A CROSS-CULTURAL STUDY OF ADOLESCENT VOICE CHANGE IN EUROPEAN MALES

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During the past 30 years a modest amount of research has been conducted on the problem of adolescent or pubescent voice change (Coffman 1968,Curry 1940, 1946, Duffy 1958, Hollien and Malcik 1962, 1967, Hollien, Malcik and Hollien 1965, Hollien and Irwin in preparation, Jerome 1937, Luchsinger and Arnold 1965, Pedrey 1945, Perello 1956, Schilling 1947, Van Oordt and Dorst 1963, and Weiss 1950). As a group, these authors have employed a variety of investigational techniques and have studied the voice change phenomenon in relation to such factors as its effect on singing; height and weight and other body dimensions, and so on. However, the effects of geographical location and/or climate upon adolescent voice change have been subjected to very little study — and the cross-cultural correlates have not been investigated at all. For example, in 1956 Perello reviewed an article by Fournier (1882) who contended that menarche in girls — and presumably voice change — is associated with climate. Indeed, Fournier reported that menstruation begins in Hindu girls at eight years of age but not until fifteen-years in Laplander girls. In discussing these findings, Perello suggested that voice change is associated with climate for both sexes. Intrigued by this discussion, Hollien and Malcik followed up on the notion in a very limited manner with groups of boys from Texas and Iowa. Unfortunately, their findings did not verify the Perello/Fournier contention, even though the respective climates of Texas and Iowa are substantially different. They did find, when they compared their data to those reported by Curry (20 years earlier), that a secular change (accelerated maturation) appeared to be taking place in the United States. That is, the average male was going through adolescent voice change earlier in the 1950's than in the 1930's. The results of these studies may be seen in Table 1. It will be noted that, while all of the 10-year-old groups were reasonably similar, as a group Curry's 14-year-olds had not initiated adolescent voice change (AVC). On

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TABLE 1

Mean speaking fundamental frequency (SFF) levels (in Hz) of the six subjects in each of the three studies and in each of the three age groups

Groups	10 year olds	14 year olds	18 year olds
Curry (Iowa)	264	233	133
Hollien/Malcik/Hollien (Texas)	235	186	116
Hollien/Malcik (Iowa)	226	184	—

the other hand, the two Hollien *et al.* groups were in the midst of the pubescent process-but showed no regional or climate differences.

As a follow-up, Hollien and Irwin attempted to obtain longitudinal and normative information on a large group of boys from Wichita, Kansas. In this regard, they studied (1) the onset, duration and termination of adolescent voice change as well as the pre- and post-adolescent voice and (2) vocal behavior in detail during the period of voice change. These objectives were pursued with an original group of 65 boys who were between the ages 11.1 and 11.11 years at the onset of the investigation. Due to attrition, however, the size of this group was reduced to 48 boys by the end of the investigational period. The experimental parameters studied included physical size, vocal frequency characteristics (i.e., speaking fundamental frequency level and variability), phonational range and laryngeal size. Data were obtained every other month for the entire five-year period. Some of the results of this investigation may be seen in Tables 2 and 3. From these results, it can be noted that, while the group

TABLE 2

Mean height (inches) and weight (pounds) for 10-18 *year old boys from several experiments*

Age in years (± 2 months)	Northern plus Southern[a] U.S. Boys (N=30)		Middle U.S.[b] Boys (N=48)		Middle European[c] Boys (N=180)	
	Height	Weight	Height	Weight	Height	Weight
10	54.8	74.2				
11						
12			58.3	87.7	59.0	86.7
13			60.8	99.8	61.6	97.2
14	64.0	109.3	63.7	113.6	64.3	109.8
15			66.3	125.8	67.7	121.7
16					68.7	131.3
17						
18	69.1	154.3				

[a] combined data from Hollien, Malcik and Hollien (1965) and Hollien and Malcik (1967).
[b] from Hollien and Irwin, Longitudinal Study (in preparation).
[c] present study.

TABLE 3

Mean speaking fundamental frequency (SFF) levels (in Hz) and standard deviations (in tones) for 10-18 year old boys from several studies (standard deviations are in parentheses)

Age in years (± 2 months)	Northern plus Southern[a] U.S. Boys (N=30)	Middle U.S.[b] Boys (N=48)	Middle European[c] Boys (N=180)
10	231 (1.6)		
11			
12		248 (1.5)	269 (1.8)
13		229 (1.4)	246 (1.9)
14	185 (1.5)	193 (1.5)	218 (2.2)
15		160 (1.5)	169 (2.4)
16			145 (2.5)
17			
18	128 (2.2)		

[a] combined data from Hollien, Malcik and Hollien (1965) and Hollien and Malcik (1967).
[b] from Hollien and Irwin, Longitudinal Study (in preparation).
[c] present study.

SFF (speaking fundamental frequency) mean at age 11 years is somewhat similar to that predicted by Curry's data, the SFF level for the group at the age of 14 is comparable to those data reported by Hollien, *et al.* That is, the data confirm the suggestion that, for the normal average male, voice change DOES commence before his fourteenth birthday. Analysis of the individual trends indicated that pubescent voice change may take as little as a few months or as long as several years to complete, and that it may be initiated (at least) as early as 12 years of age or (at least) as late as 15 years of age.

With respect to AVC data relating to cross-cultural factors, practically no information is available. Among adults a few studies have been reported (see, for example, Hanley and Snidecor 1967) but even here data are sparce. In any case, there appears to be an unnecessary information void when one attempts to relate adolescent voice change with such parameters as language and culture.

Accordingly, the purpose of this research was to investigate male adolescent voice change in a reasonably large European population of males and to relate the obtained voice and physical size measurements to climate and cross-cultural factors. In the larger study, 504 boys were investigated as follows: at least 150 boys (30 or more each for the ages 12 through 16) were drawn from each of four countries and three climates (cold, temperate and mild); *viz*, (1) cold: Sweden, (2) temparate: the Netherlands and Poland and (3) mild: Spain. Information concerning age, medical and vocal history, speech and hearing defects, speaking and singing training, and so on, was obtained on each subject — as were measures of height and weight. The major experimental variable was speaking fundamental frequency; the speech materials were obtained by having each subject orally read a standard passage in his native

language (Fairbanks 1960), which was recorded and subsequently analyzed by FFI-6, the solid state version of CSL's Fundamental Frequency Indicator. The resulting data on SFF level and variability provide for various climate and cross-cultural comparisons. However, for this report, only the data from the temperate or middle European groups will be considered; they are compared to the data already available on American populations.

Table 2 provides a height and weight comparison among the two U.S. populations (Northern/Southern boys and middle U.S. boys) and the middle European groups. It will be noted that (1) all populations and sub-populations appear to be close to the expected norms; (2) the two U.S. populations are very much alike and (3) indeed, the U.S. and European groups also are almost identical with respect to these measures. Moreover, the means for both height and weight are virtually identical for all three groups of 14 year olds and the same is true for the four sub-groups of middle U.S. and middle European males. Admittedly, the data were collected over a 12 year period but there appears to be no evidence that secular, nutritional or cross-cultural trends are operating with respect to physical size.

Table 3 presents the data on mean SFF and the mean standard deviations of these distributions for the same groups and subgroups. It can be reasonably inferred from these data that in the United States, (1) most boys have children's voices until about 12 years of age; (2) by the thirteenth year, the first major shift toward AVC appears to occur, (3) the 14 year olds, AS A GROUP, appear to be generally in the process of voice change (the pivotal year) and (4) the majority of boys appear to be either in AVC or to have completed it by their fifteenth anniversary. On the other hand, the middle European males appear to lag their U.S. counterparts by from six months to a year. Since the Europeans are very similar in size to the Americans, nutritional factors would not seem important with respect to these differences; nor would climate as this factor is quite similar for both populations. Hence, it can be speculated that cross-cultural factors may be operating, in this regard. Indeed, it can be noted that the standard deviations of the frequency distributions are almost identical for all U.S. sub-groups (except the 18-year-olds) but that they are much smaller than most of those exhibited by the European boys. This relationship lends credence to the possibility that cultural factors may be correlating with the SFF differences.

Finally, the processing of the data for the other (cold, mild) European populations is almost complete. These data should provide further information concerning both climate and cross-cultural effects on adolescent voice change in males.

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DISCUSSION

LIEBERMAN, P. (Storrs, Conn.)
The results of your study are consistent with more general studies on the relationships between diet and sexual maturation. What is the difference, if any, between the Dutch and Polish youths?

HOLLIEN
Yes, the data here are consistant with information about nutrition and pubescence. The Polish boys were SLIGHTLY smaller than the Dutch boys but the differences were not significant.

SOVIJÄRVI (Helsinki)
Could you tell us about the whole varying area of the average frequencies of the fundamental harmonics concerning each age groups?

HOLLIEN
By-and-large, the distributions within each age group were normally distributed when the boys were homogeneous with respect to pubescence — that is, when all boys had children's voices (or adult voices). However, the distributions of the means obviously were VERY large within those groups where the subjects were generally in the process of voice change. This variance was due to some boys having adult voices and some children's voices — while others were going through the AVC process. Hence, in these cases, the SFF's were widely dispersed.

LISKER (Philadelphia, Pa.)
Are there differences among your various populations in the ratios of pre-adolescent to post-adolescent frequencies?

HOLLIEN
Very little data are available in this regard. The only appropriate research here concerns just post-adolescent males. When contrasting the Hollien/Jackson data on U.S. university students with the Majewski/Hollien data on Polish university students, it was found that the Poles had SFF's that were significantly higher than the Americans. They were somewhat smaller also. Nevertheless, cross-cultural factors probably accounted for the phonatory differences.