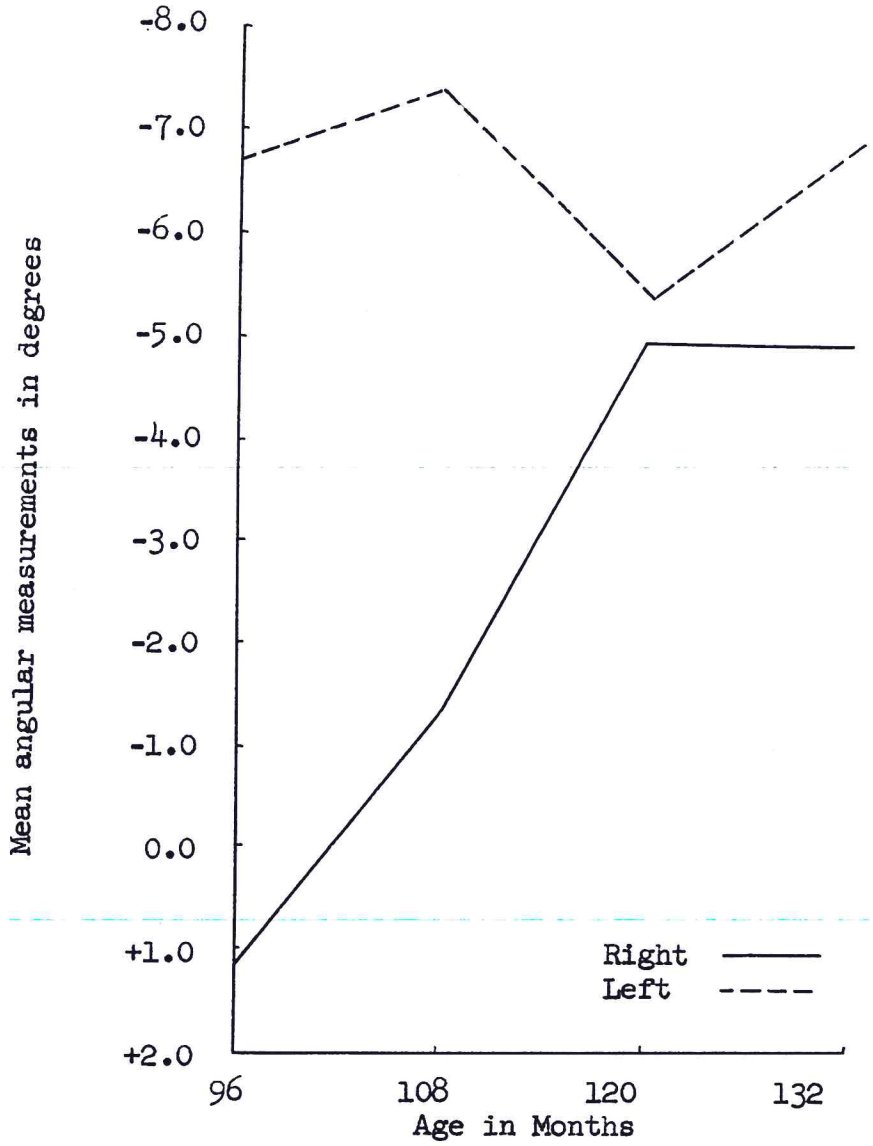


Fig. 14.--Mean angular measurements on the right and left sides in females.

TABLE 15

FINDINGS OF "t" TESTS FOR SIGNIFICANCE DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT AND LEFT SIDES IN FEMALES

Age in Months	Right $\bar{X}$ N=20	Left $\bar{X}$ N=20	"t" value	d.f.	P
96	+1.125	-6.700	2.059	38	>.05
108	-1.125	-7.350	1.550	38	>.05
120	-4.900	-5.380	.120	38	>.05
132	-4.875	-6.850	.500	38	>.05

TABLE 16

GROUPS COMPARED

Group	tested against	Group
Male control		Male experimental
Female control		Female experimental
Male right control		Female right control
Male left control		Female left control
Right control (Sexes pooled)		Left control (Sexes pooled)
Male right experimental		Female right experimental
Male left experimental		Female left experimental
Right experimental (Sexes pooled)		Left experimental (Sexes pooled)
Right control (Sexes pooled)		Right experimental (Sexes pooled)
Left control (Sexes pooled)		Left experimental (sexes pooled)

None of the differences noted between or within the control and the experimental groups were statistically significant. The means plotted in figures 15 through 24 indicate that, except in the female left experimental group, all terminal means were higher on the convergent scale than the initial means, indicating greater convergence of the long axes of the mandibular bicuspid teeth at 132 months of age than at 96 months of age.

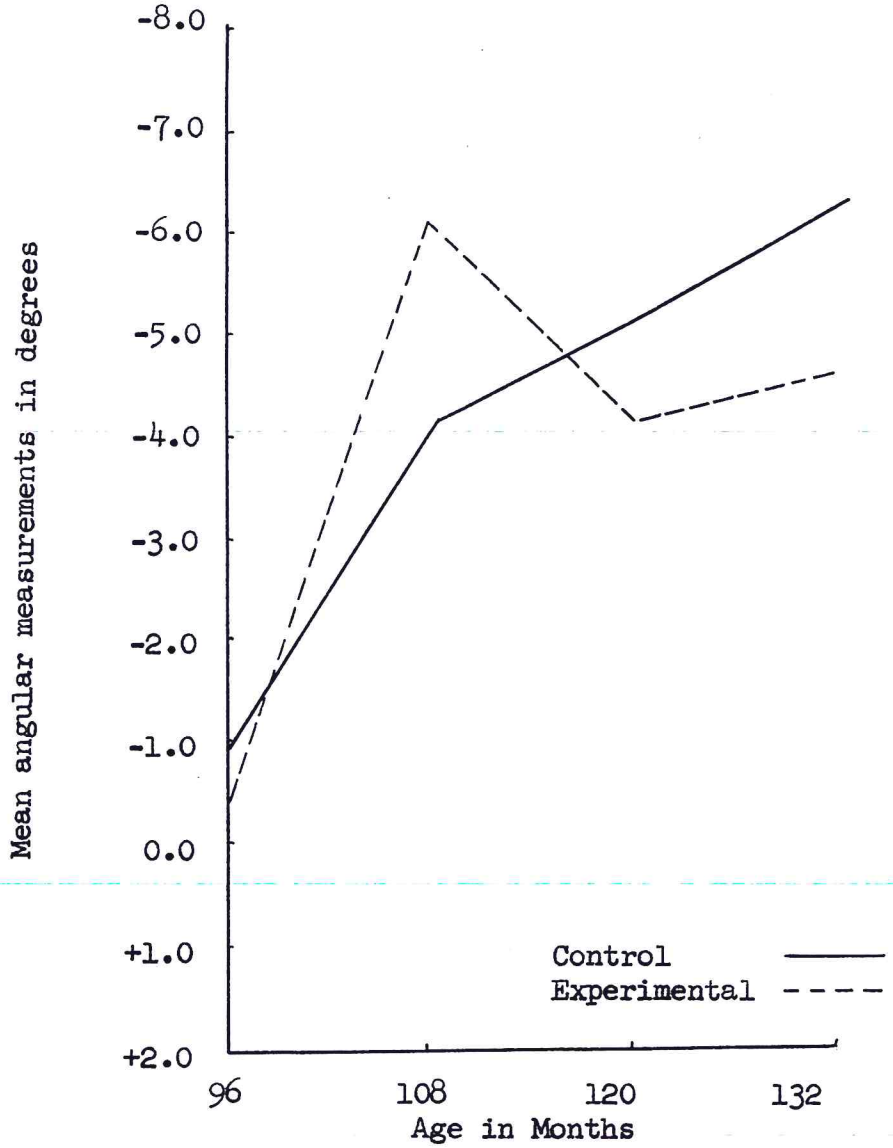


Fig. 15.--Mean angular measurements in males in the experimental and control groups.

TABLE 17

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES IN EXPERIMENTAL AND CONTROL MALES

Age in Months	Control $\bar{X}$ N=10	Experimental $\bar{X}$ N=22	"t" Value	d.f.	P
96	-0.950	-0.387	.215	30	>.05
108	-4.150	-0.610	1.269	30	>.05
120	-5.200	-4.180	.346	30	>.05
132	-6.250	-4.610	.551	30	>.05

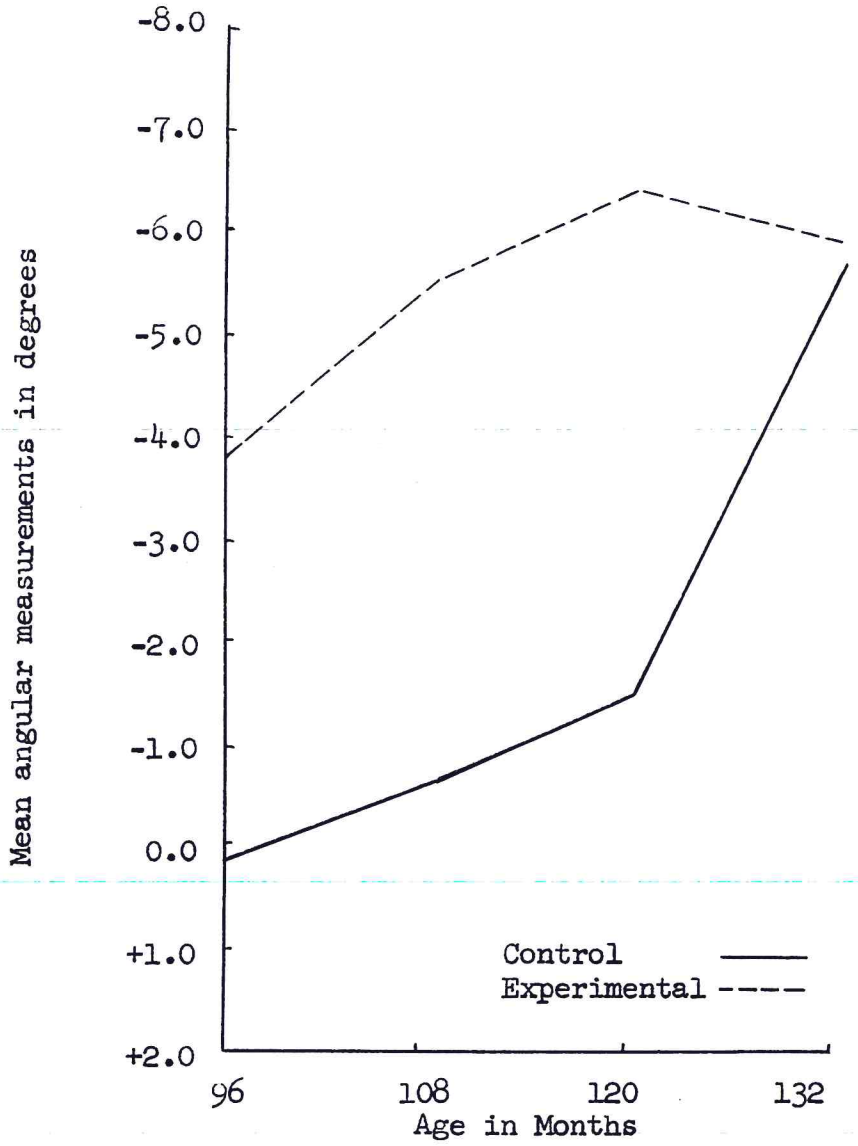


Fig. 16.--Mean angular measurements in females in the experimental and control groups.

TABLE 18

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES IN THE CONTROL AND EXPERIMENTAL FEMALES

Age in Months	Control $\bar{X}$ N=10	Experimental $\bar{X}$ N=30	"t" Value	d.f.	P
96	+0.150	-3.900	.934	28	>.05
108	-0.555	-5.470	1.040	28	>.05
120	-1.450	-6.370	1.098	28	>.05
132	-5.700	-5.920	.047	28	>.05

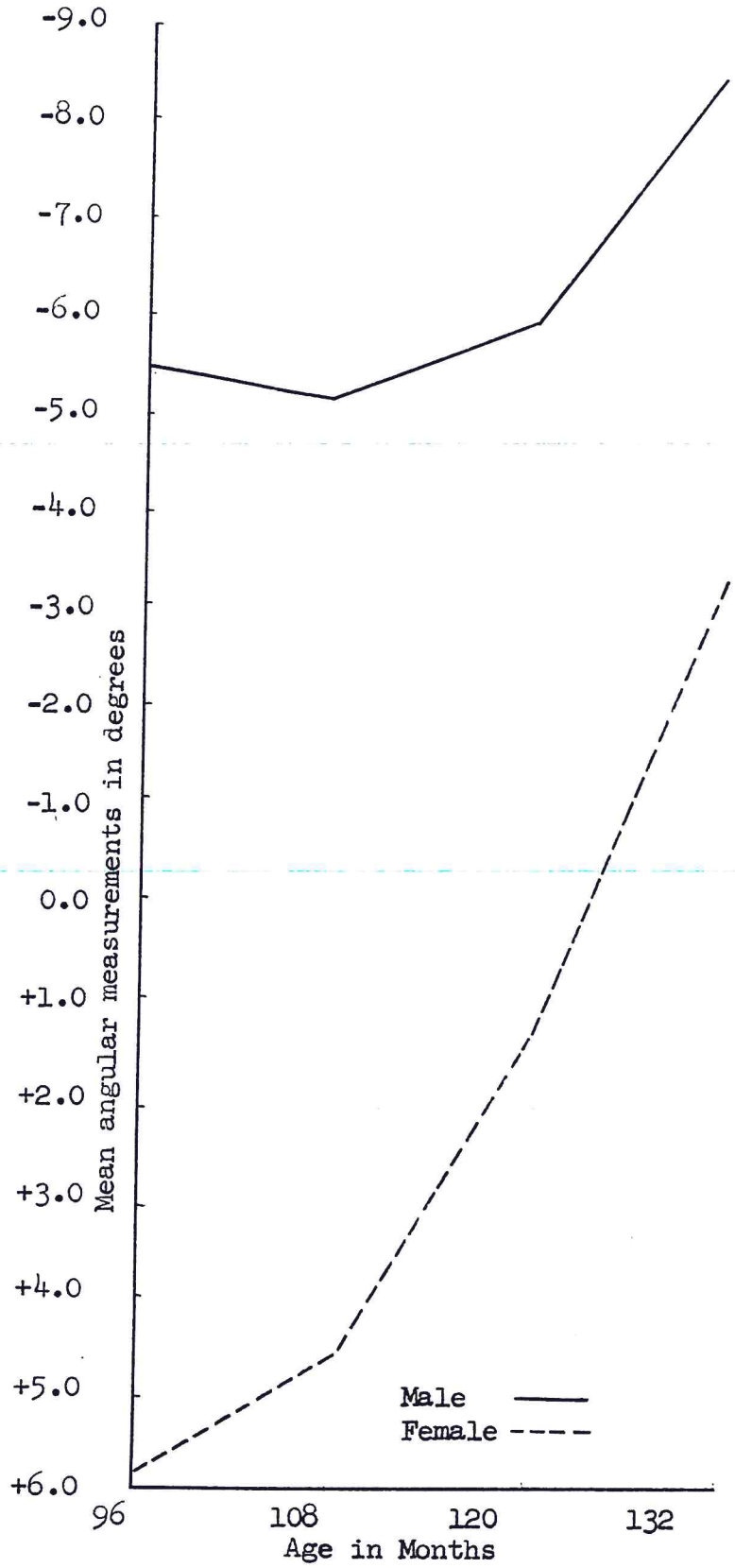


TABLE 19

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT SIDES FOR MALES AND FEMALES IN THE CONTROL GROUP

Age in Months	Male $\bar{X}$ N=5	Female $\bar{X}$ N=5	"t" Value	d.f.	P
96	-5.500	+5.900	1.537	8	>.05
108	-5.200	+4.700	1.687	8	>.05
120	-5.900	+1.600	.915	8	>.05
132	-8.500	-3.100	.874	8	>.05

Fig. 17.--Mean angular measurements on the right sides for males and females in the control group.

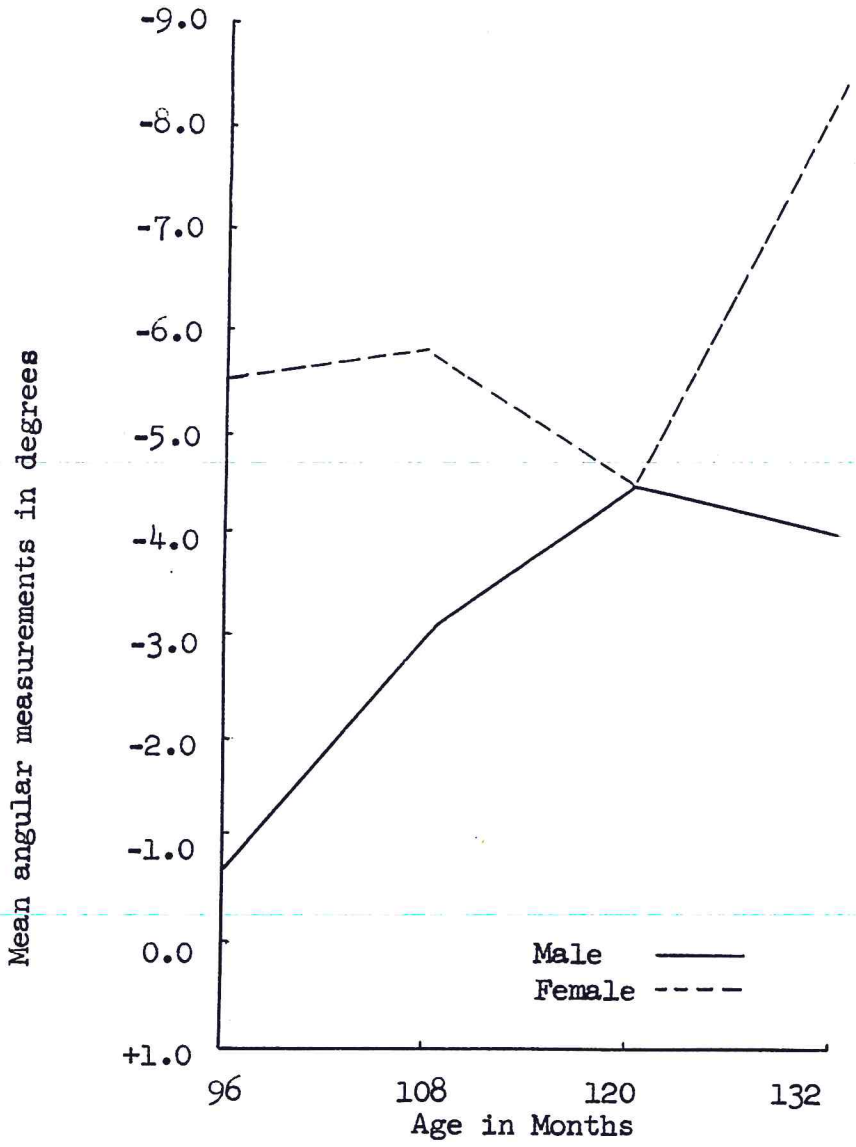


Fig. 18.--Mean angular measurements on the left sides for males and females in the control group.

TABLE 20

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE LEFT SIDES FOR MALES AND FEMALES IN THE CONTROL GROUP

	LEFT CONTROL				
Age in Months	Male $\bar{X}$ N=5	Female $\bar{X}$ N=5	"t" Values	d.f.	P
96	-0.800	-5.600	.927	8	>.05
108	-3.100	-5.800	.400	8	>.05
120	-4.500	-4.500	.000	8	>.05
132	-4.000	-8.300	.695	8	>.05

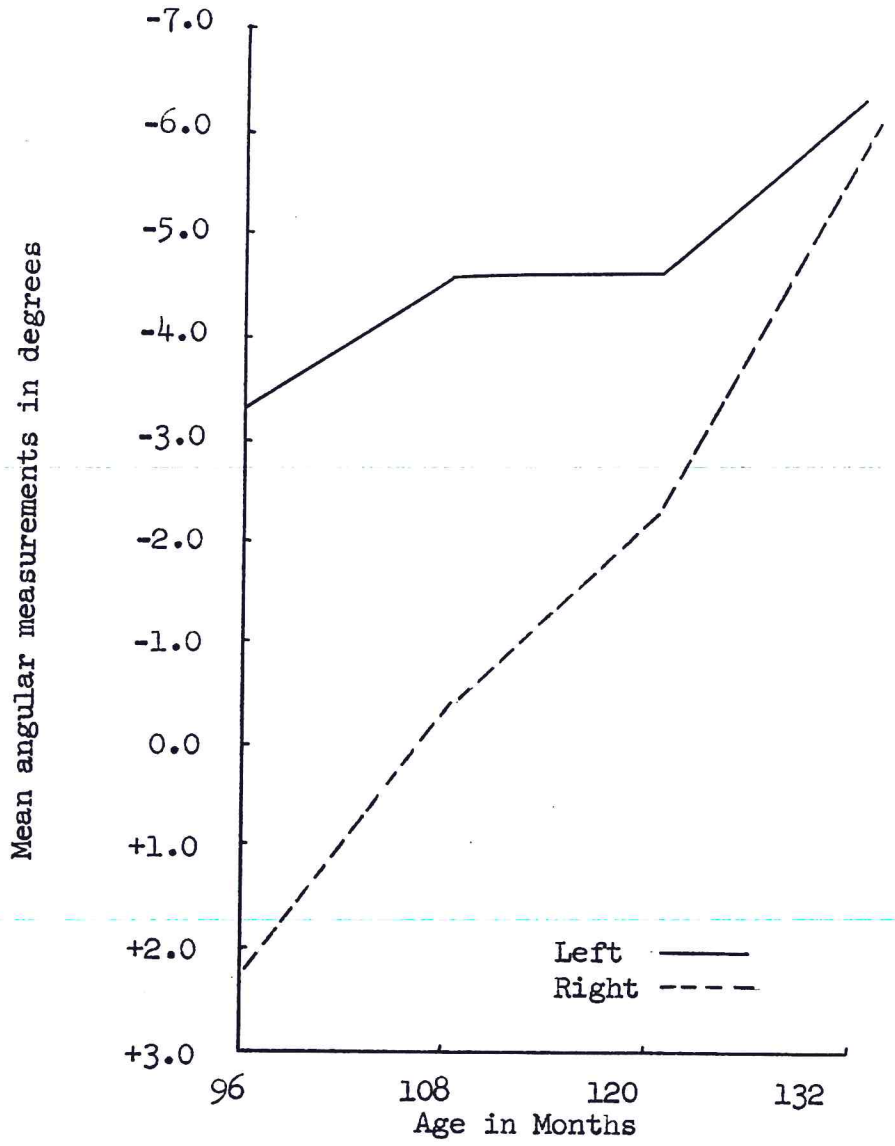


Fig. 19.--Mean angular measurements on the right and left sides in the control group.

TABLE 21

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT AND LEFT SIDES IN THE CONTROL GROUP

Age in Months	CONTROL GROUP Right $\bar{X}$ N=10	Left $\bar{X}$ N=10	"t" Value	d.f.	P
96	+2.400	-3.200	1.506	18	>.05
108	-0.250	-3.20	.872	18	>.05
120	-2.150	-4.450	.447	18	>.05
132	-5.800	-6.15	.080	18	>.05

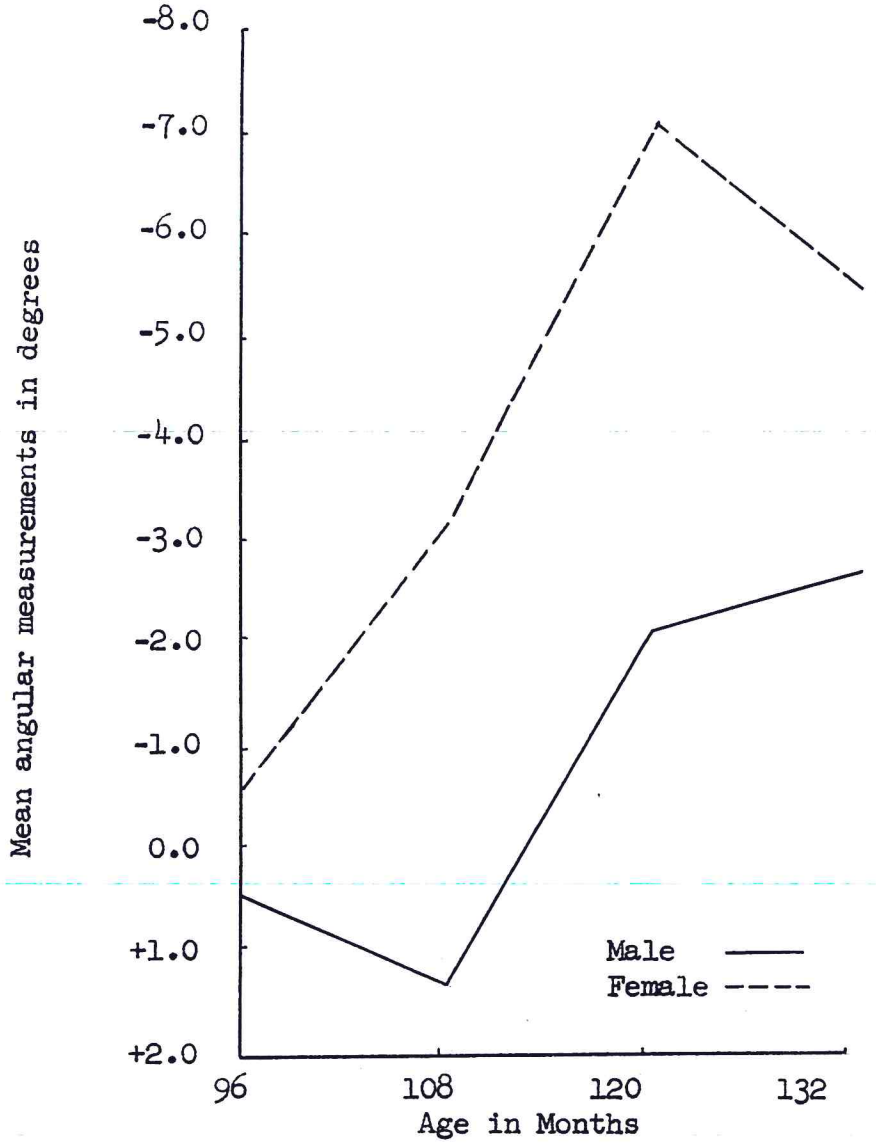


Fig. 20.--Mean angular measurements on the right sides of males and females in the experimental group.

TABLE 22

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT SIDES IN MALES AND FEMALES IN THE EXPERIMENTAL GROUP

Age in Months	RIGHT EXPERIMENTAL Male $\bar{X}$ N=11	Female X N=15	"t" Value	d.f.	P
96	+0.500	-0.430	.121	24	>.05
108	+1.360	-3.07	.930	24	>.05
120	-2.090	-7.070	1.220	24	>.05
132	-2.640	-5.470	.565	24	>.05

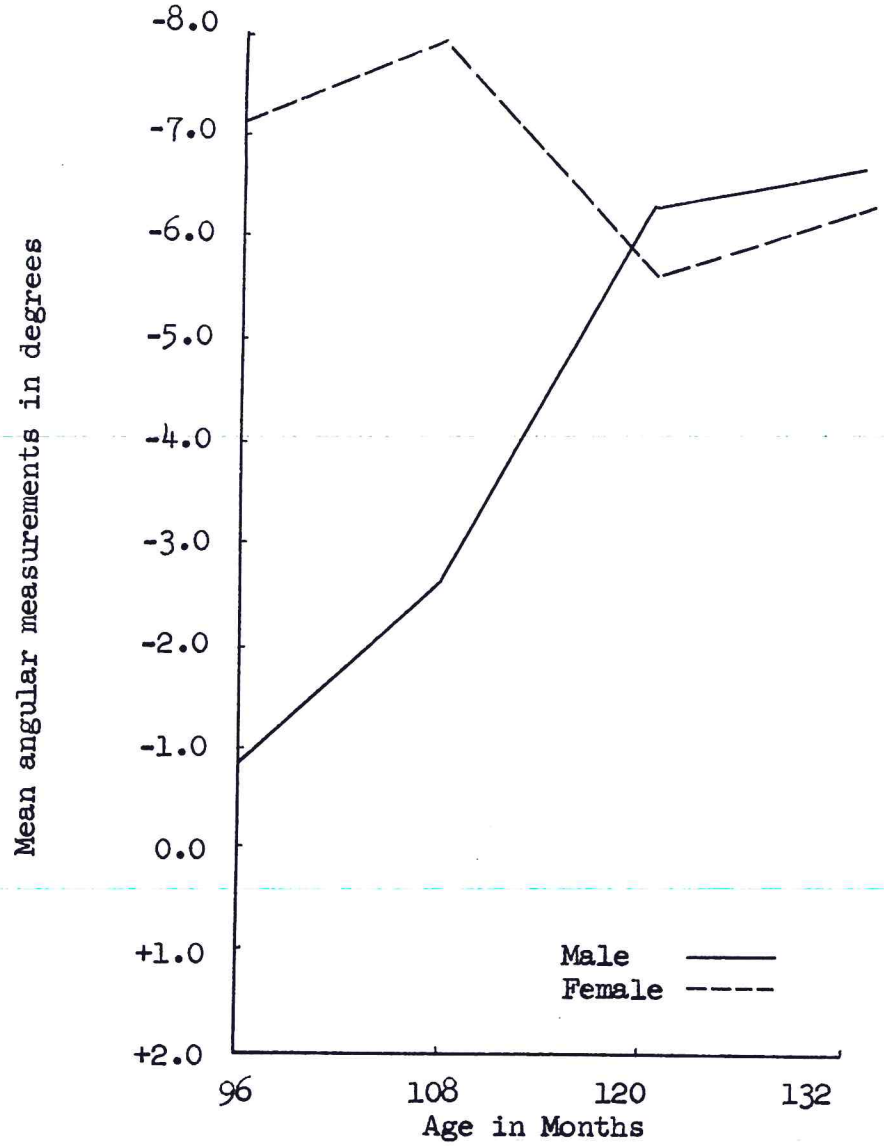


Fig. 21.--Mean angular measurements on the left sides in males and females in the experimental group.

TABLE 23

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE LEFT SIDES IN MALES AND FEMALES IN THE EXPERIMENTAL GROUP

Age in Months	Male $\bar{X}$ N=11	Female $\bar{X}$ N=15	"t" Value	d.f.	P
96	-0.820	-7.070	1.674	24	>.05
108	-2.590	-7.870	1.423	24	>.05
120	-6.260	-5.670	.146	24	>.05
132	-6.590	-6.330	.065	24	>.05

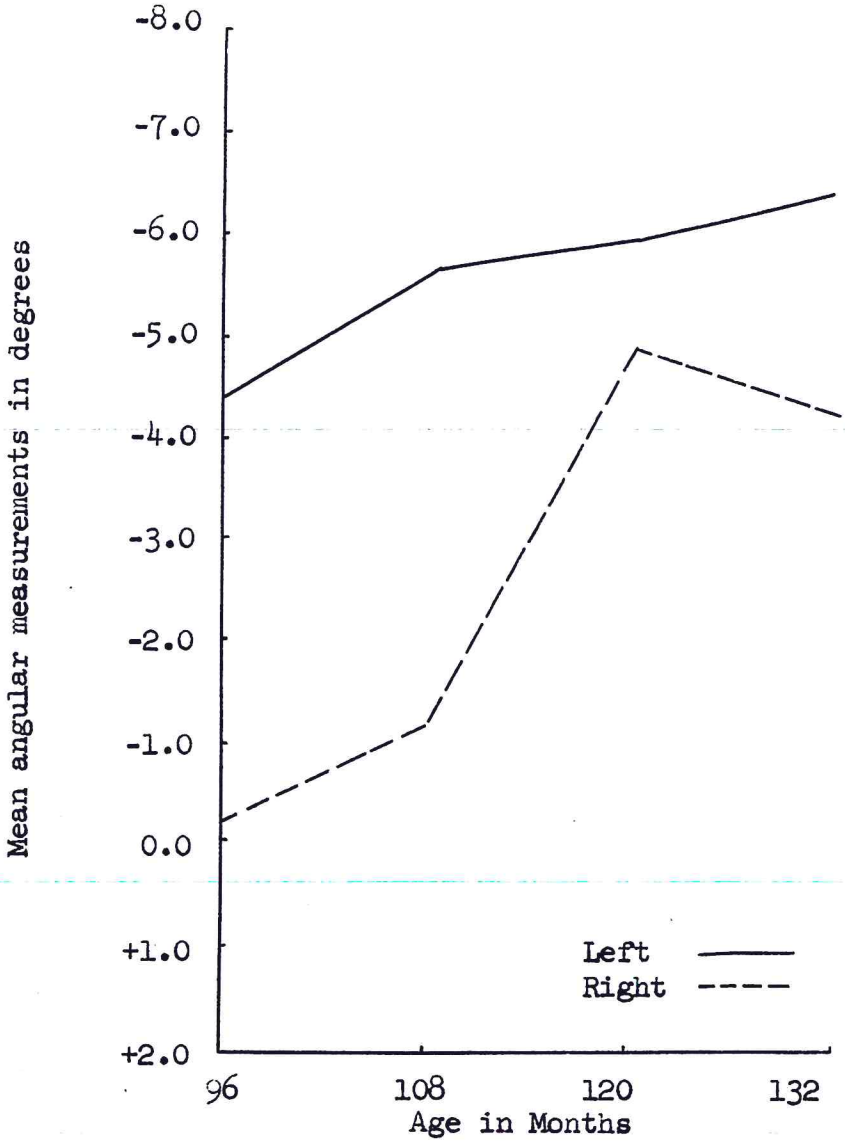


Fig. 22.--Mean angular measurements on the right and left sides in the experimental group.

TABLE 24

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT AND LEFT SIDES IN THE EXPERIMENTAL GROUP

	EXPERIMENTAL GROUP				
Age in Months	Right $\bar{X}$ N=26	Left $\bar{X}$ N=26	"t" Value	d.f.	P
96	-0.230	-4.420	1.500	50	>.05
108	-1.190	-5.630	1.482	50	>.05
120	-4.860	-5.940	.346	50	>.05
132	-4.270	-6.46	.689	50	>.05

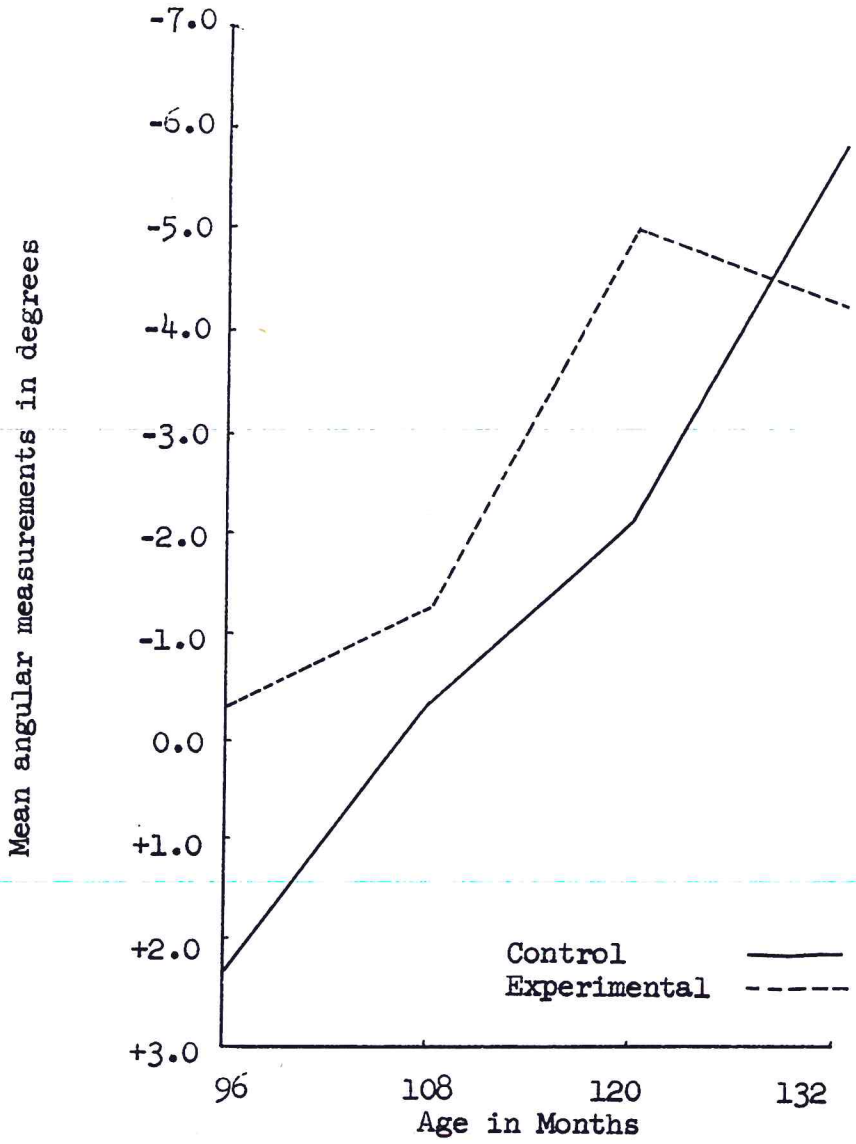


Fig. 23.--Mean angular measurements on the right sides in the experimental and control groups.

TABLE 25

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE RIGHT SIDES IN THE EXPERIMENTAL AND CONTROL GROUPS

Age in months	Control $\bar{X}$ N=10	Experimental $\bar{X}$ N=26	"t" Value	d.f.	P
96	+2.400	-0.230	.728	34	>.05
108	-0.250	-1.190	.212	34	>.05
120	-2.150	-4.960	.694	34	>.05
132	-5.800	-4.270	.349	34	>.05

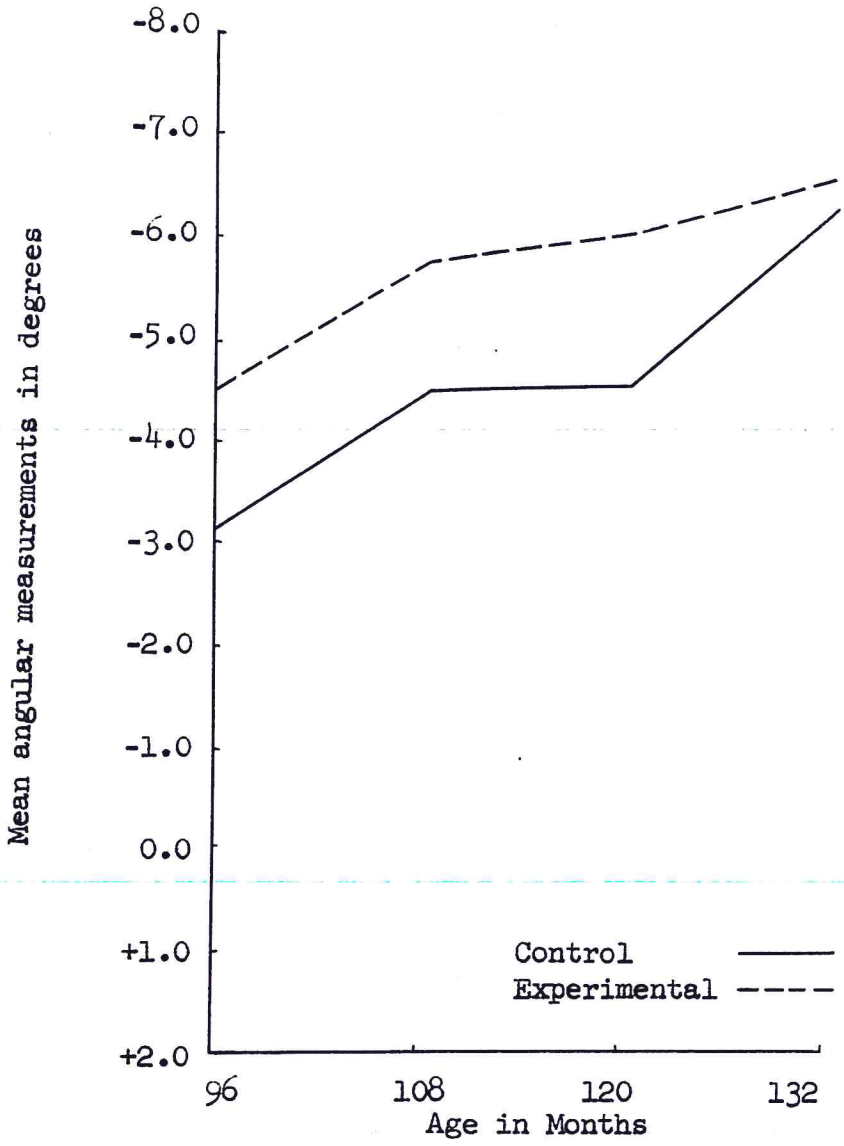


Fig. 24.--Mean angular measurements on the left sides in the experimental and control groups.

TABLE 26

FINDINGS OF "t" TESTS FOR SIGNIFICANT DIFFERENCES BETWEEN THE ANGLES ON THE LEFT SIDES IN THE EXPERIMENTAL AND CONTROL GROUPS

Age in Months	LEFT SIDE Control $\bar{X}$ N=10	LEFT SIDE Experimental $\bar{X}$ N=26	"t" Value	d.f.	P
96	-3.200	-4.420	.127	34	>.05
108	-4.450	-5.630	.328	34	>.05
120	-4.450	-5.940	.393	34	>.05
132	-6.150	-6.460	.081	34	>.05

DISCUSSION

The findings of this investigation should be interpreted with care since the number of children in each of the samples is small and the experimental error relatively large.

The findings of the error studies are of particular importance. The estimate of the error contributed by the assignment of long axes to the bicuspid teeth represents the sum of two long axes assignments; one each to the first and second bicuspid teeth. The error per long axis assignment, expressed in terms of two standard deviations, is equal to $\pm$ 1.89 degrees. Further development of the template and additional experience in its use could improve the reliability of the findings of this type of an investigation.

Greater error was noted between double determinations at ninety-six months of age than at later ages. The greater error may be attributed in part to variability in the size of the bicuspid teeth between different children at ninety-six months of age. In some cases the Z line on the long Axis Template, figure 2, fell short of the apical limit of the tooth to which a long axis line was being assigned. In such instances the registration was estimated by extending visually the contours of the tracing of the bicuspid crowns until they intersected with line Z. An additional error study should be conducted to determine whether or not the experimental error was greater in children with retarded dental maturation, and therefore shorter teeth, than in children with more fully formed teeth. A second error study could be made to determine if the errors could be reduced by using a template on which the Z registration line

was placed closer to the Y registration line.

The use of the template for assigning long axis lines to the teeth was adopted because it was considered important to use a method of assigning long axes which was not dependent upon completion of root formation. Observations of the angular relationships of the bicuspid teeth to each other would be of little predictive value if one was required to await root completion before accurate long axes could be assigned to the teeth.

Since the replication errors between Methods A and B at ages later than ninety-six months were the result of differences between the two methods, one may conclude that, for identical tracings, Method A is as accurate as Method B. This finding indicates that one need not necessarily await root completion in order to study changes in the mesiodistal axial inclinations of the mandibular bicuspid teeth.

The tracing error observed may be partially explained by noting that the template method of assigning long axis lines is dependent upon the registration of four points on the outline tracing of a tooth. The template is sensitive to very small tracing discrepancies and to variations in pencil line thickness. Since the study of error attributable to different tracings of the same cephalogram was made only with Method A, no estimate of the sensitivity of the transfer method, Method B, to tracing error was possible.

Investigator error has not been studied for the methods employed in this investigation. McGonagle (21) has illustrated the variety of findings which different clinicians reported after tracing copies of the same cephalograms. A similar study, using oblique cephalograms and the template for assigning long axis lines, would be useful.

In light of the statistically significant differences between the angular measurements on the right and left sides which have been found in this study, one should accept with reservations data based upon average tracings of the right and left images of the mandibular bicuspid teeth. It is possible that some of the "shifting and tipping" of the teeth reported by Broadbent (4) may be due to the practice of using averaged tracings of structures on the right and left sides.

No data relative to replication errors were presented in any of the reports cited in the Review of the Literature. It is, therefore, not possible to compare the findings of this study with those obtained by other investigators. Until replication data are presented, one is justified in questioning the significance of findings which indicate changes in the mesiodistal axial inclinations of the mandibular bicuspid teeth, relative to other lines, when the changes noted are less than six or seven degrees in size.

During the course of the investigation rotations of the bicuspid teeth around their long axes were noted. No attempt was made to measure the extent of the rotations.

Several additional studies may be suggested on the basis of the results of this investigation.

Correlation analyses should be made between changes in the angular relationship of the mandibular bicuspid teeth to each other and the size of the teeth. Similarly, studies should be conducted to determine if there is a significant correlation between tooth size-dental arch length discrepancies and the angular changes which occur between the axes of the bicuspid teeth. Correlation analyses should be made between the skeletal age-dental age differences reported by Brady (22), and the

changes in angular measurements between adjacent mandibular bicuspid teeth.

The sample of children studied was considered to have acceptable skeletal balance as noted at A and B points. The essentially negative findings of this investigation should be compared to those obtained from a sample of children with skeletal imbalance.

The genetic influence on the axial inclinations of the bicuspid teeth, prior to and during the period of active eruption towards the occlusal plane, could be estimated by the methods employed in this investigation.

SUMMARY

A longitudinal study was made of the mesiodistal angular changes between the long axes of adjacent mandibular bicuspid teeth. Oblique cephalograms, obtained at approximately eight, nine, ten and eleven years of age, were studied for thirty-six white elementary school children. Lateral cephalograms and plaster record casts of the dentition obtained at approximately twelve years of age were used to select control and experimental groups of children. Only children with acceptable skeletal relationships of the maxilla and mandible were studied. Estimates were made of the experimental errors in the study.

Differences in the angular relationships of the bicuspid teeth were noted between sexes, between the right and left sides, between four ages and between children in the experimental and control groups. Frequency and percentage distributions of the various angular relationships were described for the various groups and sub-groups.

Statistical analyses of the data revealed significant differences between the angular measurements on the right and left sides at ninety-six months of age. The frequency of parallel and divergent patterns decreased and the frequency of convergent patterns increased with increased age. The same angular patterns were found on both the right and left sides in sixty-six per cent of the males while only fifty-one per cent of the females had right-left symmetry of angular patterns.

Additional studies should be conducted to establish the significance of changes in the angular relationships between adjacent bicuspid teeth during the period of the mixed dentition.

CONCLUSIONS

1. A statistically significant difference was noted between the angular measurements on the right and left sides at ninety-six months of age when the data for both sexes were pooled.
2. A statistically significant difference was noted between the angular measurements on the right and left sides in females at ninety-six months of age but not in males.
3. None of the differences noted between any of the other groups were statistically significant.
4. Sixty-six per cent of the males had the same angular patterns on the right and left sides while only fifty-one per cent of the females had right-left symmetry of angular patterns.
5. The frequency of divergent and parallel patterns decreased with increasing age while convergent patterns increased with increasing age of the children.
6. Additional studies should be conducted with more accurate methods in order to determine the significance of the angular relationships of developing permanent teeth.

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APPENDIX

APPENDIX TABLE 1

AGE AT TIME OF SKELETAL AND DENTAL CLASSIFICATION

Females Age in Months				Males Age in Months		
No.	Ceph.	Casts		No.	Ceph.	Casts
			Control			
111	138	138		210	143	143
112	144	144		203	144	144
119	147	148		217	145	145
118	150	150		212	151	150
125	143	143		220	144	144
			Experimental			
104	131	132		214	139	139
122	132	132		219	143	143
105	137	137		209	143	143
114	137	137		215	143	144
107	138	138		201	144	139
109	138	138		205	144	144
108	138	138		208	144	144
117	139	138		213	144	144
101	139	139		206	144	145
103	144	144		207	145	155
110	144	144		204	152	152
121	144	144				
123	149	132				
106	149	178				
120	150	132				
102	150	150				
Mean Ages	141.95	141.71			144.50	144.88

APPENDIX TABLE 2

AGE AT WHICH OBLIQUE CEPHALOGRAMS WERE OBTAINED

Number	Age to nearest month			
118	96	108	121	132
119	97	108	120	132
111	103	115	127	139
112	96	107	121	133
125	95	107	119	131
120	95	108	119	132
107	102	114	126	138
114	102	116	126	137
105	101	113	125	137
103	96	108	120	132
104	99	108	119	132
109	103	113	127	138
108	103	117	127	138
117	90	103	114	138
102	97	108	121	134
110	97	108	121	134
101	103	115	126	139
123	101	108	119	132
122	93	103	115	128
121	96	108	120	133
217	95	109	121	132
210	95	107	121	143
212	103	115	127	139
203	96	108	120	134
220	96	107	119	131
215	95	107	120	131
219	96	107	120	132
204	96	109	120	132
208	96	108	121	133
207	96	108	121	132
206	96	108	120	132
205	95	107	120	132
213	96	109	120	133
209	89	107	120	131
214	90	103	115	127
201	117	129	141	153
Mean Ages	97.55	109.53	121.64	134.33

APPENDIX TABLE 3

SKELETAL CHARACTERISTICS OF THE CHILDREN IN THE EXPERIMENTAL AND CONTROL GROUPS

Females					Males				
No.	SNA	SNB	ANB	NAP	No.	SNA	SNB	ANB	NAP
				Experimental					
101	+	+	+	+	204	+	+	+	+
102	-	-	+	+	205	-	-	+	+
103	-	-	+	+	206	-	-	+	+
104	+	+	+	+	207	+	+	+	-
105	+	+	+	+	208	+	+	+	+
107	+	+	-	+	209	+	+	+	+
108	+	+	+	+	213	+	+	+	+
109	+	-	+	+	214	+	+	+	+
110	+	+	+	+	215	+	+	+	+
114	-	-	+	+	219	-	+	+	+
117	+	+	+	+	201	+	+	+	+
120	+	+	+	+					
121	+	+	+	+					
122	+	+	+	+					
123	+	+	+	+					
				Control					
118	+	+	+	+	217	+	+	+	+
119	+	+	+	+	210	+	+	+	+
111	+	+	-	-	212	+	+	+	+
112	-	-	+	+	203	+	+	-	+
125	+	+	+	+	220	+	+	+	+

\+ = Measurements within plus or minus one standard deviation of the means.

APPENDIX TABLE 4

DISTRIBUTION OF "P" DENTAL CHARACTERISTICS IN THE EXPERIMENTAL GROUP

Identification Number	Characteristics										Molar Relation					
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	N	D	D+	M	M+	U
108					*					*		*				
117			*		*		*			*	*	*				*
102			*			*				*	*					
110	*		*		*							*				
101			*		*							*				
123			*	*			*				*					
122			*				*				*					
107					*							*				
120			*								*					
114						*					*	*				*
105	*									*	*					
103				*							*	*				*
104			*	*							*					
109			*	*						*	*					
215			*		*	*					*					
219			*								*					
204			*								*					
208		*	*	*		*				*	*					
207			*								*					
206			*		*								*			
205			*	*			*				*					
213			*								*	*				*
209			*	*									*			
214			*		*		*			*	*	*				*
201			*		*							*				
Totals	2	1	20	7	10	3	7			7	18	11	2			5

APPENDIX TABLE 5

ABSOLUTE ANGULAR MEASUREMENTS

Number	Right Side Age in months				Left Side Age in months			
	96	108	120	132	96	108	120	132
118	+14.5	+11.0	+11.5	+10.5	+ 8.5	+11.0	+11.5	+ 7.5
119	+11.0	+ 9.5	+10.0	+ 0.5	+ 1.5	+ 0.5	+ 5.0	- 4.5
111	+12.0	+18.0	+ 4.0	- 8.0	- 6.5	- 9.5	- 5.0	-12.0
112	+ 5.0	- 0.5	+ 7.5	+ 4.5	-12.0	- 4.0	-10.0	- 9.0
125	-13.0	-14.5	-25.0	-23.0	-19.5	-27.0	-24.0	-23.5
120	+ 3.5	- 8.5	-11.0	- 1.5	-11.5	-11.5	- 3.0	+ 8.5
107	-17.0	-24.5	-18.5	-14.5	-25.0	-16.5	-14.0	-18.0
114	- 0.5	0.0	- 3.5	-10.5	- 5.0	- 7.5	- 5.5	- 2.5
105	- 4.5	- 3.5	- 2.0	- 3.0	-15.0	-22.0	-17.5	- 5.0
103	+ 6.5	+ 4.0	-19.0	-17.0	-20.5	-13.0	- 2.0	- 1.0
104	+14.0	+17.0	+13.0	+ 9.5	+11.0	+14.0	+21.5	+15.5
109	-14.0	-14.0	- 8.0	-12.0	-13.5	-11.5	- 5.0	- 7.0
108	-10.5	- 8.0	-14.0	- 8.5	- 1.0	- 7.5	- 6.5	- 5.0
117	+28.0	+35.0	+14.5	+34.0	+12.0	+ 8.0	+12.0	- 1.0
102	- 6.5	-19.0	-22.0	-22.0	+13.0	- 8.5	- 6.5	-20.0
110	- 3.0	- 0.5	- 6.0	-26.5	-14.5	-15.5	-22.5	-28.0
101	+ 3.0	+ 2.0	+ 1.5	+ 2.5	0.0	+ 2.0	+ 2.5	+ 2.5
123	+ 2.5	-14.5	-28.0	- 8.5	-11.5	+ 3.0	-10.5	-11.0
122	- 2.0	- 7.5	- 5.5	+ 2.5	-15.0	-16.0	-11.0	- 8.0
121	- 6.0	- 4.0	+ 2.5	- 6.5	- 9.5	-15.5	-17.0	-15.5
217	+ 2.5	- 4.0	- 4.0	- 4.0	- 4.0	- 3.0	- 8.5	-15.0
210	+ 6.0	+ 3.5	+ 3.5	- 4.5	+ 2.5	0.0	+ 1.0	+ 4.0
212	-11.0	-19.0	-18.5	-15.5	- 3.0	-12.5	-17.5	- 9.5
203	- 4.0	- 4.5	- 3.0	- 9.0	- 3.0	-1.0	+ 1.0	- 1.0
220	+ 1.0	- 2.0	- 7.5	- 9.5	+ 3.5	+ 1.0	+ 1.5	+ 1.5
215	- 7.5	- 3.5	- 8.5	- 2.5	- 5.5	- 5.0	-11.5	-14.0
219	- 6.0	- 9.5	- 4.0	- 2.0	- 9.0	-12.5	- 8.5	- 5.5
204	-11.5	- 5.5	-12.0	-13.5	- 5.5	-13.0	- 7.0	- 9.5
208	+ 8.5	+10.0	+ 5.0	+ 8.0	+ 3.5	+ 1.0	- 1.5	- 4.5
207	+ 5.0	+ 7.5	+ 2.0	+ 2.0	+ 1.0	- 1.5	0.0	+ 0.5
206	+ 0.5	- 2.5	- 7.5	-21.0	- 3.0	- 5.5	-17.5	-22.5
205	+ 3.5	+ 4.0	- 2.5	- 2.5	+ 5.0	+ 5.0	-16.5	- 4.0
213	+10.5	+ 8.0	+ 1.5	+ 1.5	+17.0	+15.0	+11.0	+ 3.0
209	+ 4.5	+ 6.5	+ 5.5	+ 9.0	- 2.0	+ 0.5	- 8.5	- 4.5
214	-12.0	- 6.0	-10.0	-11.5	- 8.0	- 5.5	- 7.5	- 8.5
201	+ 5.0	+ 6.0	+ 7.5	+ 3.5	- 2.5	- 7.0	- 2.0	- 3.0