AMRL-TR-79-102

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LONGITUDINAL STUDY OF HUMAN HEARING: ITS RELATIONSHIP TO NOISE AND OTHER FACTORS
II. Results From The First Three Years

ALEXANDER F. ROCHE
JOHN H. HIMES
ROGER M. SIERVOGEL

FELS RESEARCH INSTITUTE
800 LIVERMORE STREET
YELLOW SPRINGS, OHIO 45387

DANIEL L. JOHNSON

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY

NOVEMBER 1979
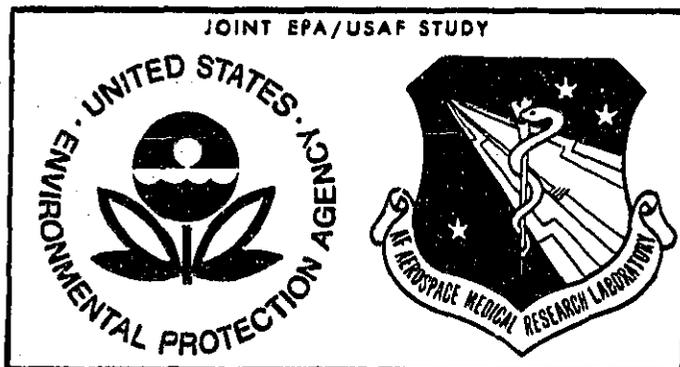
JOINT EPA/USAF STUDY

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AEROSPACE MEDICAL DIVISION
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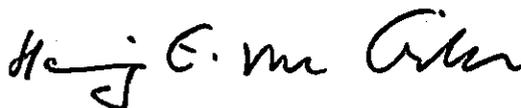
HENNING E. VON GIERKE
Director
Biodynamics and Bioengineering Division
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AIR FORCE/56780/6 February 1980 — 300

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
AMRL-TR-79-102		

4. TITLE (and Subtitle)	5. TYPE OF REPORT & PERIOD COVERED
LONGITUDINAL STUDY OF HUMAN HEARING: ITS RELATIONSHIP TO NOISE AND OTHER FACTORS II. Results From the First Three Years	Final 15 April 1977– 15 May 1979
	6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
Alexander F. Roche John H. Himes Roger M. Siervogel Daniel L. Johnson*	F3361577C0516

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
Fels Research Institute 800 Livermore Street Yellow Springs, Ohio 45387	62202F 72310809

11. CONTROLLING OFFICE NAME AND ADDRESS Air Force *Aerospace Medical Research Laboratory Aerospace Medical Division, Air Force Systems Command, Wright-Patterson AFB, OH 45433	12. REPORT DATE November 1979
	13. NUMBER OF PAGES 225

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report)
	Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Hearing Loss
Noise Exposure
Auditory Thresholds
Longitudinal
Noise

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

   Analyses have been made of serial data from children aged 6 to 18 years;
these data relate to auditory thresholds and noise exposure obtained from
questionnaires and dosimetry records. For these children, there are serial
data for body size, maturity, otological histories and inspections, and
medical histories.

   The mean thresholds tend to be lower than audiometric zero (ANSI-1969)

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except at the higher frequencies. Girls tend to have lower thresholds than
boys at all ages. The thresholds tend to decrease with age and to be higher
when there are abnormal otological findings. The changes in thresholds
(increments) for 6-month periods are normally distributed with means near zero
except at the higher frequencies where the changes are in the direction of
poorer hearing. This effect is more marked in the older children. The data
from the questionnaires indicate total noise exposure increases with age,
particularly in boys. However, these estimates of daily noise exposure are not
closely correlated with dosimetry data. Auditory thresholds are higher for
those exposed to particular sorts of noise with the strongest trends being for
those exposed to loud T.V. or power tools. Rapid maturation and stature are
associated with lower thresholds. Also, systolic blood pressure is signifi-
cantly correlated with thresholds but this association is positive in boys
and negative in girls.

SUMMARY

This report describes a serial study of auditory
thresholds in children 6 to 18 years of age. In
addition, data have been obtained from 29 participants
examined as youths and examined again after the age
of 18 years; the analysis of these data is not included
in the present report. Hearing level thresholds,
together with detailed information from noise exposure,
otological, recreational, and medical histories,
and 24-hour dosimetry records of noise for some individuals
and data relating to physical size and maturity,
and findings from otological inspections are obtained
serially from a group of Southwestern Ohio children
and youth. The data base includes 1110 satisfactory
sets of auditory thresholds and 1278 sets of questionnaires.
Serial data for thresholds obtained at 6 visits for
each individual are available from 106 participants;
the number who have been examined 1 to 5 times or
7 times varies from 14 to 31.

The major aims of the study are to determine
the variation among children in patterns of change
in thresholds with age and to analyze the relationships
between these changes in thresholds and environmental
and biological factors. The present report includes
a description of the design of the study (a more
complete account is available in AMRL-TR-76-110)
and analyses of the data collected in the first 3
years of the study.

Satisfactory auditory threshold examinations
have been obtained since 26 January 1976, after initial
difficulties with audiometric test equipment. The
data analyzed in this report were collected through
15 February 1979. The means of the recorded thresholds
are near but slightly below audiometric zero (ANSI-
1969) for the lower tonal frequencies, but are 2 to
3 dB higher at 4000 to 6000 Hz. The older participants
(12 to 17 years) have lower mean thresholds at all
frequencies than the younger ones (6 to 11 years)
and age is negatively and significantly correlated
with thresholds. Perhaps hearing ability increases
with age, or perhaps older children are more able
to perform the testing tasks. In general, the mean
and median thresholds are 2 to 6 dB lower than those
recorded in U.S. national surveys for children of
the same age and sex. There are indications some
abnormal otological findings are associated with
hearing loss and that while auditory thresholds decrease
in girls during adolescence, thresholds in boys tend
to increase during adolescence, especially at higher
frequencies. Lateral differences in thresholds are

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relatively common and occasionally large; large lateral
differences in threshold increments were not observed.

Six-month increments (n = 723) in thresholds
were obtained on 251 children; each participant has
from 1 to 6 increments. The threshold increments
are distributed normally with means of zero at the
lower frequencies. However, at 4000 and 6000 Hz,
the increments are significantly different from zero
in the direction of poorer hearing. This effect
is most evident in the older participants, although
their overall mean thresholds are lower. This is
in general agreement with the view that noise is
an important determinant of the auditory thresholds
of children. The data indicate girls have slightly
lower mean thresholds than boys, which may reflect
behavioral differences; boys have more noise exposure
than girls. Although the thresholds decrease significantly
with age, 6-month increments do not.

Quantitative scores have been derived from total
noise exposure histories (n = 259) and interval noise
exposure histories (n = 1019). The total noise exposure
histories refer to the total period preceding the
time when each history was taken; the interval noise
exposure histories relate to noise exposure since
the previous record (either a noise exposure history
or an interval noise exposure history) was obtained.
There is an increase in total noise exposure (all
sources combined) with age. This change with age
is more pronounced in boys. There is, however, little
evidence that the interval noise scores are reflective
of children's daily noise exposures, as determined
by 24-hour dosimetry for selected children.

The associations between noise scores and threshold
levels are not significant, although some trends
are present. There are statistically significant
differences in mean auditory thresholds for participant
groups reporting exposure to loud TV, loud stereo,
hi-fi, loud vehicles, power tools, and being near
or using farm machinery, relative to groups not reporting
such exposure. Loud TV and power tools demonstrated
the strongest trends.

There is suggestive evidence that rate of maturation
is associated with auditory thresholds, such that
rapid maturation, especially in girls just before
menarche, is associated with lower thresholds (better
hearing). Stature is associated with thresholds
in a similar fasion, i.e., taller children within
the same age and sex group tend to have lower thresholds,
irrespective of rate of maturation. These effects
are interrelated because rapidly maturing children
tend to be tall. There is evidence that systolic

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blood pressure is significantly correlated with auditory thresholds, although there is a qualitative difference beween the sexes in this association (boys positive; girls negative). There are no apparent associations between diastolic blood pressure and thresholds, nor between noise scores and blood pressure.

A library of computer programs for the analysis of data from auditory threshold examinations, noise exposure questionnaires, medical histories, and growth and maturation assessments has been developed. This will be used as further data are recorded and it will be expanded to allow the analysis of serial changes by curve-fitting techniques.

There are no previous studies of children dealing with auditory thresholds, and possible environmental, biological and developmental factors that could affect these thresholds. Yet such studies are necessary to determine whether the changes in thresholds observed in cross-sectional surveys are due to marked changes in a sub-sample of children or changes in all children.

The information from the study in relation to the effects of environmental noise on the hearing levels of children and youth will be of great value to the Environmental Protection Agency and the USAF, particularly when the serial data extend until these individuals become adult members of the work force.

This study aims to determine the changes in auditory patterns with age during childhood and into young adulthood and to relate these patterns to environmental and biological factors. The study is appropriate in design and has a great potential to determine the relationships between auditory thresholds, noise exposure and strictly biological variables.

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PREFACE

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INTRODUCTION

Environmental noise can adversely affect people of all ages, but children may require special consideration. One reason is the possibility that children are more susceptible to a loss of hearing ability as a result of noise exposure than adults. Another reason is that children, at various times, may be exposed to particular types of noise that may not be recognized as possibly influencing hearing. The noise exposure of a pre-school child who lives near a busy freeway and often plays outside either at ground level or on balconies overlooking a freeway is an example.

Furthermore, the effect of a marked hearing loss on a child may be more severe than on an adult due to the learning disability to which it may lead. Good hearing ability is necessary for learning and communication, especially in childhood when speech abilities and listening strategies are less well-developed than in adulthood. Even if a hearing loss did not lead to learning disabilities, any permanent reduction in the hearing ability of a child can be considered more signifi- cant than a similar reduction in an adult simply because the child can be expected to live longer. Nevertheless, there have not been effective studies of hearing loss in children in re- lation to environmental factors.

The determination of serial auditory thresholds in the same children, and their analysis in relation to other information, including noise exposure, past health, and maturity, is impor- tant if proper and timely decisions are to be made with respect to the control of various sources of environmental noise. Currently, in most analyses of environmental noise impact, it is assumed that occupational noise exposure data from an indus- trial situation can be applied directly to estimate the effects of noise on children. The validity of this assumption has not been demonstrated.

Auditory thresholds in children are probably positively correlated with the auditory thresholds in the same individuals when adult, although relevant data have not been reported. A convincing demonstration of this requires recording serial auditory thresholds in the same individuals; data at two points in time yielding a single increment for each child are unlikely to provide a convincing answer. Increased knowledge and under- standing of the factors that influence hearing levels during childhood, prior to any changes due to occupational noise exposure, will allow better understanding of the significance of the changes in hearing thresholds due to occupational noise exposure. In turn, this should lead to appropriate regulations in regard to important sources of occupational and non-occupational noise, e.g. lawnmowers.

One might ask, "How do we know there is a noise exposure problem with children?" Perhaps the best circumstantial evidence is provided by the data from the Health Examination Surveys conducted by the National Center for Health Statistics (Glorig and Roberts, 1965; Roberts, and Huber, 1970). These crosssectional surveys of large representative U. S. populations show that at 4000 Hz there is no practical difference between the distributions of the hearing levels of boys and girls at age 11 years, but by the age of 18 to 24 years there is a definite worsening in the hearing levels of men while those of women remain unchanged. In fact, one can describe this difference in the statistical distributions of hearing levels at 3000 Hz and 4000 Hz between adult men and women by stating that, in respect of hearing levels, the 20-year-old men have aged about 20 additional years. In other words, the distribution of hearing levels for 40-year-old women is approximately the same as that for 20-year-old men. There is no corresponding effect for thresholds at the audiometric frequency of 1000 Hz.

It should be stressed that these National Surveys were cross-sectional. They provide excellent sets of national reference data, but they cannot provide information about changes within individuals. The sex differences in the National Survey data require further documentation, the distribution of changes within individuals must be established and these changes must be related to possible environmental and biological causal factors. Potential biological factors include previous illnesses, otological status, body size and rate of maturation.

An unresolved question is, "Why does this difference occur between men and women at 3000 Hz and 4000 Hz?" Possible noise exposure is greater for teenage boys than for girls, but proof is lacking that this is responsible for the difference. Other factors might account for all or part of the difference. There could be sex-associated differences in susceptibility to noise, or sex-associated differences in the way in which normal hearing develops irrespective of noise exposure. Furthermore, health-related factors could influence the distribuiton of hearing thresholds at the age of 18 years. This study was planned to answer such questions. From occupational noise exposure data and laboratory studies, it is known that the auditory frequencies from 3000 Hz to 6000 Hz are the most susceptible to typical environmental noise. The maximum levels of exposure acceptable for adults are at least tentatively established. There are no existing data on which corresponding levels for children could be based.

This is the second comprehensive report from the present study. Considerable steps have been taken to obtain some, but not all, the answers needed. Audiometric data have not been recorded over long enough time spans to allow the fitting of complex curves (components in age) to sets of serial data for individuals. At the most, 6 or 7 audiograms have been

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obtained for any single participant at 6-month intervals.
The data currently available, do, however, allow detailed
analyses of individual variations in susceptibility to various
environmental factors such as noise. The development of indi-
vidual hearing threshold patterns cannot be assessed, however,
without more serial data points for the individuals already
included in the study. Since the commencement of the study
about 40 of the participants have passed the age of 18 years.
These individuals are being tested at biannual intervals and
data are being collected that correspond to those collected
from the younger participants in the study.

This report provides a cross-sectional data base together
with analyses based on increments. Auditory thresholds of the
population studied are related to data from detailed total
noise exposure histories (total exposure to time of record),
interval noise exposure histories (noise exposure since the
previous history was obtained; usually a 6-month period),
noise exposure measured with dosimeters, health histories,
otological inspections, anthropometric examinations, and
assessments of maturity. The auditory threshold levels found
in the present study are compared with those reported by others.
These analyses show that when more data become available during
the continuation of the study, and when curve fitting tech-
niques are applied to longer runs of serial data, it is reason-
able to expect a significant contribution will be made to under-
standing the development of hearing and the quantitative effects
of environmental noise on the auditory thresholds of children.

BACKGROUND

HEARING ABILITY IN CHILDREN

Ciocco and Palmer (1941) conducted a large scale
investigation of 13,982 school children in Washington, D.C.
Unfortunately, most of their observations were made using a
phonographic audiometer to test the hearing ability of the
children, in groups of about forty. There is ample evidence
this procedure lacks specificity and sensitivity, and that
it is unreliable (Fowler and Fletcher, 1926, 1928; Rodin,
1927, 1930; Laurer, 1928; Burnap, 1929; Freund, 1932; Rowe
and Drury, 1932; Partridge and MacLean, 1933; Rossell, 1933).
Ciocco and Palmer (1941) did, however, obtain air conduction
thresholds for about 1400 of their group (700 with hearing
losses and 700 normal on testing with the phonographic audio-
meter). Also, they retested some children after intervals of
3 and 5 years. They did not report distribution statistics
for thresholds but classified the audiograms into groups.
A loss at high frequencies was common and often bilateral.
Abnormal records were more common at older ages, and more
common in boys than girls for high frequencies.

Jordan and Eagles (1963) studied 4078 school children
who were broadly representative of all school children of
that age in the Pittsburgh area, except that non-whites were
somewhat over-represented. In this group, the median thres-
holds were lower than the 1951 American Standard Audiometric
Zero especially at low frequencies. However, when adjusted
using ANSI-1969 standards the median threshold values are
all well above zero. There were only slight differences in
thresholds between whites and non-whites, and between boys
and girls. There was an increase in hearing acuity to about
12 years, after which the cross-sectional data show a loss
in hearing acuity. This change occurred about one year
earlier in girls than boys, indicating that rate of maturation
might be involved directly or indirectly. Jordan and Eagles
did not attempt to establish any relationships between audi-
tory threshold levels and noise exposure.

Roberts and Huber (1970) reported population estimates
for auditory threshold levels in the United States for chldren
aged 6 to 11 years. The data were obtained by individual air
conduction testing with pure-tone audiometers. The data were
reported with reference to the 1951 American Standard Audio-
metric Zero; in the present review, they have been adjusted to
compensate for the differences between this standard and ANSI-
1969. The median thresholds reported by Roberts and Huber
(1970) are very close to those from the Pittsburgh study of
Jordan and Eagles (1963). In these cross-sectional data, there

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is a decrease in auditory thresholds with increasing age during
the age range 6 to 11 years, especially at lower frequencies
(Roberts and Huber, 1970). This may reflect differences in
levels of attention or the fit of the ear phones rather than
auditory function.

Roberts and Ahuja (1975) reported corresponding national
estimates for auditory thresholds in United States youths aged
12 to 17 years. Using the ANSI-1969 set of zero values, sub-
stantially less than half the youths have thresholds below
zero; only at 1000 and 2000 Hz do about half the youths reach
this level. The thresholds increase with frequency; this
increase is rapid in the 2000 and 6000 Hz range as progress-
ively older ages are considered. In youths aged 12 to 17 years,
the median thresholds change little with age in girls. In
boys, however, there are gradual decreases, particularly at
6000 Hz (Roberts and Ahuja, 1975). These higher frequencies
are particularly important in speech perception (Kryter, 1963;
French and Steinberg, 1947; Machrae and Birgden, 1973; Suter, 1978).
It should be noted that, as in the survey of 6 to 11-year-olds
(Roberts and Huber, 1970), these observations were made using
audiometers calibrated in 5 dB steps. Also, Lipscomb (1972,
1972a) reported a dramatically higher prevalence of high school
and college students failing audiometric tests at high fre-
quencies compared with sixth grade students. Recently, in a
study of children in North Carolina, Berger and others (1977)
reported that thresholds tended to be higher in boys and higher
in rural than in urban groups. In both groups, however, the
means were higher than ANSI-1969 zero levels.

Glorig and Roberts (1965) reported population estimates
for auditory thresholds in United States adults. Data from
the youngest age group (18-24 years) are relevant to the present
study.

An increase in hearing acuity from 3 to 15 years in
cross-sectional data has been reported (Black, 1939; Kennedy,
1957). It is not clear whether such changes represent biol-
logical changes only or whether they reflect better ability
to follow instructions and/or better fit of the earphones in
older children.

Carter and others (1978) reported descriptive statistics
for auditory thrsholds in 386 school children aged 10 to 12
years in Sydney, Australia. The schools were selected as
representative of quiet and noisy environments. In addition to
obtaining pure-tone thresholds, they did impedance testing and
otolaryngological examinations and used the data to establish
reference values for a group free of aural disease and risk
factors. In these data, the variance of auditory thresholds
changed little with frequency and was similar in each sex for
children aged 12 to 14 years, except for a greater variance at
higher frequencies in the left ears of boys in the normative
groups.

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Lenihan and co-workers (1971) reported data from 886
Scottish school children aged 5, 9 or 14 years. They excluded
those who were abnormal on an otoscopic examination. In each
sex for all age groups, the thresholds were higher at 500 Hz
than at higher frequencies up to 4000 Hz. The means decreased
with age in the boys. In the girls, the means did not change
from 5 to 9 years, but they decreased from 9 to 14 years.

SEX-ASSOCIATED DIFFERENCES

Median thresholds are slightly lower in girls than boys at
ages 5 to 14 years (Jordan and Eagles, 1963). Ciocco and
Palmer (1941) reported hearing losses are about 2.5 times more
common in boys than girls at high frequencies. Because this
difference is present at each age, they considered factors
associated with puberty could not be responsible.

Roberts and Ahuja (1975) found that in youths aged 12
to 17 years, median thresholds are higher for boys than girls
although these differences, based on the better ear, are very
slight at 1000 and 2000 Hz. These sex-associated differences
increase with age at the higher frequencies (4000 and 6000 Hz).
Roberts and Huber (1970), however, did not find sex differences
in the 6 to 11 year age range.

Cozad and others (1974) reported a survey of 18,600
Kansas school children aged 6 to 18 years. Hearing loss was
more common in boys than girls at all ages; the prevalence
of hearing loss increased with age in the boys but not the
girls. Most of the hearing losses occurred at higher fre-
quencies. There were no significant lateral differences.
Others have reported similar findings indicating that hearing
losses are more common in boys than girls (Kodman et al.,
1957; Lipscomb, 1972).

DOSIMETRY

There do not appear to be any reports of auditory thresh-
olds in children in relation to noise measured with dosimeters.

RACE

Roberts (1972) reported that white children, aged 6 to 11
years, have lower thresholds than Negro children at frequencies
of 1000, 2000 and 4000 Hz. At lower and higher frequencies,
Negro children have slightly lower thresholds than the whites.

Roberts and Ahuja (1975), in a national survey of youth aged 12 to 17 years, reported that white youths have lower thresholds than Negro youths at frequencies of 1000, 2000 and 4000 Hz, but not at 500 and 6000 Hz; these differences are small (0.6 to 1.4 dB) but all are statistically significant, except that at 500 Hz.

DEMOGRAPHIC CHARACTERISTICS

Preschool children from lower socioeconomic groups make more errors in auditory discrimination tests than more privileged children, even after the effects of chronological age and intelligence quotient are partialled out (Clark and Richards, 1966). The possible factors (e.g., illness, nutrition, motivation) were not elucidated.

Roberts and Ahuja (1975) found no consistent pattern of differences in auditory thresholds dependent upon size of place of residence. The thresholds tend to be higher in low income groups and in groups with low levels of parental education. Similar findings were obtained in other surveys of children and adults (Roberts and Huber, 1970; Glorig and Roberts, 1972). For U. S. children, youths living in the South have higher auditory thresholds and more hearing problems than those living in other areas (Roberts, 1972). In the sample studied by Carter and his associates (1978), however, socioeconomic status and the mothers' country of origin had little association with auditory thresholds.

OTOLOGICAL EXAMINATION

Ciocco and Palmer (1941) reported that serial changes in thresholds are related to the later state but not the earlier state of the tympanic membrane and that this relationship occurred at medium frequencies only.

Roberts and Federico (1972) reported data concerning the prevalence of ear, nose and throat abnormalities and their relationship to hearing threshold levels and medical events. The data were obtained from a national probability sample of 7119 children and were weighted to obtain national estimates for the United States. The prevalence of abnormalities was obtained by averaging the prevalence for the two sides. The external audiotory meatus was completely occluded in 7.2 percent, the drum was invisible in 10 percent, dull in 5.7 percent, bulging in 0.3 percent, red in 1.2 percent and perforated in 0.4 percent of ears. These authors reported higher thresholds in children with a history of earache (difference from normal about 1.5 dB), in those with perforated drums (difference about 2 dB), in those with running ears (difference about 1.5 dB) and in those with abnormal or red drums (difference about 3 dB). Others (Ciocco and Palmer,

1941; Jordan and Eagles, 1961, 1963; Eagles et al., 1967)
have reported that when the tympanic membrane is abnormal
on examination, the auditory thresholds tend to be higher
by 2 or 3 dB and, if it is perforated, the auditory thresh-
olds are from 12 to 15 dB higher.

Carter and others (1978) reported significantly higher
thresholds and increased variance in those with abnormal ears
or at risk because of their medical history. The effect of
removing such children from a sample on the observed distri-
butions of auditory thresholds was shown clearly in a sub-
stantive review by Robinson and Sutton (1978).

LATERAL DIFFERENCES

Jordan and Eagles (1963) and Ciocco and Palmer (1941)
reported a lack of systematic lateral differences in auditory
thresholds. This is in agreement with the findings of others
(Kodman et al., 1957; Lenihan et al., 1971; Carter et al.,
1978). Glorig and his co-workers (1957) reported, however,
that the right ear thresholds were lower than the left in
boys at most frequencies although girls had lower thresholds
at the higher frequencies. Similarly, Kodman and Sperazzo
(1959), in a study of 1000 children with signficant hearing
loss, found losses were more common in the left than the right
ear in each sex.

Roberts and Huber (1970) found no tendency for hearing
to be better on a particular side in children aged 6 to 11
years. They did find the magnitude of lateral differences
increased with the frequency of the tone. The lateral diff-
erences found in youths aged 12 to 17 years in the survey of
Roberts and Ahuja (1975) also increase at higher frequencies.
The differences are larger than those found in younger United
States children, aged 6 to 11 years (Roberts and Huber, 1970)
and adults (Glorig and Roberts, 1965). Furthermore, in those
aged 12 to 17 years, the left ear tends to have the poorer
hearing. There was a similar pattern among the adults includ-
ed in the national survey by Glorig and Roberts, (1965).

AUDITORY THRESHOLDS AND NOISE

Although it has been suggested children are more
susceptible than adults to temporary threshold shifts at
the same frequency as a tone presented at 100 dB, the data
are inconclusive, in part, because the thresholds have been
tested too soon after the stimulus (Hirsh and Bilger, 1955;
Harris, 1967; Fior, 1972). Others have suggested the ears
of the young are less susceptible to noise-induced hearing
loss than are the ears of the adults (Wageman, 1967).

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Temporary threshold shifts under identical experimental
conditions are less in 7-year-old children than in 12-year-
old children or young adults, but the younger subjects recover
more slowly (Ward et al., 1958; Hétu et al., 1977). There
is experimental evidence, however, that exposure to loud noises
causes more histological damage in young than in adult guinea
pigs (Jauhiainen et al., 1972) and that kittens lose more
sensitivity than cats when exposed to intense sound (Price,
1976). It has been suggested permanent changes in thresh-
olds due to noise are noted first in boys aged 16 to 18 years
and that firearms and farm machinery are the usual sources
(Weber et al., 1967; Litke, 1971). There may be a relation-
ship between age and the sensitivity of hearing ability to
noise among adults (Kup, 1966; Nowak and Dahl, 1971, 1971a).

Temporary threshold shifts in children and adolescents
have been reported after exposure to the noise associated with
toy cap guns (Marshall and Brandt, 1974), model airplanes
(Bess and Powell, 1972), snowmobiles (Bess and Poynor, 1972)
and rock and roll music (Rintelmann et al., 1971; Ulrich and
Pinheiro, 1974; Hanson and Fearn, 1975). Hanson (1975) in a
study of young adults (age range 18 to 25 years) found sta-
tistically significant losses in hearing ability among those
who admitted frequent attendance at pop music entertainment.
The loss is larger at 2000 and 4000 Hz than at other frequencies.

In a study of 230 university students and 200 clerks
aged 16 to 20 years, Carter and others (1977) found an extremely
low prevalence of aural disease and little or no hearing loss
attributable to noise. These workers (1975, 1976), in their
study of 10- to 12-year-old children, found no evidence envi-
ronmental noise affected hearing ability.

Cohen and others (1973) reported a correlation study of
children living in apartments. The analyses were based on
floor level (which had rather high negative correlations with
noise) and subsets of intelligence tests. The coefficients
between floor level and test performance were positive, large
and significant in those living in the apartment 4 years or
longer; they were not significant for those living in the
apartment for shorter periods. A stepwise regression using
data from those who had been in the apartment 4 years or more
showed floor level was more important in regard to auditory
discrimination than father's education, number of children in
the family or grade level. The authors concluded the duration
of residence in the apartment, and, therefore, the duration of
the noise was related to the impairment of auditory discrimina-
tion and that this led to learning handicaps.

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This conclusion may be correct, but one cannot be sure in the absence of serial data. One question in particular remains unanswered: did the children differ in hearing ability before they came to live in the apartment house? As pointed out by Mills (1975), the correlation between hall-way noise near windows overlooking an expressway and auditory discrimination was high but that between expressway noise level and the noise levels within the apartments was consid-erably lower. Furthermore, it is unreasonable to assume that the total noise exposure of the children occurred within the apartment building.

NOISE AND BLOOD PRESSURE

Reports concerning vibrations are relevant to the possible associations between noise and blood pressures. Unfortunately there is disagreement between the few reports available. Fenhein and Shakir (1977) reported a lack of real changes in blood pressure when large vibrating pads were worn; others have reported increases with whole body vibration (Hood and Higgins, 1965). Tysare (1967) found vasoconstric-tion when adolescents were exposed to noise in combination with vibration.

There are few, if any, convincing studies of children although there have been many reports of associations between noise exposure and blood pressure in industrial workers. Takala and others (1977) in Finnish men aged about 46 years found no difference in blood pressure between those who had a noise-induced type of hearing loss and those who did not. Hedstrand and others (1977) in a study of 2002 subjects found no significant difference in blood pressure between the 393 with a noise-induced hearing loss and the remainder. There is, however, some contrary evidence. Andrukovich (1965), in 846 women textile workers aged 16 to 49 years, exposed to intensities of 80 to 102 dB, found higher blood pressures than in a control population. Chemin and others (1970) claimed intermittent noises caused an increase in blood pressure but that the change was smaller than with continuous noise. Exposure to noise is associated also with increased diurnal variations of blood pressure (Pokroskii, 1966). Fakhre and others (1976) reported an extensive study of older adults in Egypt. The found that essential hypertension was associated with a loss of hearing ability and concluded that blood pressure had a significant effect on hearing but noise had no such effect. Jonsson and Hansson (1977) reported a study from Sweden of 196 male industrial workers. Those with a noise-induced hearing loss had higher blood pressures. The difference was highly significant and was not due to an age difference between the two groups. There could be a genetic element in such changes; young prehypertensive spontaneously

hypertensive rats show a more pronounced rise of blood pressure after stressful stimuli than normal rats (Hällback, 1975).

Krasilschikor (1967) reported industrial workers exposed to loud noise had decreases in blood pressure and pulse rate towards the end of the shift. If ear protectors were used these effects did not occur. Ponomacenko (1966) reported data from industrial situations in which there was a stable high frequency noise of 85 dB mainly at 1000 to 2000 Hz. Adolescents had decreases in blood pressure during the working day. Similar findings have been reported by others (Pokrovskii, 1966; Meinhart and Renker, 1970; Maksimova et al., 1974; Kachny, 1977) but this effect tends to reverse with increasing time on the job (Kachny, 1977).

SERIAL FINDINGS

Ciocco and Palmer (1941) reported findings for school children reexamined for pure-tone air conduction thresholds after intervals of 3.5 (N = 543) and 5 years (N = 552). About half of each group had been selected as having a probable hearing loss, and about half as being normal after group testing with a phonographic audiometer. There were marked differences between pairs of records; for example, 90 percent of the pairs separated by 3.5 years differed by 5 dB or more. The changes tended to be greater at high frequencies and similar in each ear. Eagles and others (1967) found a marked tendency for serial thresholds to decrease.

Wishik and others (1958) reported serial data for children examined when aged 5 to 6 years and again when aged 12 to 13 years. They were classified as passing or failing a pure-tone test of auditory thresholds. Among those who passed at the first examination, about 1 percent failed at the second examination whereas among those who failed at the first examination, about 30 percent passed at the second examination. Peckham and Sheridan (1976) reported a follow-up study of 46 children with severe unilateral hearing loss at the age of 7 years who were reexamined when aged 11 years; half had recovered.

There is a need for serial data relevant to the damaged ear theory (Ward, 1976). According to this theory, ears with hearing loss are more likely to show further loss on exposure to noise than are ears without hearing loss; there is some doubt about the validity of the theory but it appears that ears with changes (temporary threshold shifts) may be more susceptible to permanent changes.

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HEARING AIDS

Powerful hearing aids may produce marked threshold
shifts in the direction of hearing loss in children (Kinney,
1961; Macrae and Farrant, 1965; Macrae, 1968, 1968a; Roberts,
1970). This may be related to the cause of the hearing loss.
It has been reported that losses are greater in the aided ears
of children with deafness due to meningitis but not in those
in whom the deafness is due to maternal rubella or perinatal
causes (Barr and Wedenberg, 1965). It should be noted that only
one of the participants in the present study has a hearing loss
sufficiently severe to need a hearing aid.

RELIABILITY

The importance of appropriate training for audiometric
testing is apparent from the findings of Howell and Hartley
(1972). In testing young adults, they reported a mean inter-
observer difference of 5 dB with differences up to 21.2 dB
at 3000 and 4000 Hz. There was a systematic difference
between the two observers and their measurements differed
significantly in a Wilcoxon's signed rank test. Jordan and
Eagles (1963) reported mean interobserver differences of
1.3 to 8.8 dB with the larger differences tending to occur
at the lower frequencies. The audiometers used were grad-
uated in 5 dB steps.

SUMMATION

Consideration of the available literature relating to
thresholds in children indicates that:

-- hearing acuity tends to increase until 12 years; later
there is a small loss in acuity in boys but little change in girls,

-- sex differences in thresholds are slight to
12 years,

-- data from the U.S. indicate auditory thresholds tend
to be higher in lower socioeconomic groups; no such tendency
is present in data from Australia,

-- auditory thresholds are higher in those with abnormal
findings at otoscopic examinations,

-- from 6 to 17 years, white children have lower thresholds
than black children at 1000, 2000 and 4000 Hz. At lower and
higher frequencies the differences are in the opposite direction
and most are not significant,

-- lateral differences tend to increase with age;
hearing ability tends to be poorer in the left ear,

-- data relating auditory thresholds to noise exposure
are sparse, but there is evidence temporary shifts occur.
It has been reported these are less marked in younger children
but recovery from them is slower,

-- there is sufficient evidence to support further
research into the question as to whether exposure to continuous
loud noise is associated with increased blood pressure in
industrial worksers. Corresponding data for children have not
been reported.

-- serial findings are scarce. Apparently, rapid changes
are common, particularly at higher frequencies. Threshold
changes are related to the later but not the earlier state of
the tympanic membrane, and

-- powerful hearing aids can cause a loss of hearing
acuity.

Because so little is known (many of the above statements
being tentative), it is essential that auditory thresholds be
studied serially in children in relation to the factors likely
to be associated with these thresholds, particularly environ-
mental noise. There are no satisfactory studies of hearing
loss as a function of age before 16 years, the factors re-
sponsible for the development of a sex difference in these
levels after 12 years are unknown (it is not even clear whether
these factors are biological or environmental) and, finally, it
is not known to what level of noise children can be exposed
without increases in hearing thresholds. These questions
will remain unanswered until there is a serial study based on
appropriate types of data collected at many examinations over
a sufficient time span. The present study was planned with
this in mind. This report describes the design of the study
briefly and provides analyses of some data from the first
three years. A start has been made, but longer serial records
are needed before the most effective longitudinal analyses
will be possible.

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SAMPLE AND METHODS

SAMPLE

Two groups of children, each approximately equally
divided by sex, are being studied. The majority (N = 211)
are participants in the Fels Longitudinal Study, who were
aged between 6 and 18 years at their first audiometric
examination. Due to the expectation that auditory changes
within individual children might be more marked during
pubescence and early adolescence, it was decided to enroll
a group of middle school students from Yellow Springs to
increase the sample sizes at these ages. Consequently,
47 children aged 12.5 to 13.5 years at the commencement of
the study were enrolled. These students are now attending
the Yellow Springs High School. The total study population is
258. Of these, 251 remain active; one died, three moved out
of the state, one could not be tested reliably and was dropped
from the study, and two have refused further cooperation.

The participants in the Fels Longitudinal Study live in
Southwestern Ohio and were born between 1928 and 1973. They
were enrolled before birth at the rate of about 15 per year.
Their homes are within 30 miles of Yellow Springs, about 35
percent living in cities of medium size (populations 30,000
to 60,000), about half in small towns (populations 500 to
5000) and the remainder on farms. The educational and
occupational patterns for these three groups do not follow
the usual urban-rural differences. About 15 percent of the
fathers are professionals or major executives, 35 percent
are businessmen, 35 percent are tradesmen or white collar
workers and the remaining 15 percent are skilled or semi-
skilled laborers. About 60 percent of the parents attended
a year or more of college and about 60 percent of them were
born in Ohio. In general, they are of middle socioeconomic
level. The middle school children were reasonably represent-
ative of the Yellow Springs community; in general they are
of middle socioeconomic status. The children in each group
are "normal" in the sense that they were not selected because
of the presence of any recognized disease or disorder.

DATA COLLECTED PREVIOUSLY

The children in the Fels Longitudinal Study were enrolled
into the program prenatally. Data were recorded serially,
and continue to be recorded, at regularly scheduled visits
that are fixed in timing and are unrelated to the illness
experience of the children. Examinations are scheduled
for 1, 3, 6, 9, and 12 months and then 6-monthly to 18 years

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after which they are made annually to 24 years in boys and
22 years in girls. When the participants visit Fels, radio-
graphs of the left hand-wrist are obtained (for the assessment
of skeletal maturity), stature, weight, and other anthropomet-
ric dimensions are taken and a detailed medical history is
obtained. Until mid-1975, a complete physical examination was
made at each visit; this has been replaced by an interval
medical history accompanied by the measurement of blood pressure
and pulse rate. Consequently, there is a very large body of
early and concurrent data for these Fels participants that is
relevant to auditory thresholds.

EQUIPMENT

The equipment being used is described in detail in the
previous report (AMRL-TR-76-110; Roche et al., 1977). The
present description, as it applies to the original equipment,
will be brief. An audiometric booth (Tracor RE142B) provides
a noise reduction of 44 to 59 dB at the tonal frequencies being
tested. The booth is in a very quiet part of the building.
At the beginning of the study, there were some problems with
the test equipment. As a result, there are doubts about the
accuracy of auditory thresholds recorded before 26 January,
1976 and they have not been analysed. The other data
(questionnaires, histories, otological inspection, size,
maturity), recorded since 12 August, 1975, were, of course,
not influenced by these equipment difficulties.

Some dosimetry data have been collected since 2 May, 1978.
From 2 May, 1978 to 18 October, 1978, dosimeters from Loomis
Laboratories, Bruel and Kjaer, General Radio and Computer
Engineering were tried. We were unable to obtain satisfactory
results with the Computer Engineering equipment. Due to
experience with the other dosimeters, General Radio dosimeters
were used exclusively after 18 October, 1978. Recently, the
project was provided with two Metrosonics dosimeters; one
provides an 8-hour record and the other a 24-hour record. Each
record provides the noise exposure during 480 separate periods.
The periods are 1 minute for the 8-hour record and 3 minutes
for the 24-hour record. Trials with this equipment have shown
it to be satisfactory and it is being introduced into the study
for use in addition to General Radio dosimeters.

The dosimeters are calibrated before and after each use
and the batteries are changed after they have been used twice.
The General Radio 1954-9780 Noise Exposure Meter is read and
calibrated with the General Radio 1945 Indicator at 116.5 dB
and 1000 Hz. The Metrosonics db-301 Metrologger (dosimeter)
is calibrated with General Radio Type 1562-A Sound-Level
Calibrator at 114 dB and 1000 Hz.

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TESTING PROCEDURES

Otological Inspection -- Immediately before a partic-
ipant's auditory threshold levels are assessed, each tragus,
meatus, and ear drum is examined by a research assistant
trained to do this work. The findings are recorded on the
"Auditory Threshold Level Recording Form."*

Thresholds -- At six-month examinations, thresholds are
tested in the order 1000, 2000, 4000, 6000, 1000, 500 Hz with
the right ear first. All intensities are measured relative
to ANSI - 1969 audiometric zero. In the analysis of data,
the second value at 1000 Hz is being used. The testing is
done by one observer at each examination, with observers
assigned randomly. The threshold is obtained at each fre-
quency by beginning at a low sound intensity and increasing
the intensity until the participant signals he or she has
heard the tone. The attenuation is then increased by 10 dB
and decreased by 6 dB with small increases and decreases to
delineate the threshold as accurately as possible. This is
repeated three times for each tone in each ear.

The thresholds are recorded in 2 dB steps on the "Auditory
Threshold Level Recording Form" Comments about the continuity
and completeness of testing and the nature of the responses by
the participant are recorded both in general and for each
frequency.

Questionnaires -- A set of very detailed questionnaires
has been developed to ascertain the level of noise exposure.
The data obtained using these questionnaires allow analyses
of the relationships between auditory thresholds and environ-
mental factors.

There are two very similar questionnaires:

(i) "The Biographical, Noise Exposure and Otological
History" was administered to each participant at the first
audiometric examination (Appendix B in AMRL-TR-76-110; Roche
et al., 1977). The data obtained by means of this questionnaire
concern: personal identification, family structure and occupa-
tions, recreational activities, work activities, noise exposure
history (guns, toys, hobbies, mechanical equipment, place of
residence, TV, music) and an otological history (family and
personal information concerning hearing loss, previous testing,
infections, discharge, tinnitus). This noise exposure history
provides a quantitative noise exposure score for each individ-
ual for his lifetime prior to the first examination.

* A copy of this form is included as Appendix A in
  AMRL-TR-76-110; Roche et al., 1977.

(ii) The "Interval Audiometry Questionnaire" (Appendix C in AMRL-TR-76-110; Roche et al., 1977) is very similar to the otological history part of the preceding questionnaire, and is administered at the second and subsequent audiometric examinations. It contains questions relating to change of address, noise exposure, otological history, changes in general health and the possible occurrence of menarche since the previous visit. The figures written beside the coding squares on this questionnaire are the weightings applied in the computation of the noise scores. The interval noise exposure questionnaire provides a total noise exposure score for each individual for the 6-month interval prior to testing. In addition, the data provide an event score, a chain saw score, and a gun score (Appendix D in AMRL-TR-76-110; Roche et al., 1977). These scores are used to identify those individuals most likely to have been injured by noise exposure. In September 1976, this questionnaire was extended to include information relating to school buses, relationship of testing to underwater weighing (being done in another study) and provide space for recording the blood pressures and pulse rates of the "middle school participants" (Appendix A).

OTHER PROCEDURAL ASPECTS

(i) A visit for audiometric testing alone requires the participant to be in the Institute for about 50 minutes. Because of the large amount of data obtained from each participant, both for this study and for others, some additional visits specifically for the audiometric study have become necessary.

(ii) Skeletal maturity assessments (Greulich and Pyle, 1959; median of bone-specific skeletal ages; interpolating between standards to the nearest 3 months when this appears appropriate) have been made for boys and girls in the Fels Longitudinal Study. These assessments are not made for the middle school participants.

(iii) The stature of each Fels participant is recorded to the nearest millimeter at each examination using a Harpenden stadiometer.

(iv) Some children with a marked hearing loss have been identified and referred to appropriate physicians. Their problems are described under "Hearing Problems" in the RESULTS section.

(v)   The observations with dosimeters have been made on
62 of those children willing to participate in this part of
the investigation.   Each 24-hour record has been obtained
after explaining the purpose of the study, the nature of the
equipment and details regarding its use to the participant.
The next day the participant is visited to obtain a record,
by questionnaire, of activities for the 24-hour period during
which the dosimeter was worn.   The dosimeter is retrieved to
record the noise exposure and for calibration.   These data are
recorded on the General Radio Dosimeter Form (Appendix B) or
the Metrosonics Dosimeter Form (Appendix C).

RELIABILITY

        The otological history for the Fels participants is
highly reliable because these data have been obtained 6-monthly
since birth until the physical examinations were replaced
by 6-monthly medical histories in mid-1975.   Histories obtained
over long intervals may be less reliable (Ciocco and Palmer,
1941).   Inter- and intra-observer differences have been obtained
for thresholds determined on Fels staff.   With the present
audiometer these differences are small for all frequencies
and compare favorably with those reported by others (Table
1).   The interobserver differences tend to be smaller than
the intraobserver differences, perhaps, in part, due to the
longer interval between the latter.

        The stature measurements are highly accurate (mean
interobserver difference 0.3 cm, s.d. 0.15 cm, N = 420; Roche
and Davila, 1972).   Technicians assessing skeletal maturity
have been trained using a system shown to be satisfactory
(Roche et al., 1970) and have reached levels of accuracy
equal to, or better than, those reported by experienced research
workers and pediatric roentgenologists (Johnston et al.,
1973).

PROGRAMMING

        Much more computer programming has been necessary than
originally envisioned.   In part, this has resulted from changes in
the computer facility at The Fels Research Institute and, in part,
from the analysis of the elaborate questionnaires.   The programs
available are:

TABLE 1 – REPLICABILITY AND COMPARABILITY
            DATA RELATING TO AUDITORY THRESHOLDS
            (dB)

Frequency	Mean	s.d.
Intra-observer differences (n = 10)		
500 Hz	2.80	2.70
1000 Hz	4.40	4.19
1000 Hz	3.80	5.61
2000 Hz	5.60	3.24
4000 Hz	5.20	2.70
6000 Hz	3.80	3.82
Grand mean	4.27	
Inter-observer differences (n = 18)		
500 Hz	2.67	2.28
1000 Hz	3.53	4.61
1000 Hz	4.00	4.85
2000 Hz	3.89	3.72
4000 Hz	4.00	4.06
6000 Hz	3.56	3.40
Grand mean	3.61	

AUDIO --   From user-supplied specifications, this
           program selects a subsample of all
           audiometric examinations and computes the
           following:

           A listing of data for each examination
           sorted by participant identification number
           and examination date. The listing includes
           ID number, examination date, birth date, age,
           sex, examiner, all otological examination
           comment codes, and auditory threshold levels
           and/or increments at each tonal frequency for
           right, left, better and worse ear, as well as
           the lateral difference. Corresponding data can
           be obtained for the means of thresholds at 500
           1000 and 2000 Hz and the difference between
           thresholds at 1000 and 4000 Hz.

           For each tonal frequency in each ear, a
           frequency distribution including the level
           of attenuation, number of individuals, and
           proportion of the total at that level.

           For each tonal frequency, general
           distribution statistics of thresholds
           and/or increments in right, left, better
           and worse ear and lateral differences.
           These statistics include sample size, mean,
           standard deviation, gamma one measure of
           skewness, the significance level of the t
           value for gamma one, gamma two measure of
           kurtosis, and the significance level of the
           t value for gamma two.

           For each tonal frequency, maximum,
           minimum, and 10th, 25th, 50th, 75th, and
           90th percentiles of right, left, better ear,
           worse ear, and lateral differences.

           Prevalence table of the scores from the
           otological inspection and general comments.
           separated by ear and by sex.

           An output file of threshold and increment
           data for each examination.

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AUDREAL --   This program operates on data from noise
             exposure questionnaires. It checks all
             input data for logical inconsistencies or
             errors and lists any invalid data by ID
             number and visit date. From user supplied
             specifications the program will calculate
             from either history or interval data, the
             following:

             a separate noise score for each question
             according to assigned weightings,

             total noise score, events score, gun
             score and chain saw score,

             frequency distributions for each
             question score and for the total scores,
             and

             an output file of all computed scores
             by individual. This file is used as input
             for other programs.

LPCOPY --   This program makes line printer copy of any
             output file from AUDREAL. The AUDREAL
             record is too large to use a conventional
             system utility command.

DISTAT 2 -- This general purpose program computes
             descriptive statistics for any series of
             input variables. The statistics computed
             include: sample size, mean, standard
             deviation, gamma one measure of skewness,
             t value for gamma one, gamma two measure of
             kurtosis, and t value for gamma two,
             maximum, minimum, and 10th, 25th, 50th,
             75th and 90th percentiles. These
             statistics can be computed for any age and
             sex category at the option of the user.

SAS --   This commercial program package is available
             at Wright State University. It is used to
             compute Spearman rank correlation coefficients
             for pairs of input variables for regression
             analyses and computation of residuals,
             and principle component analysis.

AUDOVER20 -- This program selects participants with
             auditory thresholds equal to or greater than
             +20 dB at each tonal frequency.

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DREAM   --   This general purpose program constructs serial
               event files.

AUDF34 --   This program calculates the proportions of
                participants exposed to specific noise-related
                events.

                Other programs have been written to add the
                age at menarche and blood pressures of the
                high school group to the general Fels files
                and to extract from these files data relating
                to stature, blood pressure and skeletal age.

RESULTS AND DISCUSSION

DATA BASE

Since 12 August 1975, a total of 1278 audiometric
examinations have been made. Because of initial equipment
difficulties, the only auditory threshold data included in the
present analyses are those obtained after 26 January 1976.
Nevertheless, the noise exposure histories, interval questionnaires,
health history and otological inspection results for the entire
period are included. Since 26 January 1976, there have been
1110 examinations of 251 individuals, from 4 to 21 years of age.

Audiometric examinations are made six monthly, approximately
on birthdays and "half-birthdays." Therefore, in the analyses,
an age, for example, "6 years" refers to all those children
measured on or about their sixth birthday (i.e., children
between 5.75 and 6.24 years). The exact age distribution of
examinations is given in Figure 1. Of the 1110 examinations, 567
were of males and 543 of females. It is clear from Figure 1
that the number of children in each age group is fairly uniform,
except for the smaller numbers after 18 years and the larger
numbers at 13 to 16 years. The latter is due to the addition of
local school children to the Fels sample in this age range. The
distribution of children at each age is rather evenly divided
between the sexes.

The data subsequent to 26 January 1976 come from examinations
on 205 Fels participants and 46 local school children. There are
31 individuals with one examination, 29 with two, 25 with three,
23 with four, 23 with five, 106 with six, and 14 with seven
examinations. The children with more than one examination form
the sample for analyses of 6-month increments in hearing levels.

TESTING CONTINUITY AND PARTICIPANT RESPONSES

Continuity and completeness of the auditory threshold
testing procedure and the quality of participant responses
were evaluated by the technician at each examination. The
items regarding these aspects of the test and the appropriate
definitions of the corresponding scores are included in the
footnotes to Table 2. This table gives the prevalences of
each of these scores for boys and girls of two age groups.
The children represented in Table 2 comprise all children
tested since August, 1975. Complete test data were
obtained in about 92 percent of those aged 6-11 years and
in about 97 percent of those aged 12-17 years. The percentages
for whom the quality of responses was graded "good" varied
from 68 to 75 percent within sex and age groups being almost
the same in each sex and higher in the older groups.

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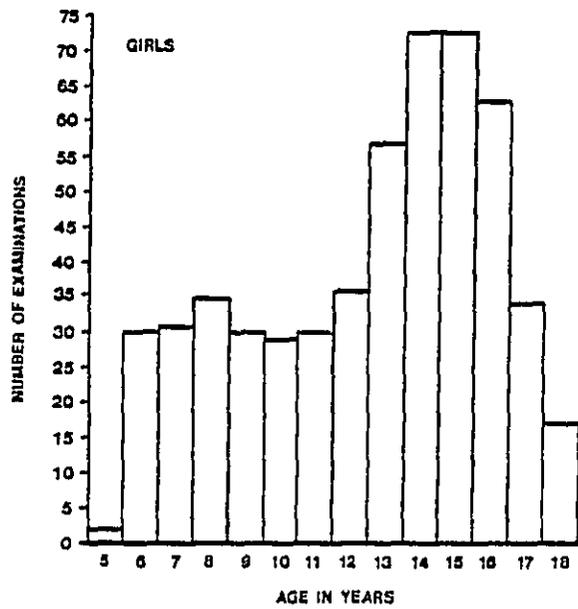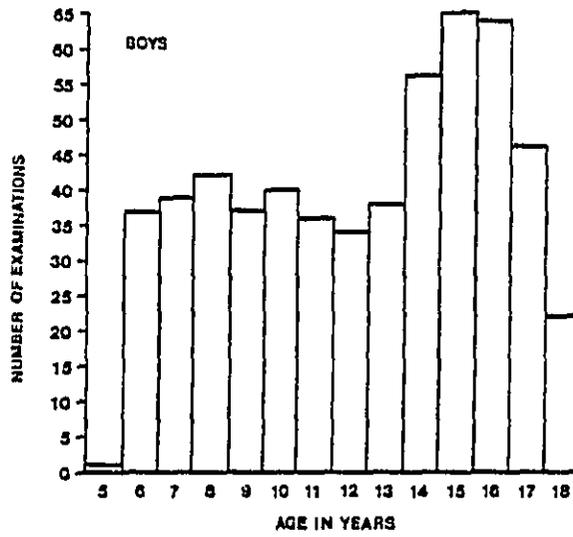
FIGURE 1 — NUMBER OF AUDIOMETRIC THRESHOLD EXAMINATIONS
OF BOYS AND GIRLS AT EACH AGE

TABLE 2 - NUMBER OF EXAMINATIONS (AND PERCENTAGES)OF CHILDREN
WITH SPECIFIC CHARACTERISTICS RATING THE CONTINUITY*
AND QUALITY+ OF AUDITORY THRESHOLD TESTING

| | | BOYS | | | | GIRLS | | | |
| | | Continuity of Testing | | Quality of Responses | | Continuity of Testing | | Quality of Responses | |
Age Group	Rating Code	n	%	n	%	n	%	n	%
6-11 years									
	0	180	68	184	71	140	66	146	69
	1	40	15	5	2	39	18	15	7
	2	1	0	1	0	3	1	0	0
	3	4	2	8	3	6	3	5	2
	4	13	5	8	3	8	4	3	1
	5	6	2	1	0	1	0	0	0
	6	4	2	6	2	9	4	3	1
	7	6	2	0	0	3	1	0	0
	8	11	4	38	14	7	3	31	14
	9	0	0	14	5	0	0	13	6
Total		265		265		216		216	
12-17 years									
	0	303	87	254	75	332	90	283	73
	1	12	3	15	4	6	2	17	5
	2	6	2	0	0	7	1	2	1
	3	6	2	8	2	8	2	12	3
	4	6	2	1	0	7	1	2	1
	5	7	2	1	0	7	1	0	0
	6	0	0	15	4	0	0	19	5
	7	1	0	0	0	0	0	0	0
	8	6	2	53	15	10	3	40	11
	9	0	0	0	0	0	0	2	1
Total		347		347		377		377	

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FOOTNOTES TO TABLE 2

* Continuity Ratings

    0 = testing completed, no breaks
    1 = testing completed, one short (<5 min) break
        between ears
    2 = testing completed, one short (<5 min) break
        during testing of right ear
    3 = testing completed, one short (<5 min) break
        during testing of left ear
    4 = testing completed, took more than one break
        (see written comments)
    5 = testing completed, certain frequencies retested
        (see written comments)
    6 = testing discontinued, participant insisted
        (tired, restless, etc.)
    7 = testing discontinued, responses too erratic
        (lack of cooperation, etc.)
    8 = other--miscellaneous written comments

+ Response Ratings

    0 = normal good responses or better
    1 = often signaled when no tone played
    2 = participant disinterested, not trying hard
    3 = participant's responses seemed somewhat
        erratic
    4 = participant very restless and "fidgety"
    5 = participant talked frequently throughout test
    6 = participant claimed to hear extraneous noises
        during test (see written comments)
    7 = participant's parent in booth during testing
    8 = other--miscellaneous written comments
    9 = participant did well at the beginning but
        lost concentration toward end of test

Continuity - Sixty-eight percent of the younger boys
completed the test without interruption (score = 0), while
of the older boys 87 percent were able to complete the test
without resting. The corresponding percentages for girls
were 65 percent for younger girls, and 88 percent for older
girls. A short interruption in the testing between ears
(score = 1) for both sexes was much more common in the
younger children than in the older children, although there
was little evidence of a systematic age difference in the
frequency of interruptions during the testing of a particular
ear (scores 2 and 3). Multiple interruptions in the overall
testing procedure (score = 4) were slightly more common in
the younger children than in the older children.

There was little difference between the two age groups
in the percentage of individuals who had to be retested at
some frequency (score = 5). While 2 percent of the younger
boys and 4 percent of the younger girls insisted that the
test be discontinued (score = 6), none of the older children
requested that the test be terminated. These findings are
consistent with our earlier findings concerning a higher
frequency of incomplete examinations in children younger
than 6 years old.

Responses - There was little difference between the sexes
in frequencies of good responses (score = 0), though good
responses were more common among the older children than among
the younger children. From 2 to 7 percent of the children
gave false responses often (score = 1). This was about as
common in older children as in younger children, and about
as common in boys as girls. Erratic responses, talking,
disinterest, and restlessness of participants (scores 2, 3,
4, 5, 9) were slightly more common in younger children.

OTOLOGICAL INSPECTIONS

Preceding the testing of auditory thresholds, an otological
inspection was given each participant to record deviations from
normality. In each category, a score of zero indicates a normal
finding. The definitions of the findings indicated by each of
the other scores of the otological inspection are given in
Table 3. Tables 4 through 7 give the prevalence of each rating
code for right and left ear of boys and girls 6 to 11 and 12
to 17 years old. The sample represented in these tables includes
all children examined since testing commenced in August, 1975.

Tragus - There is little difference between age groups or
sexes in the frequency of abnormal tragi, almost all being normal,
and a maximum of 1 percent in any age group being considered
"very large" (score = 1).

Meatus - The most frequent meatal abnormalities concerned
obstructions of the external auditory canal. There seemed
to be little sex or age difference for obstructed meati.

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TABLE 3 - DEFINITION OF RATING CODES USED IN OTOLOGICAL
EXAMINATIONS

Item	Code		Definition

Tragus

	0	=	normal
	1	=	very large
	8	=	other--miscellaneous written comments
	9	=	no examination

Meatus

	0	=	normal
	1	=	completely closed
	2	=	badly obstructed with wax, dirt, hair, almost closed
	3	=	very small or slit-like opening but unobstructed
	4	=	small opening badly obstructed with wax
	5	=	much wax, etc. in canal but not obstructed
	6	=	canal open but rather inflamed (very red) looking
	8	=	other--miscellaneous written comments
	9	=	no examination

Ear Drum

	0	=	normal
	1	=	perforated
	2	=	not seen because meatus small or obstructed
	3	=	scarred
	8	=	other--miscellaneous written comments
	9	=	no examination

Ear Drum, Cone of Light

	0	=	cone of light seen
	1	=	cone of light not seen (meatus too small or obstructed)
	2	=	cone of light not seen for other reasons
	8	=	other--miscellaneous written comments
	9	=	no examination

Ear Drum, Color

	0	=	normal
	1	=	very red and inflamed looking
	2	=	dull
	3	=	yellowish
	4	=	redder than normal, but no inflamed looking
	8	=	other-- miscellaneous written comments
	9	=	no examination

TABLE 3 - DEFINITION OF RATING CODES USED IN OTOLOGICAL
            EXAMINATIONS (CONTINUED)

Item   Code   Definition

General Health at Time of Test

            0   =   normal, not ill
            1   =   has "cold," but no ear problems
            2   =   is congested due to "sinus allergy"
            3   =   both ears "stopped up"
            4   =   right ear "stopped up"
            5   =   left ear "stopped up"
            6   =   has ear infection, but no earache
            7   =   has ear infection, with earache
            8   =   other--miscellaneous written comments
            9   =   not recorded

        Tympanic Membrane - Only one child had a perforated ear
drum when examined, and none had drum scars. The most common
abnormalities are those dealing with the ability to see the
cone of light reflected from the ear drum on otoscopic inspection.
In about 20 percent of the inspections, the cone of light was
not seen because of external auditory canal occlusion. In about
18 percent of the examinations, the cone of light was not seen
for other reasons (code = 2); the rather high frequencies of
this item may indicate inexperience of technicians, rather
than ear pathology. Five to 8 percent of boys and girls had
drums that were dull in appearance, lacking the luster typical
of the normal tympanic membrane. There was little difference
between the age groups. From 1 to 3 percent of the children
inspected had ear drums that were red, suggesting some inflamma-
tion. The frequencies of additional comments (score = 8)
indicates that many of the participants' conditions did not
fit into any of the categories given.

THRESHOLDS

        General Findings - Thresholds tend to decrease over time
in children aged 6 to 17 years. The changes are summarized in
Table 8, which presents, for each sex at each frequency in
better and worse ears, the slopes of the linear regression of
threshold on age. These slopes are smaller at higher
frequencies in the boys. In both sexes, and in both ears,
the tendency for a decrease in thresholds over age is
present; in most cases, the slopes are significantly
different from zero. There is also a tendency for the
change with age to be smaller as the frequencies increase.
The implication of these findings is that hearing improves
during this age range. An alternative explanation is
that the children's concentration and ability to perform
the threshold examination improves with age, implying
that thresholds measured in younger children are not
their true thresholds.

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TABLE 4 - PERCENTAGE OF EXAMINATIONS OF CHILDREN
6-11 YEARS OF AGE WITH SPECIFIC CODES
ON OTOLOGICAL INSPECTION (LEFT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of Light	Color
Boys					
0	99	72	82	66	76
1	0	0	1	16	2
2	--	10	12	17	5
3	--	3	0	--	0
4	--	2	--	--	1
5	--	10	--	--	--
6	--	1	--	--	--
8	1	2	5	1	10
9	0	0	0	0	6
Girls					
0	100	64	74	60	65
1	0	2	0	22	1
2	--	12	17	16	5
3	--	5	0	--	0
4	--	2	--	--	3
5	--	10	--	--	--
6	--	3	--	--	--
8	0	2	8	2	18
9	0	0	1	0	8

[1]See Table 3 for code definitions.
Based on data from approximately 229 examinations in
boys and 185 examinations in girls.

TABLE 5 - PERCENTAGE OF EXAMINATIONS OF CHILDREN
12-17 YEARS OF AGE WITH SPECIFIC CODE
ON OTOLOGICAL INSPECTION (LEFT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of light	Color
Boys					
0	98	75	81	63	70
1	1	1	0	15	2
2	--	10	10	18	8
3	--	1	0	--	0
4	--	0	--	--	2
5	--	9	--	--	--
6	--	1	--	--	--
8	1	3	8	3	13
9	0	0	1	1	5
Girls					
0	100	77	84	61	77
1	0	2	0	19	1
2	--	8	10	18	6
3	--	1	0	--	0
4	--	0	--	--	0
5	--	8	--	--	--
6	--	1	--	--	--
8	0	3	5	2	11
9	0	0	1	0	5

[1] See Table 3 for code definitions.
Based on data from approximately 300 examinations in
boys and 336 examinations in girls.

TABLE 6 - PERCENTAGE OF EXAMINATIONS OF CHILDREN 6-11 YEARS OF AGE WITH SPECIFIC CODES ON OTOLOGICAL INSPECTION (RIGHT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of Light	Color
Boys					
0	99	68	83	62	77
1	0	0	0	16	0
2	--	10	11	19	7
3	--	4	0	--	0
4	--	2	--	--	0
5	--	14	--	--	--
6	--	0	--	--	--
8	1	2	6	3	12
9	0	0	0	0	4
Girls					
0	100	64	79	58	74
1	0	0	0	23	1
2	--	15	15	17	5
3	--	3	0	--	0
4	--	3	--	--	1
5	--	12	--	--	--
6	--	1	--	--	--

[1]See Table 3 for code definitions.
 Based on data from approximately 229 examinations in boys and 185 examinations in girls.

TABLE 7 -PERCENTAGE OF EXAMINATIONS OF CHILDREN 12-17
YEARS OF AGE WITH SPECIFIC CODES ON OTOLOGICAL
INSPECTION (RIGHT EAR)[1]

Code	Tragus	Meatus	Ear Drum	Cone of light	Color
Boys					
0	98	72	84	59	78
1	1	1	0	19	0
2	--	10	10	20	5
3	--	1	0	--	0
4	--	0	--	--	2
5	--	11	--	--	--
6	--	2	--	--	--
8	1	3	6	2	10
9	0	0	0	0	5
Girls					
0	100	72	82	63	79
1	0	4	0	20	0
2	--	9	12	15	5
3	--	1	0	--	0
4	--	1	--	--	0
5	--	9	--	--	--
6	--	1	--	--	--
8	0	3	5	2	12
9	0	0	1	0	4

[1] See Table 3 for code definitions.
Based on data from approximately 300 examinations in
boys and 336 examinations in girls.

TABLE 8 - SLOPE OF THE LINEAR REGRESSION OF AUDITORY
THRESHOLD ON AGE IN BETTER OR WORSE EARS OF
CHILDREN AGED 6 TO 17 YEARS

Frequency (Hz)	Better ear Slope (dB/year)	Worse Ear Slope
Boys		
500	-0.4 ± 0.1 **	-0.5 ± 0.1 **
1000	-0.3 ± 0.1 **	-0.4 ± 0.1 **
2000	-0.2 ± 0.1 *	-0.2 ± 0.1 *
4000	-0.1 ± 0.1	-0.1 ± 0.1
6000	-0.2 ± 0.1 *	-0.1 ± 0.1
Girls		
500	-0.7 ± 0.1 **	-0.8 ± 0.1 **
1000	-0.6 ± 0.1 **	-0.5 ± 0.1 **
2000	-0.6 ± 0.1 **	-0.5 ± 0.1 **
4000	-0.6 ± 0.1 **	-0.4 ± 0.1 **
6000	-0.5 ± 0.1 **	-0.4 ± 0.1 **

* $.01 < p \leq .05$

** $p \leq .01$

Threshold data at each annual age between 6 and 17 years
are summarized in Tables 9 through 32. Each table presents,
for a specific age and sex, the sample size, mean, standard
deviation and quartiles for each frequency in right, left,
better and worse ears and the right-left differences. In
addition to standard frequencies, three derived variables are
included. The difference between the two 1000 Hz tests (1st
less 2nd) is designated "D1" and the difference between
thresholds at 1000 Hz and 4000 Hz (1000 less 4000) is designated
"D4." Finally, the mean threshold of those tested at 500 Hz,
1000 Hz and 2000 Hz, within an ear, is designated "M512."

The variation (standard deviation) about the mean threshold
appears to be fairly constant across frequencies in a given ear
(Tables 9-32); although there may be slightly more variation at
the higher frequencies. The older children appear to show slightly
less variation than the younger ones, with the exception of 17 year
old males, who have unusually large standard deviations.

There is a very definite tendency, apparent at most every
age, in each sex and ear, for thresholds to be higher at 4000 and
6000 Hz, than at 500, 1000 and 2000 Hz. Analysis of variance
(randomized block design) indicated that significant differences
among frequencies occurred at virtually every age. Duncan's
multiple range tests indicated that there was a tendency for the 500,
1000 and 2000 Hz frequencies to have means not significantly
different from each other; these threshold means tend to be smaller
than those at 4000 and 6000 Hz. This effect was most pronounced
in children aged 14 years and older. these findings are summarized
in Table 33, where the overall mean auditory thresholds at each
frequency are reported for right and left ears in boys and girls.
In virtually every case, the ranking of means from largest to
smallest is: 6000 Hz, 4000 Hz, 500 Hz, 1000 Hz, 2000 Hz.

Furthermore, there is a significanct Spearman rank correlation
between age and auditory thresholds in each ear and sex at virtually
every frequency (Table 34). The correlations are highly significant
and all negative. There tend to be higher negative correlations
with age at the lower frequencies. A negative correlation indicates
that as the chidlren get older, their tresholds get lower; that
is, their hearing improves. The negative correlations are somewhat
larger in girls (-.2 to -.4),. than in boys (-.1 to -.3).

Median thresholds are grouped across age for each
frequency in better and worse ears in Figures 2 through 11.
Each of these figures compares boys with girls. With a single
exception, at each frequency, and in both the better
and worse ears, there is a tendency for the median threshold
at an age to be lower in girls, that is, the girls have better
hearing. However, t-tests testing the significance of the
sex differences between means at each frequency at each annual age
revealed no significant differences. The tendency for females to
have lower thresholds is least apparent at 4000 Hz.

TABLE 9 — DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	36	4.44	7.17	0.5	4.0	8.0
1000	37	3.84	8.30	0.0	4.0	10.0
2000	37	0.05	7.42	-6.0	0.0	6.0
4000	37	2.00	7.47	-4.0	2.0	7.0
6000	36	4.00	8.43	0.0	2.0	9.5
M512	36	3.00	6.25	0.0	2.5	9.0
D4	37	1.84	9.62	-4.0	0.0	6.0
D1	37	0.81	3.54	0.0	0.0	4.0
LEFT EAR						
500	30	5.13	9.03	0.0	3.0	8.5
1000	31	2.52	8.45	-4.0	0.0	8.0
2000	35	2.69	10.73	-4.0	2.0	8.0
4000	33	4.97	10.10	0.0	2.0	10.0
6000	31	6.06	8.37	0.0	8.0	12.0
M512	30	3.77	7.76	-1.2	1.0	5.5
D4	31	-1.87	8.99	-8.0	0.0	6.0
D1	31	0.32	3.83	-2.0	0.0	2.0
BETTER EAR						
500	37	2.00	6.72	-2.0	2.0	6.0
1000	37	0.65	6.90	-5.0	0.0	4.0
2000	37	-2.22	6.71	-8.0	-4.0	3.0
4000	37	-0.32	6.79	-4.0	0.0	2.0
6000	37	1.68	7.49	-2.0	0.0	7.0
M512	37	0.54	5.58	-4.0	1.0	4.0
D4	37	0.97	7.60	-4.0	0.0	5.0
WORSE EAR						
500	29	8.28	8.26	4.0	6.0	11.0
1000	31	6.32	8.95	0.0	4.0	14.0
2000	35	5.09	10.05	0.0	4.0	10.0
4000	33	7.58	9.15	3.0	6.0	12.0
6000	30	9.00	7.77	2.0	10.0	14.0
M512	29	6.97	7.30	1.5	5.0	12.0
D4	31	-0.84	10.20	-8.0	0.0	6.0
LEFT-RIGHT DIFFERENCES						
500	29	-0.41	9.20	-6.0	0.0	3.0
1000	31	-1.61	8.57	-6.0	-2.0	2.0
2000	35	2.51	11.29	-4.0	0.0	6.0
4000	33	2.97	11.72	-4.0	2.0	8.0
6000	30	1.67	9.35	-4.0	2.0	8.0
M512	29	0.52	6.98	-2.5	0.0	2.5

TABLE 10 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	27	3.33	7.06	0.0	2.0	6.0
1000	29	2.48	6.84	-1.0	2.0	6.0
2000	30	-0.13	5.96	-4.0	1.0	4.5
4000	29	3.79	6.15	0.0	4.0	9.0
6000	28	3.50	8.14	-2.0	4.0	7.5
M512	27	1.74	4.98	0.0	1.0	4.0
D4	28	-1.29	7.61	-6.0	-2.0	5.5
D1	29	0.41	2.69	-1.0	0.0	2.0
LEFT EAR						
500	21	3.14	8.73	-2.0	0.0	5.0
1000	23	-0.09	8.06	-6.0	0.0	4.0
2000	24	1.25	7.15	-2.0	1.0	5.5
4000	22	6.00	9.56	-0.5	6.0	12.0
6000	21	6.00	11.80	-3.0	6.0	13.0
M512	21	1.38	7.04	-2.0	0.0	2.5
D4	21	-6.38	8.55	-13.0	-6.0	0.0
D1	23	0.26	2.85	0.0	0.0	2.0
BETTER EAR						
500	27	1.41	5.89	-2.0	0.0	4.0
1000	29	-0.90	5.97	-6.0	0.0	4.0
2000	30	-1.53	5.70	-6.0	-2.0	2.5
4000	29	2.76	6.24	-1.0	4.0	7.0
6000	28	1.71	7.81	-3.5	2.0	6.0
M512	27	-0.15	4.38	-2.0	0.0	3.0
D4	28	-3.71	7.11	-7.5	-4.0	0.0
WORSE EAR						
500	21	5.62	9.24	0.0	2.0	9.0
1000	23	4.17	8.24	0.0	2.0	8.0
2000	24	3.00	6.65	0.0	3.0	6.0
4000	22	7.36	8.95	1.5	8.0	12.0
6000	21	8.38	11.11	-1.0	8.0	15.0
M512	21	3.95	7.05	0.0	3.0	5.5
D4	21	-4.10	7.99	-10.0	-6.0	4.0
LEFT-RIGHT DIFFERENCES						
500	21	0.38	7.92	-3.0	0.0	4.0
1000	23	-1.91	8.12	-8.0	-2.0	2.0
2000	24	1.25	6.43	-3.5	0.0	7.0
4000	22	2.09	5.77	-2.0	3.0	6.0
6000	21	3.05	10.89	-4.0	2.0	7.0
M512	21	0.48	5.21	-3.0	0.0	2.0

TABLE 11 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	3.57	8.51	-2.0	4.0	8.0
1000	37	2.97	9.16	-3.0	2.0	7.0
2000	38	-0.47	7.43	-6.0	0.0	4.5
4000	38	3.32	7.22	0.0	5.0	10.0
6000	38	3.00	8.34	-7.5	3.0	7.0
M512	37	2.43	6.91	-1.5	2.0	7.0
D4	37	-0.05	7.43	-6.0	0.0	4.0
D1	37	0.92	2.61	0.0	0.0	2.0
LEFT EAR						
500	37	1.03	7.16	-4.0	0.0	5.0
1000	38	0.95	8.35	-6.0	0.0	6.5
2000	38	-0.11	8.29	-6.0	-1.0	4.5
4000	38	3.00	7.49	-2.0	4.0	8.0
6000	37	3.89	9.79	-4.0	4.0	11.0
M512	37	1.00	6.40	-4.0	1.0	5.0
D4	38	-2.05	8.89	-10.0	-1.0	4.5
D1	38	0.05	3.62	-2.0	0.0	2.0
BETTER EAR						
500	38	0.16	7.36	-4.5	0.0	4.0
1000	38	-0.26	8.06	-8.0	0.0	6.0
2000	38	-2.68	7.07	-7.0	-4.0	2.0
4000	38	0.21	7.36	-4.5	0.0	6.0
6000	38	0.56	8.66	-6.5	0.0	4.5
M512	38	-0.39	6.31	-6.0	0.0	3.0
D4	38	-0.47	6.98	-6.0	0.0	4.5
WORSE EAR						
500	36	4.56	7.95	-2.0	4.0	9.5
1000	37	4.22	8.98	-2.0	4.0	8.0
2000	38	2.11	7.89	-4.0	1.0	6.5
4000	38	6.11	6.03	2.0	6.0	10.0
6000	37	6.38	8.55	2.0	6.0	11.0
M512	36	3.89	6.79	0.0	4.5	7.0
D4	37	-1.68	8.35	-8.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	36	-2.39 *	6.50	-4.0	-2.0	1.5
1000	37	-1.68	6.17	-4.0	0.0	2.0
2000	38	0.37	6.32	-4.0	0.0	4.0
4000	38	-0.32	8.40	-4.0	0.0	4.0
6000	37	0.92	7.19	-5.0	0.0	6.0
M512	36	-0.61	4.31	-1.0	0.0	3.0

* .01< p ≤ .05

TABLE 12 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	31	3.35	7.01	-2.0	2.0	8.0
1000	31	1.23	7.96	-4.0	0.0	6.0
2000	31	-0.26	6.30	-4.0	0.0	4.0
4000	31	3.68	8.81	-2.0	4.0	8.0
6000	31	2.32	8.92	-2.0	0.0	4.0
M512	31	1.97	5.94	-2.0	0.0	5.0
D4	31	-2.45	7.67	-8.0	-4.0	4.0
D1	31	1.48	3.93	0.0	2.0	4.0
LEFT EAR						
500	27	0.67	5.32	-2.0	0.0	4.0
1000	28	-0.43	5.64	-4.0	0.0	3.5
2000	28	0.71	4.88	-4.0	0.0	6.0
4000	28	0.50	6.75	-5.5	0.0	6.0
6000	28	0.50	7.46	-4.0	0.0	5.5
M512	27	0.78	3.91	-2.0	0.0	3.0
D4	28	-0.93	7.35	-6.0	-1.0	4.0
D1	28	0.50	2.22	0.0	0.0	2.0
BETTER EAR						
500	31	0.26	5.88	-2.0	0.0	2.0
1000	31	-1.10	6.34	-6.0	0.0	4.0
2000	31	-1.81	4.80	-4.0	-2.0	2.0
4000	31	-0.39	6.35	-6.0	0.0	4.0
6000	31	-0.52	6.71	-4.0	0.0	2.0
M512	31	-0.19	4.32	-3.0	0.0	2.0
D4	31	-0.71	7.67	-4.0	0.0	4.0
WORSE EAR						
500	27	4.22	6.36	0.0	4.0	8.0
1000	28	2.14	7.30	-3.5	0.0	6.0
2000	28	2.43	5.74	0.0	2.0	6.0
4000	28	5.00	8.75	-1.5	6.0	8.0
6000	28	3.64	9.29	-1.5	2.0	7.5
M512	27	3.19	5.53	0.0	2.0	6.0
D4	28	-2.86	6.96	-8.0	-4.0	1.5
LEFT-RIGHT DIFFERENCES						
500	27	-2.81*	5.64	-6.0	-2.0	0.0
1000	28	-1.50	5.41	-4.0	-1.0	1.5
2000	28	0.71	5.37	-2.0	0.0	4.0
4000	28	-3.71**	6.92	-6.0	-3.0	2.0
6000	28	-2.00	5.91	-6.0	0.0	0.0
M512	27	-0.70	4.08	-2.0	0.0	1.0

* .01 < p ≤ .05

** p ≤ .01

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TABLE 13 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	42	1.33	8.04	-4.0	1.0	6.0
1000	42	0.33	6.80	-4.0	0.0	4.0
2000	42	-0.24	7.98	-6.0	0.0	4.5
4000	42	1.71	6.56	-2.0	1.0	6.0
6000	42	2.62	9.09	-2.0	2.0	6.5
M512	42	0.93	5.68	-1.0	1.5	3.0
D4	42	-1.38	6.29	-4.0	-2.0	2.0
D1	42	1.38	2.81	0.0	0.0	2.5
LEFT EAR						
500	42	-0.29	7.98	-4.0	0.0	2.0
1000	42	0.29	6.21	-4.0	0.0	4.0
2000	42	-0.62	7.71	-6.5	2.0	4.0
4000	42	0.48	6.17	-4.0	0.0	6.0
6000	42	2.76	9.32	-2.5	4.0	8.5
M512	42	0.29	5.33	-3.3	0.5	3.0
D4	42	-0.19	6.87	-4.0	0.0	4.5
D1	42	0.52	3.25	0.0	0.0	2.0
BETTER EAR						
500	42	-1.33	7.41	-6.5	-2.0	2.0
1000	42	-1.62	6.53	-6.0	-2.0	2.0
2000	42	-2.95	7.65	-10.0	-5.0	2.5
4000	42	-1.14	5.96	-4.0	-2.0	2.5
6000	42	-0.14	7.53	-2.5	0.0	4.0
M512	42	-1.29	5.16	-6.0	0.0	1.2
D4	42	-0.48	5.58	-4.0	0.0	2.5
WORSE EAR						
500	42	2.38	8.23	-2.0	2.0	6.0
1000	42	2.24	5.88	-2.0	2.0	4.0
2000	42	2.10	7.18	-0.5	4.0	6.0
4000	42	3.33	6.00	0.0	4.0	8.0
6000	42	5.52	9.82	0.0	6.0	10.5
M512	42	2.50	5.42	0.0	3.0	5.0
D4	42	-1.10	6.69	-4.5	0.0	4.0
LEFT-RIGHT DIFFERENCES						
500	42	-1.62*	4.76	-4.5	-2.0	0.5
1000	42	-0.05	5.38	-2.0	0.0	4.0
2000	42	-0.38	6.96	-4.0	0.0	4.5
4000	42	-1.24	6.10	-6.0	0.0	2.0
6000	42	0.14	8.24	-4.0	0.0	6.0
M512	42	-0.17	3.39	-1.0	0.0	1.0

* .01 < $p \leq$ .05

TABLE 14 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	3.59	6.82	-0.5	5.0	8.0
1000	35	0.86	6.49	-4.0	0.0	6.0
2000	35	-1.31	7.45	-6.0	-2.0	2.0
4000	35	2.91	8.45	-4.0	4.0	8.0
6000	35	0.69	9.63	-8.0	0.0	6.0
M512	34	1.59	5.12	-1.0	1.0	5.5
D4	35	-2.06	9.26	-10.0	-2.0	4.0
D1	35	1.77	3.69	0.0	2.0	4.0
LEFT EAR						
500	34	0.18	7.29	-6.0	0.0	6.0
1000	34	-2.06	7.34	-8.5	-1.0	2.5
2000	34	-2.29	5.31	-4.5	-2.0	1.0
4000	34	-0.82	6.64	-6.0	0.0	4.0
6000	34	-0.65	8.75	-8.5	0.0	6.0
M512	34	-0.88	4.82	-4.0	0.0	1.2
D4	34	-1.24	8.50	-6.5	-2.0	2.0
D1	34	1.53	3.78	0.0	2.0	4.0
BETTER EAR						
500	34	-1.12	6.90	-7.0	0.0	4.0
1000	35	-2.51	6.92	-8.0	-4.0	2.0
2000	35	-4.29	4.63	-8.0	-4.0	-2.0
4000	35	-2.69	6.67	-8.0	-2.0	2.0
6000	35	-2.63	6.99	-10.0	-2.0	4.0
M512	34	-1.88	4.54	-5.3	-1.0	0.2
D4	35	0.17	8.19	-4.0	0.0	2.0
WORSE EAR						
500	34	4.88	6.29	0.0	6.0	10.0
1000	34	1.41	6.67	0.0	2.0	6.0
2000	34	0.76	7.10	-4.0	0.0	4.0
4000	34	4.94	6.98	0.0	5.0	10.0
6000	34	2.76	10.36	-8.0	4.0	8.5
M512	34	2.68	5.19	0.0	2.0	7.0
D4	34	-3.53	8.53	-10.0	-4.0	0.5
LEFT-RIGHT DIFFERENCES						
500	34	-3.41 **	6.63	-8.0	-4.0	0.5
1000	34	-3.06 **	4.60	-6.0	-2.0	0.0
2000	34	-1.12	7.41	-4.0	0.0	2.5
4000	34	-4.00 *	9.07	-8.0	-5.0	2.0
6000	34	-1.47	7.82	-4.5	0.0	2.0
M512	34	-1.85 **	3.81	-4.0	-2.0	0.2

* .01 < p $\leq$ .05

** p $\leq$ .01

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TABLE 15 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	1.84	9.62	-5.0	0.0	7.0
1000	37	0.97	8.39	-4.0	0.0	5.0
2000	37	0.92	8.12	-4.0	0.0	4.0
4000	37	1.73	6.53	-2.0	2.0	6.0
6000	37	2.05	8.08	-5.0	2.0	8.0
M512	37	1.62	6.53	-2.5	1.0	6.0
D4	37	-0.76	7.86	-5.0	-2.0	4.0
D1	37	1.03	2.77	0.0	0.0	2.0
LEFT EAR						
500	35	0.34	8.66	-4.0	0.0	4.0
1000	35	-0.23	8.23	-6.0	-2.0	6.0
2000	36	-1.06	8.19	-8.0	-2.0	4.0
4000	36	-0.67	6.22	-4.0	0.0	4.0
6000	35	3.94	10.05	-4.0	4.0	10.0
M512	35	0.26	6.53	-4.0	0.0	5.0
D4	35	0.40	6.56	-4.0	0.0	4.0
D1	35	0.57	3.35	0.0	0.0	2.0
BETTER EAR						
500	37	-0.65	8.47	-6.0	-2.0	2.0
1000	37	-1.68	7.67	-7.0	-2.0	4.0
2000	37	-1.95	7.82	-8.0	-4.0	2.0
4000	37	-1.89	5.60	-5.0	-2.0	2.0
6000	37	-0.16	8.37	-6.0	2.0	5.0
M512	37	-0.78	5.90	-4.5	-1.0	2.5
D4	37	0.22	7.08	-6.0	0.0	4.0
WORSE EAR						
500	35	2.97	9.55	-2.0	2.0	8.0
1000	35	2.57	8.44	-2.0	2.0	10.0
2000	36	1.89	8.14	-4.0	1.0	5.5
4000	36	3.06	6.37	0.0	4.0	8.0
6000	35	6.29	8.71	0.0	6.0	12.0
M512	35	2.91	6.88	-1.0	2.0	6.0
D4	35	-0.63	6.56	-4.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	35	-1.77*	4.70	-4.0	0.0	2.0
1000	35	-1.26	6.06	-8.0	0.0	2.0
2000	36	-1.94*	4.82	-4.0	-2.0	1.5
4000	36	-2.50*	6.26	-6.0	-2.0	1.5
6000	35	1.89	7.87	-4.0	2.0	8.0
M512	35	-1.11	3.40	-3.0	0.0	1.0

* .01 < p $\leq$ .05

TABLE 16 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	30	-0.33	5.71	-4.0	0.0	4.0
1000	30	-1.53	4.97	-6.0	-2.0	2.5
2000	30	-1.73	5.65	-6.0	-2.0	4.0
4000	30	0.93	7.44	-6.0	1.0	6.0
6000	30	1.87	8.07	-4.0	2.0	6.0
M512	30	-0.63	3.74	-3.0	0.0	2.3
D4	30	-2.47	8.18	-7.5	-2.0	2.5
D1	30	0.67	2.75	-2.0	0.0	2.0
LEFT EAR						
500	26	-0.69	5.93	-6.0	0.0	4.0
1000	28	-1.21	6.85	-6.0	-3.0	4.0
2000	29	-2.83	4.91	-6.0	-2.0	0.0
4000	28	0.29	5.52	-4.0	2.0	6.0
6000	28	0.93	7.84	-6.0	1.0	7.5
M512	26	-1.04	4.28	-4.3	0.0	1.5
D4	27	-1.85	7.36	-8.0	-2.0	2.0
D1	28	-0.43	2.90	-2.0	0.0	0.0
BETTER EAR						
500	30	-1.93	5.50	-6.0	-2.0	2.0
1000	30	-3.40	5.23	-6.5	-4.0	0.0
2000	30	-4.60	4.04	-8.0	-4.0	-2.0
4000	30	-1.40	5.54	-6.0	-2.0	4.0
6000	30	-0.73	7.47	-6.5	0.0	4.0
M512	30	-2.60	3.65	-4.0	-2.5	0.0
D4	30	-2.00	6.71	-6.5	-2.0	0.0
WORSE EAR						
500	26	1.15	5.72	-2.5	2.0	4.0
1000	28	0.79	5.90	-4.0	1.0	4.0
2000	29	0.14	5.40	-4.0	0.0	5.0
4000	28	2.79	6.91	0.0	3.0	6.0
6000	28	3.71	7.83	0.5	4.0	10.0
M512	26	1.12	4.14	-1.2	1.0	3.0
D4	27	-2.37	7.36	-6.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	26	-0.38	4.31	-4.0	0.0	2.5
1000	28	0.29	5.75	-4.0	0.0	5.0
2000	29	-1.10	6.36	-5.0	0.0	4.0
4000	28	-0.43	6.07	-4.0	0.0	4.0
6000	28	-0.71	6.72	-3.5	0.0	4.0
M512	26	0.23	3.01	-1.2	0.0	1.2

TABLE 17 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	40	2.35	7.80	-2.0	0.0	6.0
1000	40	0.25	7.31	-5.5	0.0	6.0
2000	40	1.15	6.56	-4.0	2.0	6.0
4000	40	2.50	6.84	-3.5	4.0	8.0
6000	40	1.55	6.48	-4.0	2.0	6.0
M512	40	1.63	5.12	-1.0	1.0	4.8
D4	40	-2.25	7.91	-6.0	-4.0	1.5
D1	40	1.90	2.60	0.0	2.0	4.0
LEFT EAR						
500	37	0.05	7.89	-5.0	0.0	4.0
1000	39	-0.67	6.98	-4.0	-2.0	2.0
2000	39	-1.23	6.35	-6.0	-2.0	4.0
4000	39	1.69	6.74	-4.0	0.0	8.0
6000	39	3.85	7.94	0.0	4.0	10.0
M512	37	0.08	5.41	-2.0	0.0	2.5
D4	39	-2.36	7.22	-6.0	-2.0	2.0
D1	39	0.36	3.37	-2.0	0.0	2.0
BETTER EAR						
500	40	-0.70	7.90	-4.0	-2.0	4.0
1000	40	-2.10	6.26	-6.0	-4.0	1.5
2000	40	-2.20	6.21	-6.0	-4.0	3.5
4000	40	-1.30	5.95	-4.0	-2.0	2.0
6000	40	-0.15	6.77	-6.0	0.0	4.0
M512	40	-1.02	4.85	-3.7	-1.0	0.7
D4	40	-0.80	6.93	-6.0	0.0	3.5
WORSE EAR						
500	37	3.35	7.39	0.0	0.0	6.0
1000	39	1.74	7.49	-4.0	0.0	8.0
2000	39	2.21	6.15	0.0	2.0	6.0
4000	39	5.59	5.72	2.0	6.0	10.0
6000	39	5.54	6.68	0.0	6.0	10.0
M512	37	2.86	5.47	0.0	2.0	6.0
D4	39	-3.85	6.87	-6.0	-6.0	0.0
LEFT-RIGHT DIFFERENCES						
500	37	-2.16 *	5.38	-6.0	-2.0	2.0
1000	39	-0.92	4.98	-4.0	0.0	2.0
2000	39	-2.62 **	4.92	-6.0	-2.0	0.0
4000	39	-0.87	8.72	-6.0	-2.0	6.0
6000	39	2.36	7.37	-2.0	2.0	8.0
M512	37	-1.32 *	3.20	-3.0	0.0	0.5

* .01 < p ≤ .05

** p ≤ .01

TABLE 18 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	29	-1.31	5.35	-6.0	0.0	2.0
1000	29	-1.03	5.55	-6.0	-2.0	4.0
2000	29	-0.28	6.41	-4.0	-2.0	2.0
4000	29	1.24	7.38	-4.0	0.0	6.0
6000	29	1.10	7.16	-4.0	2.0	5.0
M512	29	-0.31	3.87	-2.5	0.0	2.0
D4	29	-2.28	9.39	-6.0	0.0	4.0
D1	29	0.97	2.37	0.0	0.0	3.0
LEFT EAR						
500	29	-1.45	5.93	-4.0	-2.0	2.0
1000	29	-2.69	7.84	-10.0	-4.0	4.0
2000	29	-4.07	5.79	-8.0	-6.0	-1.0
4000	28	-0.36	7.66	-7.5	0.0	4.0
6000	29	-0.14	8.33	-7.0	-2.0	6.0
M512	29	-2.07	5.00	-6.0	-2.0	1.5
D4	28	-2.21	7.70	-6.0	-2.0	2.0
D1	29	1.38	3.71	0.0	0.0	4.0
BETTER EAR						
500	29	-3.72	5.36	-7.0	-4.0	0.0
1000	29	-4.90	5.89	-10.0	-6.0	1.0
2000	29	-5.10	4.80	-9.0	-6.0	-2.0
4000	29	-2.34	7.11	-10.0	-2.0	4.0
6000	29	-3.10	7.36	-10.0	-6.0	3.0
M512	29	-3.79	4.11	-7.0	-3.0	0.0
D4	29	-2.55	6.74	-6.0	-2.0	2.0
WORSE EAR						
500	29	0.97	4.86	-2.0	0.0	4.0
1000	29	1.17	6.31	-5.0	2.0	6.0
2000	29	0.76	6.42	-3.0	0.0	4.0
4000	28	3.36	6.84	-1.5	3.0	7.5
6000	29	4.07	6.38	-1.0	4.0	6.0
M512	29	1.41	4.32	-2.0	0.0	4.5
D4	28	-1.93	9.12	-6.0	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	29	-0.14	5.78	-5.0	-2.0	4.0
1000	29	-1.66	7.50	-7.0	-2.0	3.0
2000	29	-3.79**	6.01	-8.0	-4.0	0.0
4000	28	-2.07	6.52	-6.0	-2.0	2.0
6000	29	-1.24	9.26	-9.0	0.0	4.0
M512	29	-1.21	3.56	-4.0	-2.0	1.0

** p ≤ .01

TABLE 19 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	35	0.06	6.92	-4.0	0.0	4.0
1000	36	-0.22	6.23	-4.0	0.0	4.0
2000	36	-2.17	6.00	-6.0	-2.0	0.0
4000	36	-0.22	6.10	-5.5	1.0	4.0
6000	36	0.56	8.49	-6.0	-2.0	6.0
M512	35	-0.46	4.80	-4.0	0.0	3.0
D4	36	0.00	5.89	-4.0	0.0	2.0
D1	36	1.72	2.79	0.0	2.0	4.0
LEFT EAR						
500	36	-0.39	6.60	-5.5	0.0	4.0
1000	36	-0.44	5.64	-6.0	-1.0	3.5
2000	36	-5.56	5.06	-10.0	-6.0	-2.0
4000	36	-2.00	6.91	-6.0	-2.0	3.5
6000	36	0.33	7.86	-6.0	1.0	6.0
M512	36	-1.50	4.25	-4.8	-1.0	1.8
D4	36	1.56	7.52	-4.0	2.0	6.0
D1	36	-0.17	1.99	-2.0	0.0	0.0
BETTER EAR						
500	36	-1.44	6.57	-6.0	-2.0	3.5
1000	36	-1.94	5.73	-6.0	-2.0	2.0
2000	36	-5.94	5.14	-11.5	-7.0	-2.0
4000	36	-3.22	5.96	-7.5	-3.0	1.5
6000	36	-2.67	7.19	-8.0	-4.0	2.0
M512	36	-2.44	4.37	-5.8	-2.0	0.0
D4	36	1.28	5.56	-2.0	0.0	4.0
WORSE EAR						
500	35	1.14	6.71	-4.0	2.0	4.0
1000	36	1.28	5.70	-3.5	2.0	4.0
2000	36	-1.78	5.67	-6.0	-1.0	0.0
4000	36	1.00	6.48	-4.0	2.0	6.0
6000	36	3.56	7.90	-2.0	4.0	8.0
M512	35	0.51	4.55	-2.0	1.0	3.0
D4	36	0.28	6.25	-3.5	0.0	3.5
LEFT-RIGHT DIFFERENCES						
500	35	-0.80	4.09	-2.0	0.0	2.0
1000	36	-0.22	4.16	-3.5	0.0	4.0
2000	36	-3.39**	5.17	-6.0	-2.0	0.0
4000	36	-1.78 *	5.12	-6.0	-2.0	1.5
6000	36	-0.22	8.79	-3.5	2.0	4.0
M512	35	-0.80	2.55	-2.0	0.0	1.0

* .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 20 – DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	30	-1.67	4.93	-6.0	-2.0	2.0
1000	30	-2.67	5.59	-6.5	-2.0	0.5
2000	30	-2.00	7.93	-6.5	-4.0	2.0
4000	30	0.60	7.54	-4.0	0.0	6.0
6000	30	0.33	8.12	-4.0	1.0	6.0
M512	30	-1.50	4.48	-4.3	-0.5	1.0
D4	30	-3.27	8.21	-10.0	-5.0	1.0
D1	30	1.07	3.05	0.0	2.0	2.0
LEFT EAR						
500	30	-1.27	5.79	-6.0	0.0	4.0
1000	30	-2.40	4.91	-6.5	-2.0	0.0
2000	30	-3.47	6.56	-10.0	-4.0	0.0
4000	30	1.00	9.21	-6.0	-1.0	8.0
6000	30	3.33	8.67	-2.0	2.0	10.5
M512	30	-1.77	4.30	-5.3	-1.0	1.0
D4	30	-3.40	8.92	-8.0	-2.0	2.0
D1	30	0.40	2.59	-2.0	0.0	2.0
BETTER EAR						
500	30	-2.80	5.19	-6.5	-2.0	2.0
1000	30	-3.80	4.68	-8.0	-3.0	0.0
2000	30	-5.20	5.29	-10.0	-5.0	-2.0
4000	30	-2.27	7.23	-6.0	-4.0	4.5
6000	30	-1.47	6.97	-7.0	-2.0	4.5
M512	30	-3.10	3.99	-6.0	-2.0	0.0
D4	30	-1.53	7.64	-6.5	-1.0	2.5
WORSE EAR						
500	30	-0.13	5.22	-4.5	1.0	4.0
1000	30	-1.27	5.50	-4.5	0.0	2.0
2000	30	-0.27	8.15	-6.0	-2.0	4.0
4000	30	3.87	8.37	-2.0	4.0	9.0
6000	30	5.13	8.64	0.0	4.0	12.5
M512	30	-0.10	4.84	-4.0	0.0	2.5
D4	30	-5.13	8.08	-10.0	-6.0	0.0
LEFT-RIGHT DIFFERENCES						
500	30	0.40	3.30	-2.0	0.0	2.5
1000	30	0.27	3.96	-2.0	0.0	2.0
2000	30	-1.47	7.50	-4.5	-1.0	2.0
4000	30	0.40	7.87	-6.0	0.0	6.0
6000	30	3.00*	8.03	-2.0	1.0	10.0
M512	30	0.20	2.11	-1.2	0.0	1.0

* .01 <p $\leq$ .05

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TABLE 21 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	-0.53	4.81	-4.0	-1.0	2.0
1000	34	-0.88	4.49	-4.0	0.0	2.0
2000	34	-1.29	4.37	-6.0	-1.0	2.0
4000	34	-0.06	5.49	-4.0	1.0	4.0
6000	34	0.35	6.56	-4.0	0.0	6.0
M512	34	-0.24	2.97	-1.0	0.0	1.0
D4	34	-0.82	6.72	-6.0	-2.0	2.5
D1	34	1.71	2.15	0.0	2.0	2.5
LEFT EAR						
500	33	-1.27	8.98	-6.0	-2.0	2.0
1000	33	-1.94	4.49	-4.0	-2.0	0.0
2000	33	-3.82	6.64	-9.0	-6.0	1.0
4000	33	-2.24	7.26	-9.0	-2.0	4.0
6000	33	-0.24	7.79	-5.0	0.0	5.0
M512	33	-1.55	5.54	-4.0	-2.0	0.0
D4	33	0.30	7.95	-6.0	2.0	6.0
D1	33	0.91	2.79	0.0	0.0	2.0
BETTER EAR						
500	34	-3.12	3.94	-6.0	-2.0	0.0
1000	34	-3.12	3.76	-6.0	-4.0	0.0
2000	34	-5.35	4.56	-8.5	-6.0	-2.0
4000	34	-3.59	6.28	-10.0	-3.0	2.0
6000	34	-1.94	6.54	-6.0	-2.0	2.5
M512	34	-2.88	3.14	-4.3	-2.0	-0.7
D4	34	0.47	6.89	-4.0	2.0	6.0
WORSE EAR						
500	33	1.39	8.84	-4.0	0.0	4.0
1000	33	0.36	4.54	-2.0	0.0	2.0
2000	33	0.36	5.35	-3.0	0.0	3.0
4000	33	1.39	5.71	-4.0	2.0	5.0
6000	33	2.12	7.24	-4.0	4.0	6.0
M512	33	1.12	5.04	0.0	0.0	2.0
D4	33	-1.03	6.84	-6.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	33	-0.73	9.26	-4.0	-2.0	0.0
1000	33	-1.21	4.55	-4.0	0.0	2.0
2000	33	-2.48	7.05	-8.0	-4.0	2.0
4000	33	-2.06	6.43	-4.0	-2.0	3.0
6000	33	-0.55	6.27	-5.0	0.0	2.0
M512	33	-0.88	5.14	-3.5	0.0	0.0

TABLE 22 – DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	35	-0.11	5.55	-4.0	0.0	4.0
1000	36	-0.56	6.00	-4.0	0.0	3.5
2000	36	-1.50	7.03	-7.5	-2.0	3.5
4000	36	-0.22	7.85	-6.0	0.0	4.0
6000	36	-0.44	8.09	-7.5	0.0	4.0
M512	35	-0.17	4.97	-2.0	0.0	1.0
D4	36	-0.33	7.41	-6.0	0.0	4.0
D1	36	0.67	3.41	0.0	0.0	2.0
LEFT EAR						
500	35	1.54	12.22	-6.0	-2.0	4.0
1000	35	1.54	13.98	-4.0	-2.0	4.0
2000	35	-2.17	10.93	-10.0	-6.0	6.0
4000	35	0.74	11.63	-10.0	2.0	6.0
6000	35	2.63	13.13	-12.0	2.0	10.0
M512	35	0.91	11.28	-4.0	-2.0	3.0
D4	35	0.80	10.12	-6.0	2.0	10.0
D1	35	1.31	6.40	-2.0	0.0	2.0
BETTER EAR						
500	35	-2.17	5.77	-6.0	-2.0	2.0
1000	36	-2.72	6.22	-4.0	-2.0	-2.0
2000	36	-4.89	6.77	-10.0	-7.0	0.0
4000	36	-3.33	7.04	-10.0	-4.0	2.0
6000	36	-2.89	8.45	-12.0	-3.0	4.0
M512	35	-2.66	4.94	-5.0	-3.0	0.0
D4	36	0.61	7.10	-4.0	2.0	5.5
WORSE EAR						
500	35	3.60	11.46	-2.0	2.0	6.0
1000	35	3.77	13.16	-2.0	0.0	4.0
2000	35	1.31	10.16	-6.0	0.0	8.0
4000	35	3.94	10.98	-4.0	4.0	10.0
6000	35	5.14	11.73	0.0	4.0	10.0
M512	35	3.43	10.63	-1.0	0.0	4.0
D4	35	-0.17	9.58	-6.0	0.0	8.0
LEFT-RIGHT DIFFERENCES						
500	35	1.66	11.09	-4.0	0.0	2.0
1000	35	2.06	13.27	-4.0	0.0	2.0
2000	35	-0.51	10.26	-6.0	-2.0	2.0
4000	35	0.86	11.61	-6.0	0.0	4.0
6000	35	2.91	10.13	-4.0	2.0	8.0
M512	35	1.77	10.21	-4.0	0.0	1.0

TABLE 23 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	38	-2.58	5.62	-6.0	-2.0	2.0
1000	38	-2.79	3.93	-4.5	-2.0	0.0
2000	38	-4.21	6.25	-10.0	-5.0	0.0
4000	38	-2.58	7.20	-8.5	-3.0	2.0
6000	38	-2.16	8.32	-12.0	-1.0	4.5
M512	38	-2.39	3.67	-5.0	-2.0	0.0
D4	38	-0.21	7.08	-4.0	0.0	4.0
D1	38	1.05	2.22	0.0	0.0	2.0
LEFT EAR						
500	37	-3.19	5.78	-8.0	-4.0	2.0
1000	37	-3.68	5.36	-7.0	-4.0	0.0
2000	38	-5.21	6.21	-10.0	-6.0	-1.5
4000	38	-2.74	7.06	-10.0	-2.0	4.0
6000	38	-2.58	7.31	-10.0	-3.0	4.0
M512	37	-3.27	4.61	-7.0	-3.0	0.0
D4	37	-0.65	6.58	-5.0	0.0	4.0
D1	37	0.92	2.85	0.0	0.0	2.0
BETTER EAR						
500	38	-4.16	5.33	-8.5	-4.0	0.0
1000	38	-4.84	4.64	-10.0	-4.0	-2.0
2000	38	-6.32	5.78	-10.5	-6.0	-4.0
4000	38	-5.16	6.06	-12.0	-6.0	0.0
6000	38	-5.16	6.98	-12.0	-8.0	0.0
M512	38	-4.29	4.13	-8.0	-4.0	-0.7
D4	38	0.32	5.31	-4.0	0.0	2.5
WORSE EAR						
500	37	-1.57	5.78	-6.0	0.0	3.0
1000	37	-1.57	4.17	-4.0	-2.0	0.0
2000	38	-3.11	6.29	-8.0	-4.0	2.0
4000	38	-0.16	7.22	-6.5	1.0	4.0
6000	38	0.42	7.61	-6.5	2.0	6.0
M512	37	-1.38	3.97	-4.0	-1.0	1.0
D4	37	-1.19	7.42	-6.0	-2.0	5.0
LEFT-RIGHT DIFFERENCES						
500	37	-0.59	3.68	-2.0	0.0	2.0
1000	37	-0.86	4.44	-4.0	0.0	3.0
2000	38	-1.00	4.96	-2.0	0.0	2.0
4000	38	-0.16	6.70	-4.0	0.0	4.0
6000	38	-0.42	7.41	-6.0	0.0	2.5
M512	37	-0.35	2.49	-1.5	0.0	1.0

TABLE 24 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	57	-0.25	7.13	-5.0	0.0	4.0
1000	57	-1.40	7.02	-6.0	-2.0	2.0
2000	57	-3.40	6.67	-9.0	-4.0	0.0
4000	57	-0.77	7.59	-6.0	0.0	4.0
6000	57	0.07	9.17	-6.0	0.0	4.0
M512	57	-1.04	5.42	-4.5	-1.0	1.0
D4	57	-0.63	6.73	-6.0	0.0	4.0
D1	57	0.91	3.25	0.0	2.0	3.0
LEFT EAR						
500	57	-1.65	8.82	-8.0	-4.0	3.0
1000	57	-2.11	11.27	-9.0	-6.0	0.0
2000	56	-2.64	11.10	-10.0	-6.0	0.0
4000	57	0.28	11.29	-9.0	0.0	6.0
6000	57	-0.67	9.79	-10.0	-2.0	6.0
M512	56	-1.27	9.16	-6.8	-4.0	0.0
D4	57	-2.39	6.55	-6.0	-2.0	2.0
D1	57	0.07	3.32	-2.0	0.0	2.0
BETTER EAR						
500	57	-3.30	7.04	-8.0	-4.0	0.0
1000	57	-5.05	5.88	-10.0	-6.0	-4.0
2000	57	-5.93	6.09	-12.0	-8.0	-3.0
4000	57	-3.44	6.78	-10.0	-4.0	1.0
6000	57	-3.68	8.36	-11.0	-6.0	0.0
M512	57	-3.91	5.15	-7.0	-6.0	-1.5
D4	57	-1.61	5.59	-6.0	-2.0	2.0
WORSE EAR						
500	57	1.40	8.31	-4.0	0.0	4.0
1000	57	1.54	10.95	-6.0	0.0	5.0
2000	56	-0.07	10.64	-6.0	-2.0	2.0
4000	57	2.95	10.90	-4.0	2.0	8.0
6000	57	3.09	9.34	-4.0	4.0	8.0
M512	56	1.48	8.74	-3.7	0.0	2.8
D4	57	-1.40	6.97	-5.0	-2.0	3.0
LEFT-RIGHT DIFFERENCES						
500	57	-1.40	6.07	-6.0	-2.0	2.0
1000	57	-0.70	11.02	-6.0	-4.0	2.0
2000	56	0.96	11.13	-4.0	0.0	2.0
4000	57	1.05	10.30	-6.0	0.0	3.0
6000	57	-0.74	9.12	-6.0	0.0	5.0
M512	56	0.30	7.89	-3.0	-1.0	0.0

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TABLE 25 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	56	-1.96	6.10	-6.0	-2.0	2.0
1000	56	-3.07	4.79	-6.0	-4.0	0.0
2000	56	-2.79	6.62	-8.0	-4.0	2.0
4000	56	-0.39	7.38	-6.0	0.0	6.0
6000	56	-1.04	7.54	-6.0	-2.0	4.0
M512	56	-1.91	4.11	-5.0	-2.0	0.7
D4	56	-2.68	8.16	-8.0	-4.0	2.0
D1	56	1.11	3.28	0.0	0.0	2.0
LEFT EAR						
500	56	-3.04	5.95	-8.0	-4.0	0.0
1000	56	-4.61	5.69	-10.0	-6.0	0.0
2000	56	-2.96	6.67	-8.0	-4.0	0.0
4000	56	-0.32	7.00	-5.5	0.0	5.5
6000	56	-0.32	8.32	-8.0	0.0	6.0
M512	56	-2.80	4.68	-7.0	-3.5	0.7
D4	56	-4.29	7.25	-10.0	-4.0	0.0
D1	56	0.32	1.82	0.0	0.0	2.0
BETTER EAR						
500	56	-4.21	5.85	-8.0	-6.0	0.0
1000	56	-5.43	5.21	-10.0	-6.0	-0.5
2000	56	-4.79	5.90	-10.0	-6.0	0.0
4000	56	-2.50	6.61	-7.5	-3.0	2.0
6000	56	-3.46	7.00	-10.0	-4.0	1.5
M512	56	-3.95	4.30	-8.0	-4.0	-1.0
D4	56	-2.93	7.06	-8.0	-4.0	0.0
WORSE EAR						
500	56	-0.79	5.73	-6.0	-1.0	2.0
1000	56	-2.25	4.93	-6.0	-2.0	2.0
2000	56	-0.96	6.79	-6.0	-2.0	4.0
4000	56	1.79	7.10	-2.0	4.0	6.0
6000	56	2.11	7.85	-4.0	4.0	8.0
M512	56	-0.71	4.31	-4.0	-1.0	3.0
D4	56	-4.04	7.56	-10.0	-5.0	0.0
LEFT-RIGHT DIFFERENCES						
500	56	-1.07	4.58	-4.0	0.0	2.0
1000	56	-1.54 **	3.98	-4.0	-2.0	1.5
2000	56	-0.18	5.34	-2.0	0.0	2.0
4000	56	0.07	5.73	-4.0	0.0	4.0
6000	56	0.71	7.23	-4.0	0.0	6.0
M512	56	-0.39	2.40	-2.0	0.0	1.0

** $p \leq .01$

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TABLE 26 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD EXAMINATIONS OF GIRLS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	73	-2.19	6.11	-6.0	-2.0	0.0
1000	73	-3.45	5.68	-6.0	-4.0	0.0
2000	73	-3.95	6.00	-10.0	-6.0	0.0
4000	73	-1.07	6.47	-4.0	0.0	4.0
6000	73	-0.52	8.45	-6.0	-2.0	4.0
M512	73	-2.42	4.54	-6.0	-2.0	0.5
D4	73	-2.38	6.41	-6.0	-2.0	2.0
D1	73	1.67	3.04	0.0	2.0	4.0
LEFT EAR						
500	73	-2.79	6.32	-8.0	-4.0	2.0
1000	73	-3.56	10.52	-8.0	-6.0	-1.0
2000	73	-4.49	9.31	-10.0	-6.0	-4.0
4000	73	-0.14	11.19	-6.0	-2.0	4.0
6000	73	-1.05	8.46	-8.0	-2.0	4.0
M512	73	-2.79	7.40	-6.5	-5.0	0.0
D4	73	-3.42	8.50	-7.0	-2.0	2.0
D1	73	0.08	2.82	-2.0	0.0	2.0
BETTER EAR						
500	73	-4.19	5.75	-8.0	-4.0	0.0
1000	73	-6.16	4.59	-10.0	-6.0	-4.0
2000	73	-6.82	5.05	-10.0	-8.0	-5.0
4000	73	-3.78	6.11	-10.0	-4.0	0.0
6000	73	-3.53	7.37	-10.0	-6.0	2.0
M512	73	-4.82	4.09	-8.0	-5.0	-2.0
D4	73	-2.38	5.39	-6.0	-2.0	0.0
WORSE EAR						
500	73	-0.79	6.22	-6.0	-2.0	4.0
1000	73	-0.85	10.37	-6.0	-4.0	2.0
2000	73	-1.62	9.14	-6.0	-4.0	1.0
4000	73	2.58	10.48	-4.0	0.0	6.0
6000	73	1.96	8.58	-4.0	2.0	8.0
M512	73	-0.44	7.15	-5.0	-1.0	1.0
D4	73	-3.42	8.31	-6.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	73	-0.60	4.46	-4.0	-2.0	2.0
1000	73	-0.11	11.11	-4.0	-2.0	0.0
2000	73	-0.55	9.00	-4.0	-2.0	0.0
4000	73	0.93	10.89	-4.0	0.0	4.0
6000	73	-0.53	7.33	-6.0	0.0	4.0
M512	73	0.22	7.06	-2.0	-1.0	1.0

TABLE 27 – DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	65	-2.46	6.10	-6.0	-4.0	1.0
1000	65	-2.46	5.86	-6.0	-2.0	1.0
2000	65	-2.98	6.40	-8.0	-2.0	1.0
4000	65	0.52	7.56	-4.0	2.0	5.0
6000	65	-1.11	9.58	-8.0	-2.0	4.0
M512	65	-1.91	4.46	-5.0	-2.0	0.0
D4	65	-2.98	6.41	-8.0	-4.0	2.0
D1	65	0.83	3.39	0.0	0.0	2.0
LEFT EAR						
500	65	-3.26	5.87	-7.0	-4.0	0.0
1000	65	-2.89	6.22	-6.0	-4.0	0.0
2000	65	-2.80	7.25	-8.0	-4.0	0.0
4000	65	0.25	7.80	-4.0	0.0	4.0
6000	65	-0.22	9.27	-9.0	0.0	7.0
M512	65	-2.17	4.67	-4.5	-2.0	-0.5
D4	65	-3.14	9.09	-10.0	-4.0	2.0
D1	65	0.12	2.57	-2.0	0.0	2.0
BETTER EAR						
500	65	-5.02	5.34	-10.0	-4.0	-1.0
1000	65	-5.08	5.12	-10.0	-4.0	-2.0
2000	65	-5.60	5.64	-10.0	-6.0	-2.0
4000	65	-1.88	7.40	-9.0	-2.0	2.0
6000	65	-3.54	7.92	-11.0	-4.0	2.0
M512	65	-4.38	4.04	-7.0	-5.0	-2.0
D4	65	-3.20	7.11	-9.0	-4.0	1.0
WORSE EAR						
500	65	-0.71	5.84	-4.0	0.0	2.0
1000	65	-0.28	5.93	-4.0	0.0	2.0
2000	65	-0.18	6.85	-4.0	0.0	2.0
4000	65	2.65	7.27	-2.0	4.0	6.0
6000	65	2.22	9.93	-6.0	0.0	8.0
M512	65	0.25	4.57	-2.0	0.0	2.0
D4	65	-2.92	7.89	-8.0	-4.0	4.0
LEFT-RIGHT DIFFERENCES						
500	65	-0.80	5.54	-4.0	0.0	4.0
1000	65	-0.43	6.28	-4.0	-2.0	2.0
2000	65	0.18	7.96	-4.0	0.0	4.0
4000	65	-0.28	6.21	-4.0	0.0	4.0
6000	65	0.89	7.67	-3.0	0.0	6.0
M512	65	0.23	3.79	-2.0	0.0	2.5

TABLE 28 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	73	-3.70	6.02	-8.0	-4.0	0.0
1000	73	-3.78	5.73	-8.0	-4.0	0.0
2000	73	-4.41	5.63	-8.0	-6.0	0.0
4000	73	-1.90	6.69	-6.0	-2.0	2.0
6000	73	-1.81	8.46	-10.0	-2.0	4.0
M512	73	-3.15	4.48	-6.0	-4.0	0.0
D4	73	-1.88	6.62	-8.0	0.0	2.0
D1	73	1.04	2.61	0.0	0.0	2.0
LEFT EAR						
500	73	-4.63	6.23	-10.0	-6.0	-2.0
1000	73	-3.75	10.58	-10.0	-6.0	-2.0
2000	73	-3.64	10.02	-10.0	-6.0	-2.0
4000	73	-0.79	10.57	-10.0	-2.0	6.0
6000	73	-1.32	8.29	-9.0	0.0	4.0
M512	73	-3.21	7.59	-8.0	-4.0	-1.0
D4	73	-2.96	7.82	-8.0	-2.0	2.0
D1	73	0.36	2.55	0.0	0.0	2.0
BETTER EAR						
500	73	-6.03	5.24	-12.0	-6.0	-2.0
1000	73	-6.77	4.55	-12.0	-6.0	-4.0
2000	73	-6.66	4.91	-10.0	-8.0	-4.0
4000	73	-4.45	6.16	-12.0	-4.0	0.0
6000	73	-3.92	7.11	-12.0	-4.0	0.0
M512	73	-5.53	4.14	-9.0	-6.0	-3.0
D4	73	-2.32	5.41	-6.0	-2.0	0.0
WORSE EAR						
500	73	-2.30	6.39	-6.0	-4.0	2.0
1000	73	-0.77	10.28	-6.0	-2.0	0.0
2000	73	-1.40	9.71	-6.0	-4.0	1.0
4000	73	1.75	9.98	-5.0	2.0	6.0
6000	73	0.79	8.86	-5.0	2.0	5.0
M512	73	-0.81	7.23	-5.0	-2.0	0.5
D4	73	-2.52	7.43	-8.0	-2.0	2.0
LEFT-RIGHT DIFFERENCES						
500	73	-0.93	4.73	-4.0	-2.0	2.0
1000	73	0.03	11.27	-4.0	0.0	2.0
2000	73	0.77	9.82	-4.0	0.0	4.0
4000	73	1.11	9.74	-5.0	0.0	6.0
6000	73	0.49	6.50	-3.0	0.0	4.0
M512	73	0.60	7.13	-2.0	0.0	1.0

TABLE 29 – DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	64	-1.72	5.41	-6.0	-2.0	2.0
1000	64	-2.31	5.32	-6.0	-4.0	2.0
2000	64	-1.53	5.91	-6.0	-1.0	4.0
4000	64	1.13	7.62	-4.0	2.0	6.0
6000	64	1.75	7.74	-4.0	0.0	6.0
M512	64	-1.22	4.17	-4.0	0.0	1.0
D4	64	-3.44	7.19	-8.0	-4.0	0.0
D1	64	0.87	2.76	0.0	0.0	2.0
LEFT EAR						
500	64	-3.69	6.04	-8.0	-4.0	1.5
1000	64	-3.03	6.17	-8.0	-2.0	0.0
2000	64	-1.75	7.25	-7.5	-4.0	4.0
4000	64	1.94	7.87	-4.0	2.0	6.0
6000	64	1.97	9.49	-5.5	3.0	8.0
M512	64	-2.14	4.97	-6.0	-2.0	1.0
D4	64	-4.97	8.08	-10.0	-6.0	1.5
D1	64	0.62	2.78	-1.5	0.0	2.0
BETTER EAR						
500	64	-4.63	5.06	-8.0	-5.0	-2.0
1000	64	-4.34	5.40	-10.0	-4.0	0.0
2000	64	-3.94	5.78	-8.0	-6.0	0.0
4000	64	-1.50	7.02	-6.0	0.0	2.0
6000	64	-1.31	7.79	-8.0	0.0	4.0
M512	64	-3.50	4.21	-6.8	-4.0	0.0
D4	64	-2.84	7.32	-6.0	-2.0	0.0
WORSE EAR						
500	64	-0.78	5.88	-5.5	-2.0	2.0
1000	64	-1.00	5.65	-5.5	0.0	4.0
2000	64	0.66	6.59	-4.0	2.0	6.0
4000	64	4.56	7.24	0.0	5.0	8.0
6000	64	5.03	8.29	0.0	6.0	9.5
M512	64	0.16	4.63	-3.0	0.0	2.8
D4	64	-5.56	7.01	-10.0	-6.0	-2.0
LEFT-RIGHT DIFFERENCES						
500	64	-1.97 **	4.68	-5.5	-2.0	1.5
1000	64	-0.72	4.18	-4.0	-1.0	2.0
2000	64	-0.22	5.87	-4.0	0.0	4.0
4000	64	0.81	7.50	-4.0	0.0	6.0
6000	64	0.22	8.02	-5.5	2.0	5.5
M512	64	-0.52	2.88	-2.0	0.0	1.0

** p $\leq$ .01

TABLE 30 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	63	-4.03	6.39	-8.0	-4.0	0.0
1000	63	-4.22	6.02	-8.0	-4.0	0.0
2000	63	-4.70	6.15	-10.0	-6.0	0.0
4000	63	-2.06	6.75	-8.0	-2.0	4.0
6000	63	-3.11	7.92	-10.0	-6.0	2.0
M512	63	-3.48	5.03	-7.0	-4.0	0.0
D4	63	-2.16	7.19	-8.0	-2.0	4.0
D1	63	1.21	3.36	0.0	0.0	4.0
LEFT EAR						
500	63	-5.43	5.67	-10.0	-6.0	-2.0
1000	63	-6.29	4.71	-10.0	-8.0	-4.0
2000	63	-6.16	5.22	-12.0	-6.0	-4.0
4000	63	-1.05	9.97	-8.0	-2.0	2.0
6000	63	-1.52	8.70	-10.0	0.0	4.0
M512	63	-5.05	4.30	-9.0	-5.0	-2.0
D4	63	-5.24	9.48	-10.0	-4.0	0.0
D1	63	0.51	2.85	0.0	0.0	2.0
BETTER EAR						
500	63	-6.95	4.43	-12.0	-6.0	-2.0
1000	63	-7.43	3.84	-12.0	-8.0	-4.0
2000	63	-7.84	4.02	-12.0	-8.0	-4.0
4000	63	-4.95	5.81	-10.0	-4.0	0.0
6000	63	-5.43	6.48	-12.0	-8.0	0.0
M512	63	-6.43	3.39	-10.0	-6.0	-4.0
D4	63	-2.48	5.20	-6.0	-2.0	0.0
WORSE EAR						
500	63	-2.51	6.66	-8.0	-2.0	0.0
1000	63	-3.08	6.02	-6.0	-4.0	0.0
2000	63	-3.02	6.18	-8.0	-4.0	2.0
4000	63	1.84	9.39	-4.0	2.0	4.0
6000	63	0.79	8.83	-6.0	0.0	8.0
M512	63	-2.08	5.12	-6.0	-2.0	0.0
D4	63	-4.92	9.85	-10.0	-4.0	2.0
LEFT-RIGHT DIFFERENCES						
500	63	-1.40	6.87	-4.0	-2.0	2.0
1000	63	-2.06 *	6.24	-4.0	-2.0	2.0
2000	63	-1.46	7.23	-4.0	0.0	2.0
4000	63	1.02	11.48	-4.0	-2.0	2.0
6000	63	1.59	8.32	-2.0	0.0	8.0
M512	63	-0.94	5.45	-2.0	0.0	1.0

* $.01 < p \leq .05$

TABLE 31 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF BOYS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	46	-0.91	12.83	-6.5	-2.0	2.0
1000	46	-1.78	13.02	-6.0	-4.0	0.0
2000	46	-2.04	12.65	-8.5	-4.0	0.0
4000	46	1.43	15.25	-4.5	0.0	6.0
6000	46	2.61	16.03	-8.0	1.0	10.0
M512	46	-0.87	12.11	-6.0	-2.0	1.0
D4	46	-3.22	7.86	-8.0	-3.0	2.0
D1	46	1.78	3.02	0.0	0.0	4.0
LEFT EAR						
500	46	-2.96	13.08	-8.0	-4.0	0.0
1000	46	-1.70	13.45	-6.5	-3.0	0.0
2000	46	-2.00	14.03	-12.0	-5.0	2.5
4000	46	1.70	14.92	-6.0	0.0	6.0
6000	46	2.43	16.44	-10.0	-1.0	6.5
M512	46	-1.41	12.77	-7.0	-3.0	0.0
D4	46	-3.39	6.66	-6.5	-2.0	2.0
D1	46	-0.22	2.77	-2.0	0.0	2.0
BETTER EAR						
500	46	-4.17	12.89	-10.0	-6.0	-2.0
1000	46	-3.35	13.13	-8.5	-6.0	-2.0
2000	46	-4.65	12.99	-12.0	-7.0	-2.0
4000	46	-1.30	14.66	-10.0	-4.0	2.0
6000	46	-0.91	14.65	-12.0	-4.0	2.5
M512	46	-3.20	12.41	-8.0	-6.0	-2.0
D4	46	-2.04	6.36	-8.0	0.0	0.5
WORSE EAR						
500	46	0.30	12.70	-4.5	-2.0	2.0
1000	46	-0.13	13.15	-4.5	-2.0	2.0
2000	46	0.61	13.19	-6.0	-2.0	4.0
4000	46	4.43	14.94	-2.0	2.0	8.0
6000	46	5.96	16.99	-4.5	4.0	10.0
M512	46	0.93	12.32	-3.3	0.0	2.0
D4	46	-4.57	6.47	-10.0	-4.0	0.0
LEFT-RIGHT DIFFERENCES						
500	46	-2.04 *	5.29	-6.0	-2.0	2.0
1000	46	0.09	4.38	-4.0	0.0	2.0
2000	46	0.04	6.81	-4.0	0.0	4.0
4000	46	0.26	7.50	-4.5	0.0	4.0
6000	46	-0.17	9.41	-6.0	0.0	4.5
M512	46	-0.09	3.12	-2.0	0.0	1.0

* .01 < p ≤ .05

TABLE 32 - DESCRIPTIVE STATISTICS OF AUDITORY THRESHOLD
EXAMINATIONS OF GIRLS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	34	-4.59	7.78	-10.0	-6.0	-2.0
1000	34	-3.94	9.14	-12.0	-4.0	-2.0
2000	34	-4.35	6.54	-10.0	-6.0	-1.5
4000	34	-4.35	6.83	-12.0	-5.0	0.5
6000	34	-1.12	10.68	-10.5	-4.0	4.5
M512	34	-3.44	7.05	-8.3	-4.0	-1.8
D4	34	0.41	9.54	-6.0	0.0	4.0
D1	34	0.59	3.06	0.0	0.0	2.0
LEFT EAR						
500	34	-5.76	6.26	-12.0	-8.0	0.0
1000	34	-5.88	4.43	-10.0	-5.0	-2.0
2000	34	-5.71	6.84	-10.5	-7.0	-2.0
4000	34	0.12	10.35	-7.0	0.0	6.0
6000	34	0.29	8.49	-10.0	1.0	6.0
M512	34	-4.94	4.66	-10.0	-5.5	-1.0
D4	34	-6.00	9.12	-10.0	-4.0	0.0
D1	34	0.53	1.99	0.0	0.0	2.0
BETTER EAR						
500	34	-7.35	5.32	-12.0	-10.0	-5.5
1000	34	-7.29	4.06	-12.0	-6.0	-4.0
2000	34	-7.71	3.91	-12.0	-8.0	-4.0
4000	34	-5.76	5.82	-12.0	-6.0	0.0
6000	34	-4.18	7.34	-12.0	-4.0	2.0
M512	34	-6.47	3.80	-10.0	-7.0	-3.0
D4	34	-1.53	4.75	-4.0	0.0	0.0
WORSE EAR						
500	34	-3.00	7.90	-8.0	-4.0	0.5
1000	34	-2.53	8.77	-7.0	-4.0	-1.5
2000	34	-2.35	7.78	-8.0	-5.0	2.0
4000	34	1.53	10.14	-4.5	2.0	6.0
6000	34	3.35	10.19	-4.5	5.0	10.5
M512	34	-1.91	6.95	-5.3	-2.0	0.0
D4	34	-4.06	11.33	-8.5	-3.0	0.0
LEFT-RIGHT DIFFERENCES						
500	34	-1.18	7.02	-2.5	0.0	2.0
1000	34	-1.94	9.58	-2.5	0.0	2.0
2000	34	-1.35	8.37	-4.5	-2.0	0.0
4000	34	4.47*	10.92	0.0	2.0	8.5
6000	34	1.41	10.85	-2.0	0.0	8.0
M512	34	-1.03	7.07	-1.2	0.0	1.0

* .01 < p $\leq$ .05

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TABLE 33 - MEAN AUDITORY THRESHOLDS (dB) OF CHILDREN AGED 6 TO 17
YEARS. MEANS NOT CONNECTED BY LINES ARE SIGNIFICANTLY
DIFFERENT FROM EACH OTHER AT THE 0.05 LEVEL OF
SIGNIFICANCE, AS DETERMINED BY DUNCAN'S MULTIPLE
RANGE TEST.

	Frequency				
	6000 Hz	4000 Hz	500 Hz	1000 Hz	2000 Hz
Boys					
left ear	1.82	0.67	-1.31	-1.51	-2.09
right ear	1.16	0.96	0.06	-0.63	-1.38
Girls					
left ear	-0.05	-0.01	-2.45	-3.06	-3.57
right ear	-0.34	-0.39	-1.37	-2.15	-2.89

A considerable proportion of the participants have
thresholds at -10 to -12 dB. The latter is the lower
limit of the audiometer used in this study. The proportion
of children with thresholds at or below -10 dB is often over
15 percent and tends to be higher in older than in
younger children. Figures 12 through 17 present representative
examples of this phenomenon, namely, the proportions of boys
and girls hearing at each threshold level at 4000 Hz in the
right ear.

One explanation for the relative lack of younger
children hearing at attenuation levels of -10 and -12 dB
and the significant negative correlations with age is that
younger children may not concentrate sufficiently to reach their
"true" thresholds. This explanation would account for the
slightly higher means of the younger children and the significant
correlations. If the difference between the age groups is real,
and not due to sampling error, nor lack of concentration in
younger children, an alternative explanation is that hearing
improves with age as a result of some developmental or
environmental change.

TABLE 34 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN AGE AND AUDITORY THRESHOLD IN RIGHT
EAR, LEFT EAR, BETTER EAR AND WORSE EAR OF
ALL EXAMINATIONS IN BOYS AND GIRLS

Frequency (Hz)	n	Boys Correlation Coefficient	n	Girls Correlation Coefficient
Right Ear				
500	563	-0.24 **	538	-0.41 **
1000	566	-0.23 **	542	-0.35 **
2000	567	-0.15 **	543	-0.26 **
4000	567	-0.12 **	542	-0.28 **
6000	565	-0.10 *	541	-0.20 **
M512	563	-0.26 **	538	-0.41 **
D4	566	-0.12 **	541	0.01
Left Ear				
500	551	-0.26 **	522	-0.37 **
1000	555	-0.12 **	527	-0.30 **
2000	561	-0.15 **	528	-0.31 **
4000	559	-0.05	525	-0.15 **
6000	555	-0.12 **	525	-0.12 **
M512	551	-0.24 **	521	-0.38 **
D4	555	-0.15 **	523	-0.09 **
Better Ear				
500	566	-0.28 **	538	-0.43 **
1000	567	-0.22 **	542	-0.37 **
2000	567	-0.17 **	543	-0.35 **
4000	567	-0.10 *	542	-0.27 **
6000	566	-0.14 **	541	-0.21 **
M512	566	-0.27 **	538	-0.44 **
D4	567	-0.14 **	541	-0.05
Worse Ear				
500	548	-0.25 **	522	-0.39 **
1000	554	-0.23 **	527	-0.31 **
2000	561	-0.16 **	528	-0.28 **
4000	559	-0.10 *	525	-0.20 **
6000	554	-0.11 *	525	-0.14 **
M512	548	-0.26 **	521	-0.37 **
D4	548	-0.16 **	523	-0.39

* .01 < p ≤ .05
** p ≤ .01
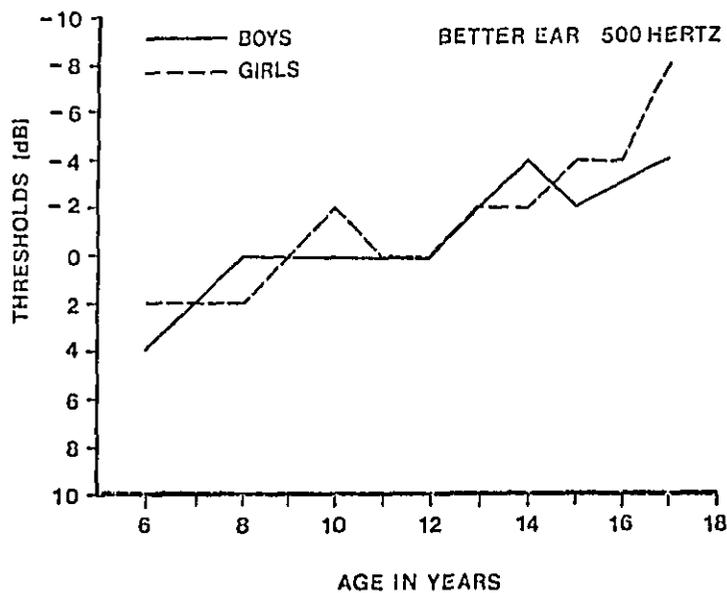
FIGURE 2 — MEDIAN AUDITORY THRESHOLDS (dB) AT 500 Hz
COMPARING THE BETTER EAR OF BOYS AND GIRLS

FIGURE 3 — MEDIAN AUDITORY THRESHOLDS (dB) AT 500 Hz
COMPARING THE WORSE EAR OF BOYS AND GIRLS

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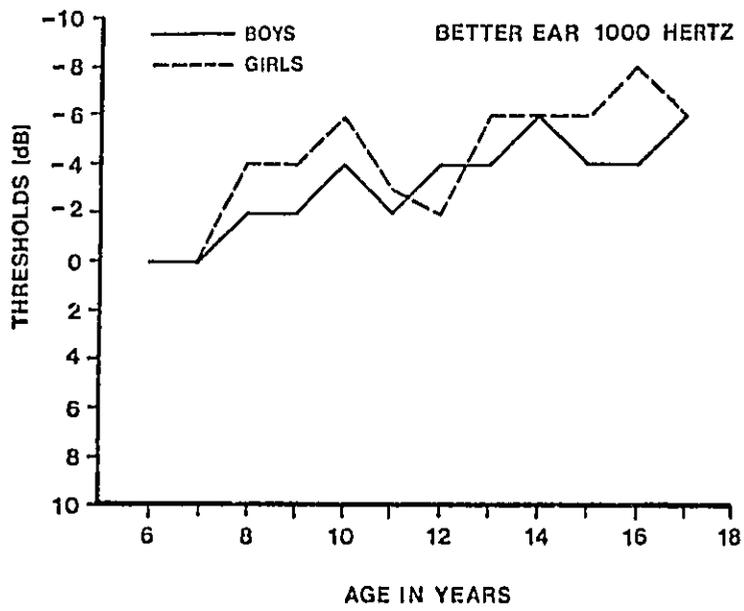
FIGURE 4 —MEDIAN AUDITORY THRESHOLDS (dB) AT 1000 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS
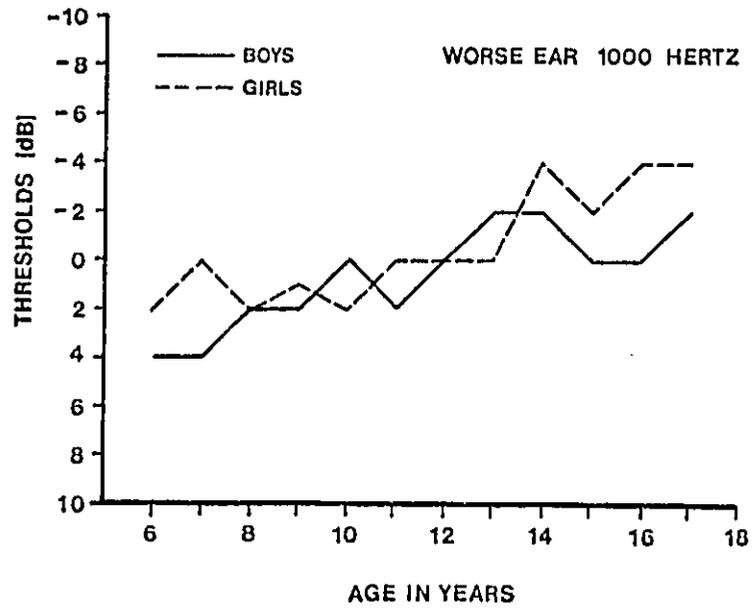
FIGURE 5 —MEDIAN AUDITORY THRESHOLDS (dB) AT 1000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS
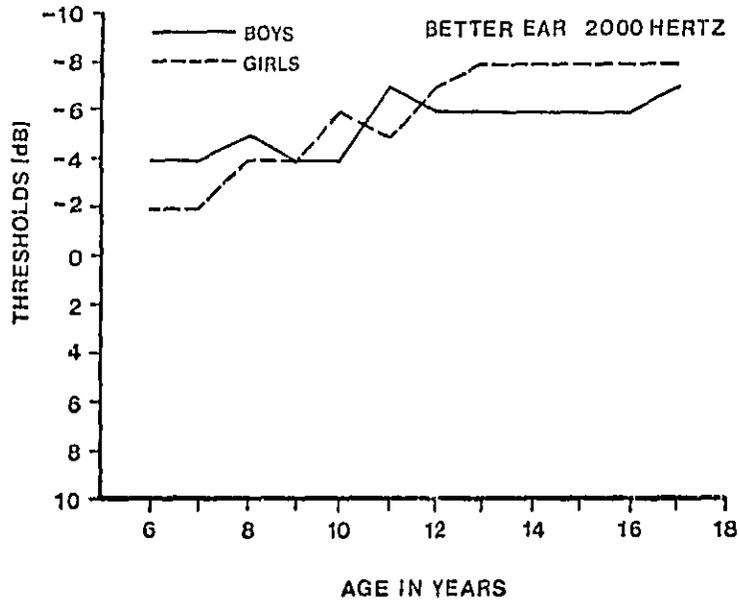
FIGURE 6   —MEDIAN AUDITORY THRESHOLDS (dB) AT 2000 Hz
            COMPARING THE BETTER EAR OF BOYS AND GIRLS

FIGURE 7   —MEDIAN AUDITORY THRESHOLDS (dB) AT 2000 Hz
            COMPARING THE WORSE EAR OF BOYS AND GIRLS

FIGURE 8   -MEDIAN AUDITORY THRESHOLDS (dB) AT 4000 Hz
COMPARING THE BETTER EAR OF BOYS AND GIRLS

FIGURE 9   -MEDIAN AUDITORY THRESHOLDS (dB) AT 4000 Hz
COMPARING THE WORSE EAR OF BOYS AND GIRLS
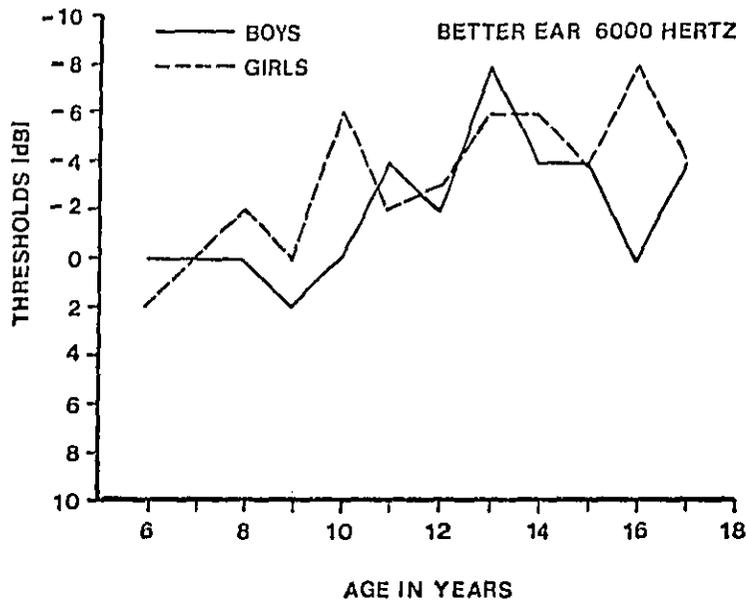
FIGURE 10 —MEDIAN AUDITORY THESHOLDS (dB) AT 6000 Hz COMPARING THE BETTER EAR OF BOYS AND GIRLS

FIGURE 11 —MEDIAN AUDITORY THESHOLDS (dB) AT 6000 Hz COMPARING THE WORSE EAR OF BOYS AND GIRLS

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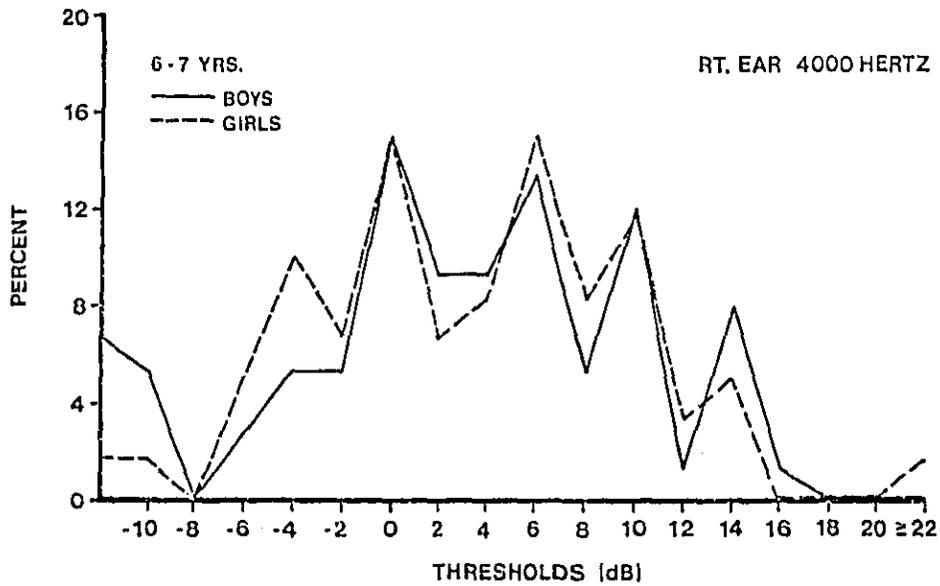
FIGURE 12   -PROPORTION OF EXAMINATIONS OF CHILDREN 6-7 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR
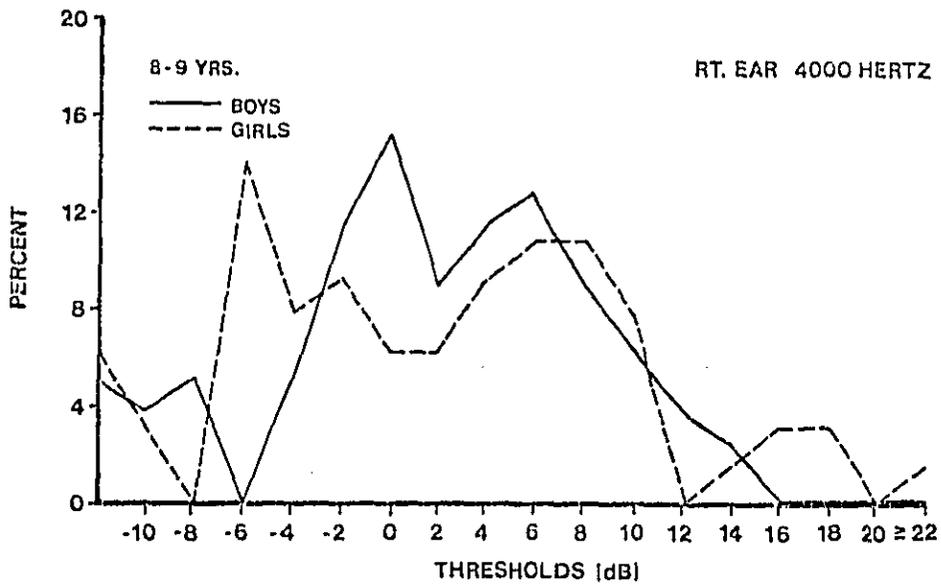
FIGURE 13   -PROPORTION OF EXAMINATIONS OF CHILDREN 8-9 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR
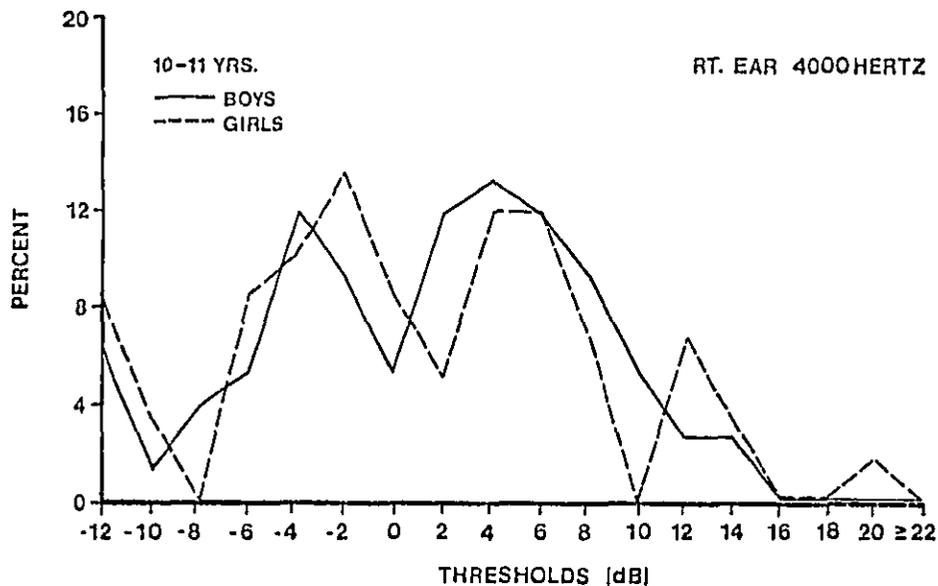
FIGURE 14   -PROPORTION OF EXAMINATIONS OF CHILDREN 10-11 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR
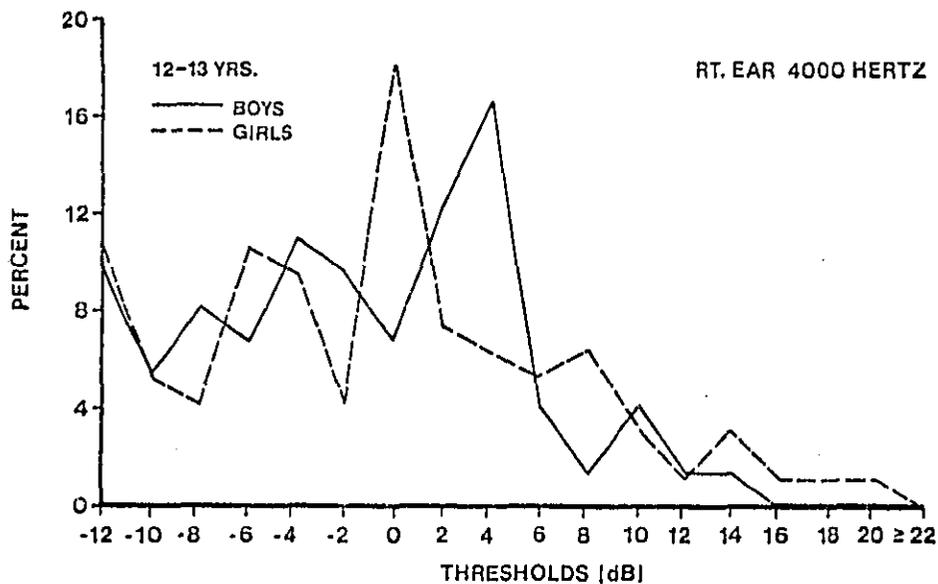
FIGURE 15   -PROPORTION OF EXAMINATIONS OF CHILDREN 12-13 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR

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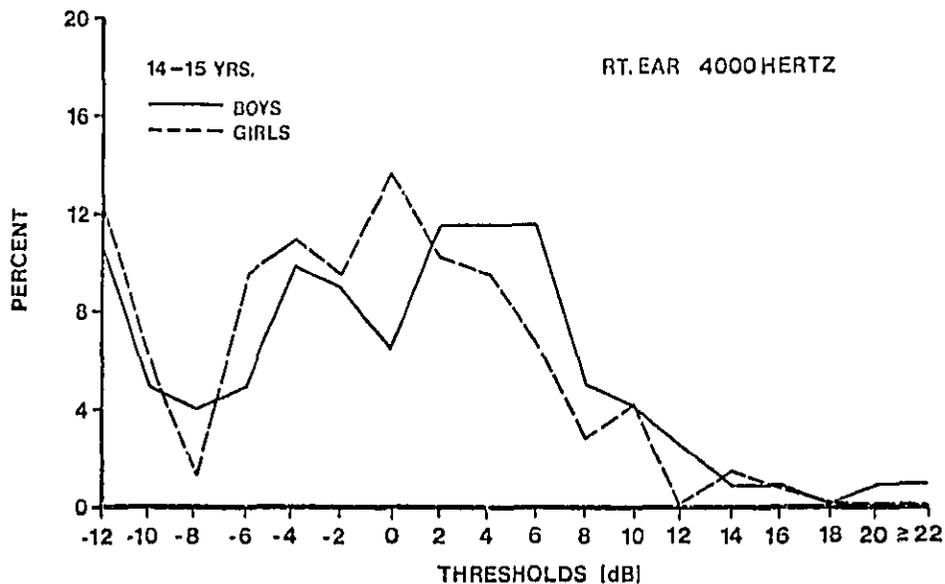
FIGURE 16   -PROPORTION OF EXAMINATIONS OF CHILDREN 14-15 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR
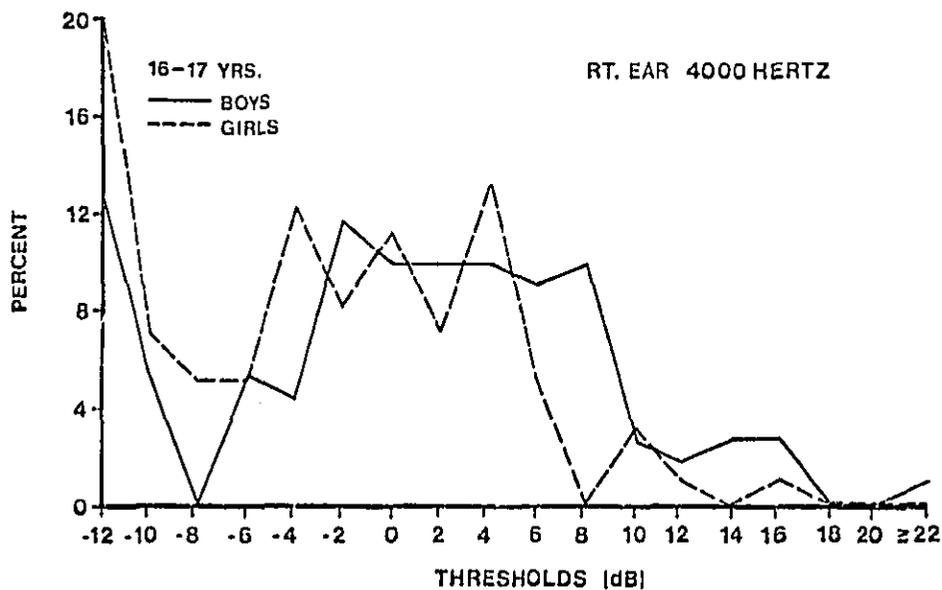
FIGURE 17   -PROPORTION OF EXAMINATIONS OF CHILREN 16-17 YEARS OLD
             HEARING AT SPECIFIC AUDITORY THRESHOLDS (dB) MEASURED
             AT 4000 Hz IN THE RIGHT EAR

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Fels Auditory Thresholds Compared with National Data -
Comparisons of the threshold distributions of the Fels and
National Center for Health Statistics (NCHS) samples are
presented in Figures 18 through 27. These figures show the
proportion of the 12-to 17-year-old boys and girls in each sample
that fall into six auditory threshold ranges. While these
figures deal only with findings for the right ear, the results
for the left ear are similar. The skewness and leptokurtosis of
the distributions are evident. At each frequency, the Fels
distribution is shifted toward lower thresholds (i.e., better
hearing) compared to the NCHS distributions. The shape of the
distribution and degree of shift is similar in males and females,
except that the proportion of females in the lowest threshold
category (-14 to -5 dB) is higher than in males at each frequency.

In Figures 28 through 37, the median threshold levels for the
right ear of Fels boys and girls are presented with the
corresponding NCHS medians at each age. The slight irregularity
of the Fels curves is probably due to relatively small sample
sizes at each age (see Figure 1). In general, for each sex, the
Fels medians indicate lower thresholds compared to the National
sample, and, the Fels and NCHS medians follow parallel
courses across age. There is some variation at 2000 Hz where the
Fels thresholds tend to decrease with age, whereas those from the
National Center for Health Statistics show little change in
either sex. A major exception is seen at 4000 Hz (Figures 34 and
35) where the NCHS data show a precipitous decrease (6 dB) in
hearing ability between 11 and 12 years of age. It should be
noted that the reference data for 6- to 11-year-olds, and those
for 12- to 17-year-olds, are from different NCHS cross-sectional
surveys. Consequently, the marked change in median thresholds
from 11 to 12 years of age at 4000 Hz probably represents
sampling error or instrument variation, rather than biological
development. That this occurs in cross-sectional analyses, even
those unusually well planned and based on large representative
samples, such as NCHS, emphasizes the need for serial studies to
establish the true changes. For determining hearing levels
of the U. S. population as a whole, the best cross-sectional
data available are those from NCHS. There are differences
between the NCHS and Fels samples, e.g., sample sizes, age
range, racial distribution, geographical distribution,
screening and testing procedures.

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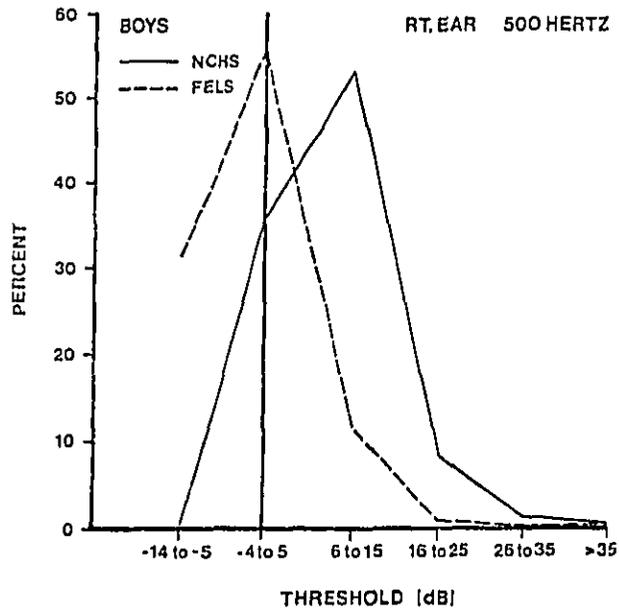
FIGURE 18   -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 500 Hz, RIGHT EAR, BOYS
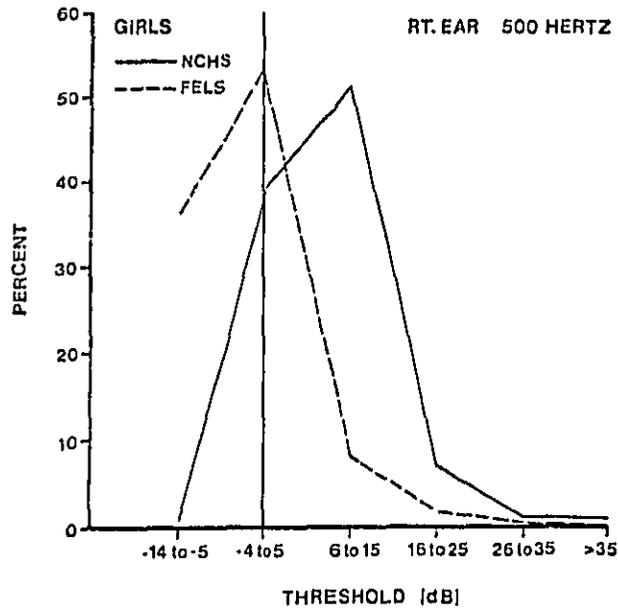
FIGURE 19   -PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 500 Hz, RIGHT EAR, GIRLS

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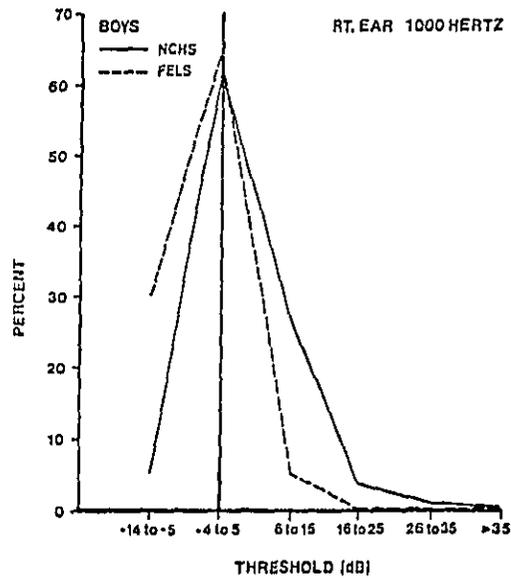
FIGURE 20 —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 1000 Hz, RIGHT EAR, BOYS
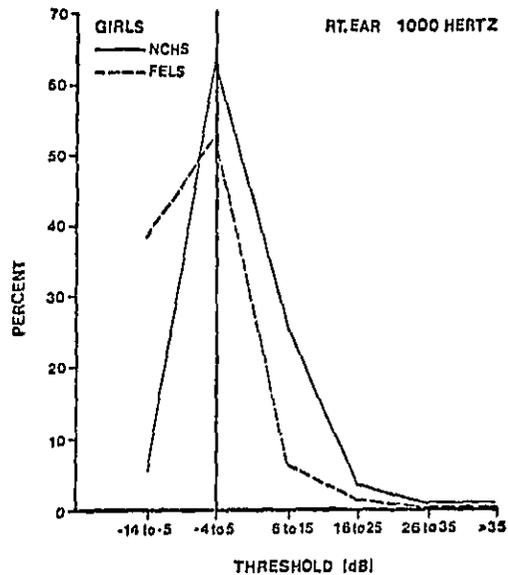
FIGURE 21 —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS AND AHUJA, 1975); 1000 Hz, RIGHT EAR, GIRLS

95
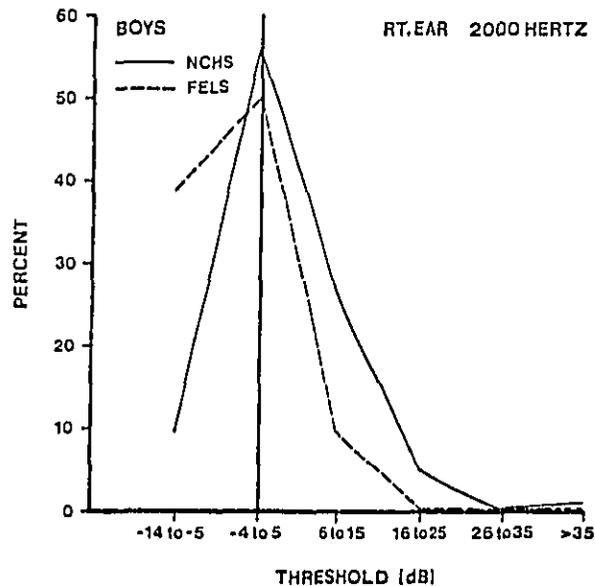
FIGURE 22   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
(dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
AND AHUJA, 1975); 2000 Hz, RIGHT EAR, BOYS
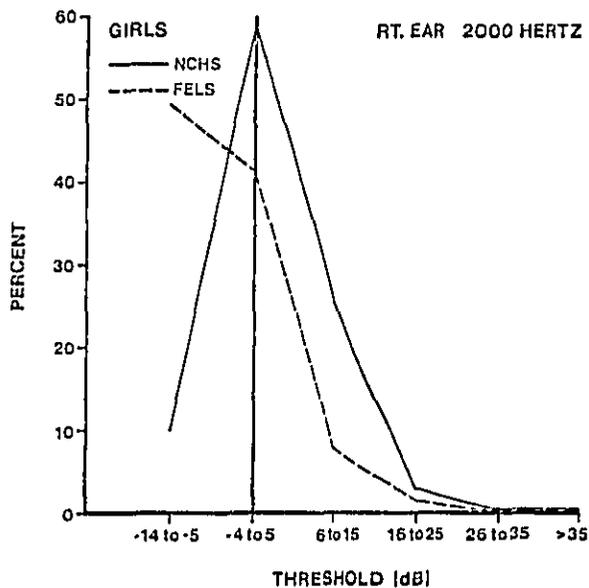
FIGURE 23   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
(dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
AND AHUJA, 1975); 2000 Hz, RIGHT EAR, GIRLS

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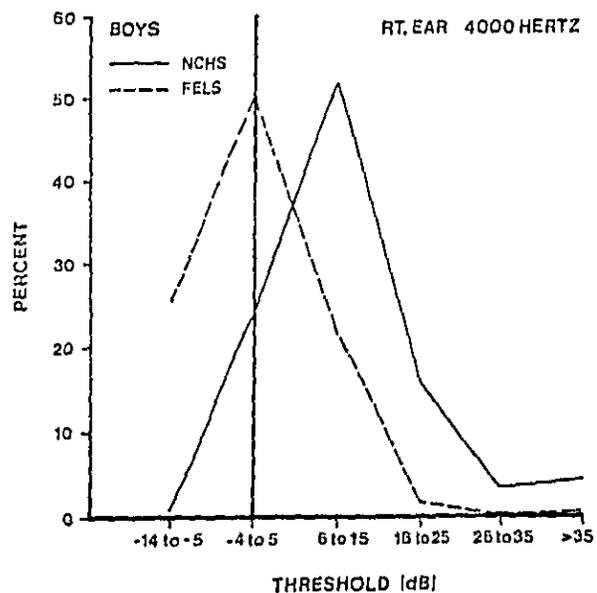
FIGURE 24   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 4000 Hz, RIGHT EAR, BOYS
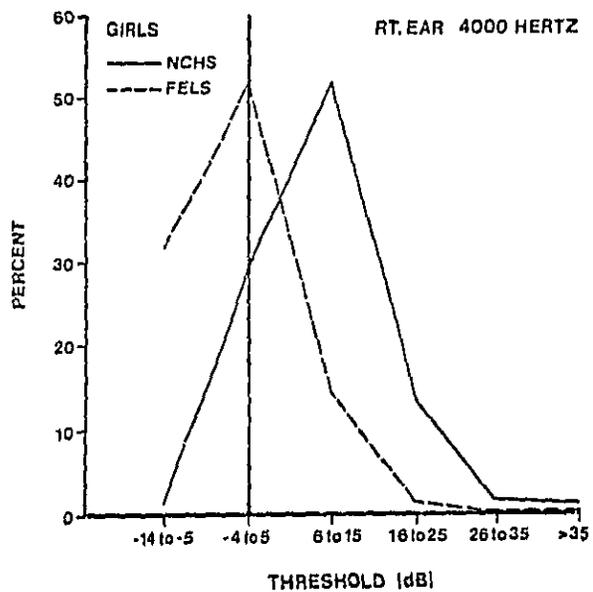
FIGURE 25   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 4000 Hz, RIGHT EAR, GIRLS

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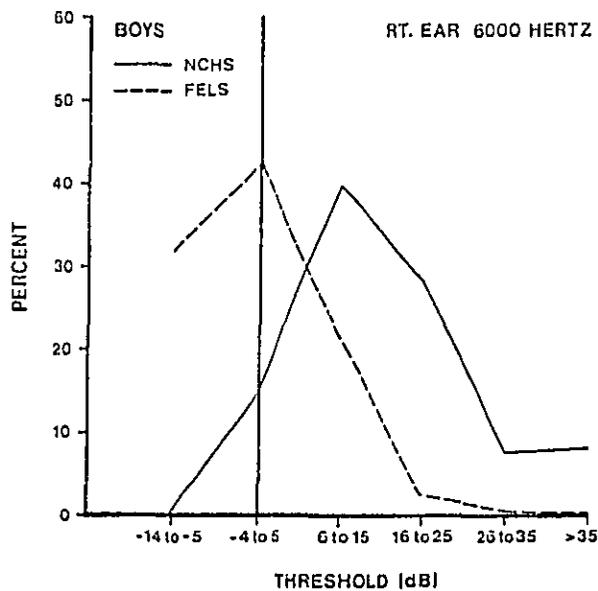
FIGURE 26   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 6000 Hz, RIGHT EAR, BOYS
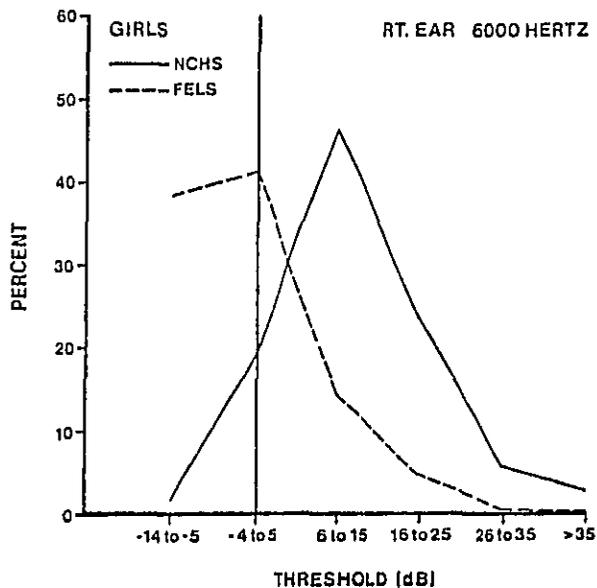
FIGURE 27   —PERCENTAGE FREQUENCY DISTRIBUTION OF AUDITORY THRESHOLDS
             (dB) AT 12-17 YEARS FROM FELS AND NCHS SAMPLES (ROBERTS
             AND AHUJA, 1975); 6000 Hz, RIGHT EAR, GIRLS

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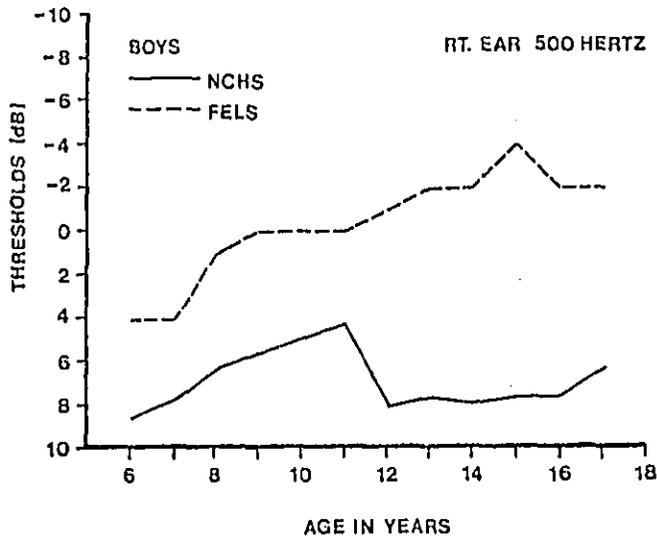
FIGURE 28   -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970: ROBERTS
                 AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
                 (dB) MEASURED AT 500 Hz IN THE RIGHT EAR OF BOYS
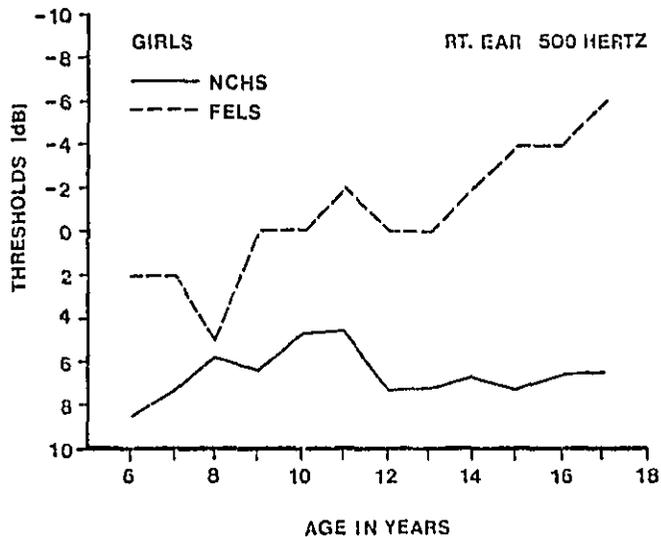
FIGURE 29   -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970: ROBERTS
                 AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
                 (dB) MEASURED AT 500 Hz IN THE RIGHT EAR OF GIRLS

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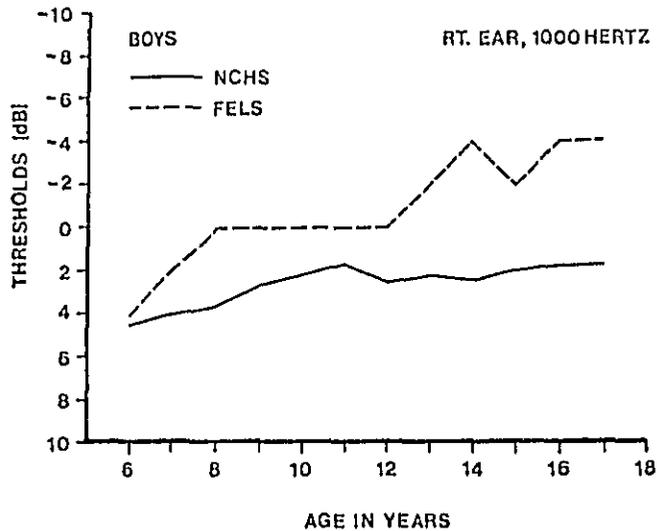
FIGURE 30 —FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 1000 Hz IN THE RIGHT EAR OF BOYS
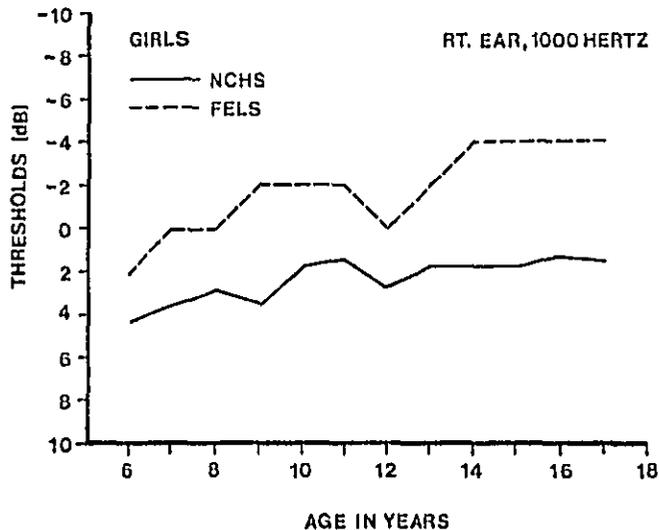
FIGURE 31 —FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS (dB) MEASURED AT 1000 Hz IN THE RIGHT EAR OF GIRLS

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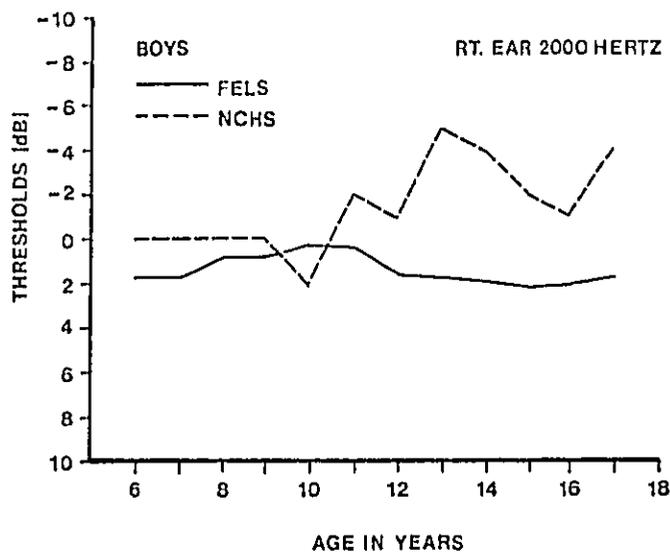
FIGURE 32   -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS
                   AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
                   (dB) MEASURED AT 2000 Hz IN THE RIGHT EAR OF BOYS
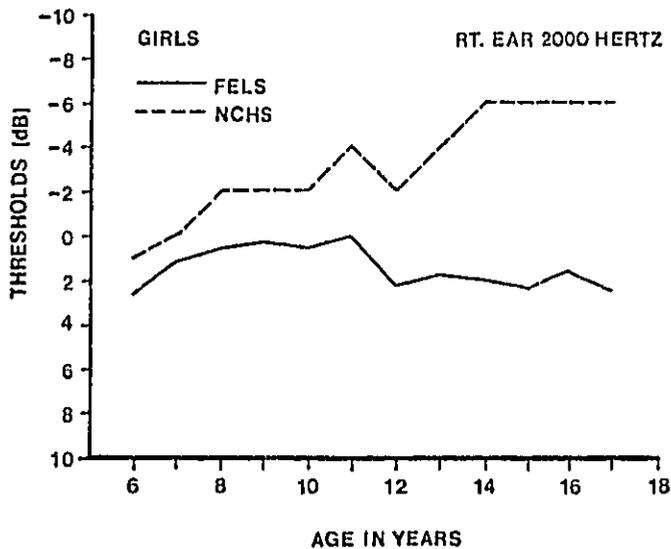
FIGURE 33   -FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS
                   AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
                   (dB) MEASURED AT 2000 Hz IN THE RIGHT EAR OF GIRLS

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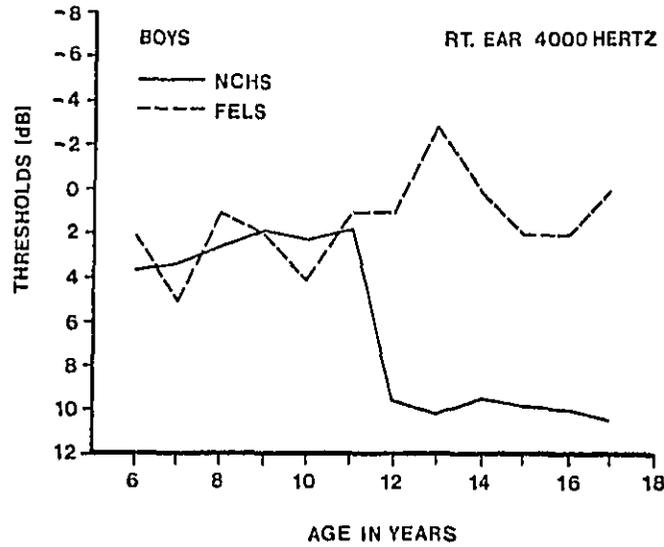
FIGURE 34   —FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS
             AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
             (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR OF BOYS
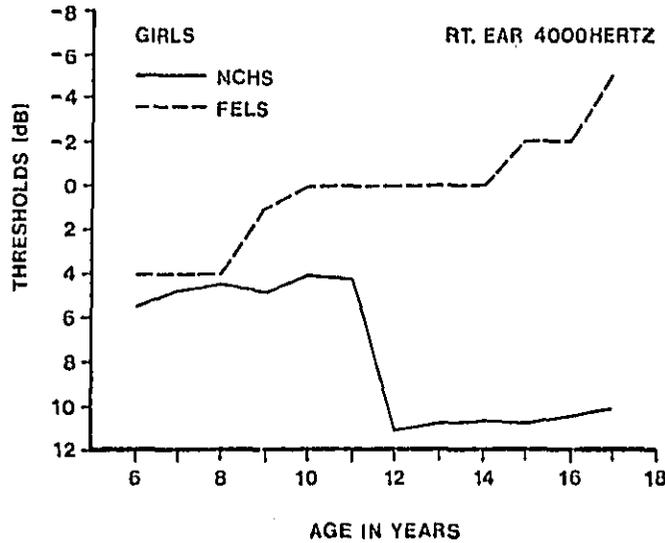
FIGURE 35   —FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS
             AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
             (dB) MEASURED AT 4000 Hz IN THE RIGHT EAR OF GIRLS

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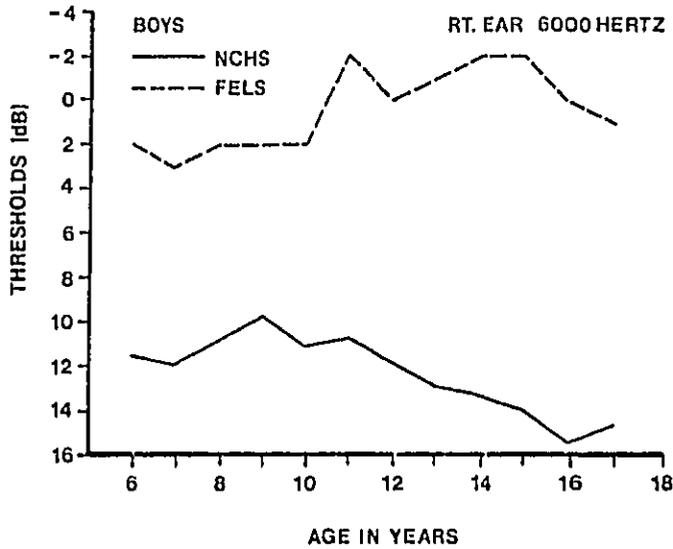
FIGURE 36   —FELS AND NCHS SAMPLES (ROBERTS AND HUBER, 1970; ROBERTS
AND AHUJA, 1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
(dB) MEASURED AT 6000 Hz IN THE RIGHT EAR OF BOYS
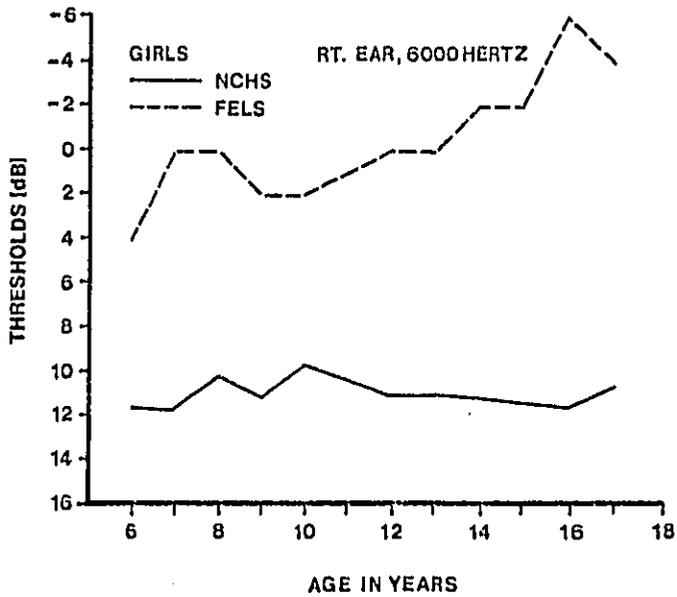
FIGURE 37   —FELS AND NCHS SAMPLES (ROBERTS AND HUBER,1970; ROBERTS
AND AHUJA,1975) COMPARED FOR MEDIAN AUDITORY THRESHOLDS
(dB) MEASURED AT 6000 Hz IN THE RIGHT EAR OF GIRLS

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Increments - The increments are the changes in
threshold levels from one visit to the next. They are calculated
so that a positive value indicates a rise in threshold and,
therefore, a change in the direction of a hearing loss. The
calculations are made from pairs of examinations and represent
a time interval of 5 to 7 months. The total number of 6-month
increments between the ages of 6 and 17 years is 701. The age
distribution of the children at the increment examinations is
given in Table 35. Increments at each annual age for boys and
girls 6 through 17 years of age are given in Tables 36 through
59. At each annual age and for each sex, the sample size, mean
increment, standard deviation and quartiles are presented for
each ear. Mean increments significantly different from zero are
indicated with asterisks.

Only 7.5 percent of the mean increments are significantly
different from zero at the 0.05 level of significance (asterisks
in Tables 36 through 59); few more than expected by chance.
There is a higher proportion of significant increments at the
older ages (i. e.,.16 and 17 years) and when significant differences
occur, they tend to be negative. In fact, about 68 percent of
the mean increments for right and left ears are negative; this
implies that at each subsequent examination, children tend to
hear better than at the previous one.

There are no apparent changes in increments associated
with age at any frequency, except as already mentioned, there
appear to be more increments that are statistically significant
from zero at the older ages in both boys and girls. Spearman
rank correlation coefficients between age and 6-month auditory
threshold increments (Table 60) are not significantly different
from zero in boys or girls at any frequency or in any ear.

Increments appear to be approximately normally
distributed about a mean of zero in boys and girls at every
frequency and at every age. Figures 38 through 43 show
histograms of the number of examinations at 4000 Hz (right ear)
in each increment class of boys and girls. These figures are
representative of the shape and positioning of the distributions
at other frequencies and those in the left ear.

Lateral Differences - Tables 9 through 32 give
descriptive statistics for left less right auditory thresholds
at each frequency, at each annual age in boys and girls. There
is little evidence of an age or sex trend in lateral differences.
However, the mean thresholds for the left ear are lower than right
ear means at corresponding frequencies in about 60 percent of
the cases, considering both sexes across all ages (Tables 9
through 32). Twice as many differences (21/220) are significant
at the 0.05 level of significances than expected due to chance,
and almost all of these (19) are negative. The lateral differences
that are significantly different from zero are often in the range
of -1 to -3 dB, indicating higher thresholds in the right ear.

TABLE   35   - AGE DISTRIBUITON OF 6-MONTHLY
               AUDITORY THRESHOLD INCREMENT
               EXAMINATIONS

Age in years	Number of increments in Boys	Number of increments in Girls
5.75- 6.74	11	12
6.75- 7.74	23	19
7.75- 8.74	26	27
8.75- 9.74	24	20
9.75-10.74	25	21
10.75-11.74	25	23
11.75-12.74	25	23
12.75-13.74	23	36
13.75-14.74	37	49
14.75-15.74	51	53
15.75-16.74	49	47
16.75-17.74	32	20

TABLE 36 - DESCRIPTIVE STATISTICS OF SIX-MONTH
          INCREMENTS IN AUDITORY THRESHOLD
          OF BOYS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	11	-0.18	10.33	-8.0	0.0	8.0
1000	11	3.82	9.18	-2.0	2.0	10.0
2000	11	2.91	6.77	-2.0	4.0	6.0
4000	11	-2.91	7.45	-8.0	-2.0	0.0
6000	11	0.55	6.20	-4.0	0.0	4.0
M512	11	2.00	7.04	-4.0	1.0	5.0
D4	11	6.73**	7.11	0.0	4.0	16.0
D1	11	-1.64	4.37	-4.0	-2.0	4.0
LEFT EAR						
500	7	4.29	7.70	0.0	4.0	6.0
1000	8	3.50	7.91	-2.0	2.0	10.0
2000	11	4.91*	5.54	0.0	4.0	10.0
4000	9	4.22	10.74	-6.0	10.0	12.0
6000	8	-1.00	10.31	-7.0	-1.0	3.5
M512	7	2.86	5.55	-2.0	2.0	5.0
D4	8	0.00	10.58	-10.5	1.0	6.0
D1	8	-2.75	5.12	-8.5	-2.0	1.5
BETTER EAR						
500	11	1.45	9.43	-4.0	4.0	4.0
1000	11	1.82	6.42	-2.0	2.0	4.0
2000	11	1.45	4.48	-2.0	0.0	6.0
4000	11	-1.09	8.22	-6.0	-4.0	4.0
6000	11	-0.91	8.73	-6.0	0.0	2.0
M512	11	1.09	5.20	-2.0	0.0	3.0
D4	11	2.91	7.76	0.0	6.0	6.0
WORSE EAR						
500	7	1.71	9.55	-6.0	0.0	6.0
1000	8	6.25	10.00	-1.0	5.0	13.0
2000	11	6.36**	6.62	2.0	8.0	10.0
4000	9	2.00	10.82	-8.0	8.0	11.0
6000	8	1.00	6.59	-4.0	-1.0	6.0
M512	7	3.43	5.94	-1.0	2.0	8.0
D4	8	5.25	8.28	-3.0	3.0	14.0
LEFT-RIGHT DIFFERENCES						
500	7	7.14	13.90	-2.0	2.0	12.0
1000	8	-1.50	9.55	-6.0	-4.0	7.5
2000	11	2.00	8.29	-6.0	2.0	6.0
4000	9	7.11	10.78	-1.0	8.0	16.0
6000	8	-1.00	9.26	-11.0	2.0	7.0
M512	7	2.43	7.02	-3.0	1.0	8.0

  * .01 < p ≤ .05

 ** p ≤ .01

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TABLE 37 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 6 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR
500	9	-2.22	7.10	-7.0	-2.0	4.0
1000	11	-2.18	4.85	-6.0	-2.0	0.0
2000	12	0.00	7.34	-5.5	-1.0	7.0
4000	10	-1.20	8.18	-7.0	0.0	4.5
6000	9	-5.33	7.55	-10.0	-8.0	2.0
M512	9	-1.33	4.56	-4.5	0.0	2.0
D4	9	-3.33	6.78	-9.0	-4.0	2.0
D1	11	1.82	3.52	0.0	2.0	4.0
LEFT EAR
500	7	6.86	11.94	0.0	2.0	10.0
1000	7	5.43	6.70	2.0	4.0	6.0
2000	8	2.25	6.27	-1.5	1.0	7.5
4000	8	4.00	10.31	-4.0	3.0	6.0
6000	7	3.43	11.00	-4.0	0.0	10.0
M512	7	4.71	7.97	0.0	4.0	4.0
D4	7	0.00	5.29	-2.0	-2.0	4.0
D1	7	0.29	2.93	-2.0	2.0	2.0
BETTER EAR
500	9	-0.44	8.71	-6.0	2.0	5.0
1000	11	-0.18	6.78	-2.0	0.0	4.0
2000	12	0.50	6.33	-4.0	0.0	7.5
4000	10	-0.20	8.46	-2.5	0.0	5.5
6000	9	-4.00	8.89	-11.0	-2.0	3.0
M512	9	0.44	5.22	-1.0	1.0	3.5
D4	9	-1.56	4.56	-5.0	0.0	2.0
WORSE EAR
500	7	4.57*	3.95	2.0	4.0	6.0
1000	7	0.57	3.78	-2.0	0.0	2.0
2000	8	1.50	5.32	-3.5	0.0	7.0
4000	8	2.75	7.63	-1.5	2.0	3.5
6000	7	0.57	10.44	-10.0	0.0	6.0
M512	7	1.71	4.03	-1.0	0.0	3.0
D4	7	-3.43	4.86	-6.0	-2.0	0.0
LEFT-RIGHT DIFFERENCES
500	7	6.29	15.25	-2.0	0.0	12.0
1000	7	8.29	9.55	2.0	4.0	12.0
2000	8	-0.50	10.99	-7.0	2.0	6.0
4000	8	2.00	11.56	-7.5	2.0	10.5
6000	7	9.71	13.54	2.0	6.0	12.0
M512	7	4.29	10.18	-2.0	4.0	4.0

*   .01 < p ≤ .05

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TABLE 38 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	20	0.70	5.81	-3.5	0.0	4.0
1000	20	1.10	7.24	-4.0	1.0	5.5
2000	22	-0.82	7.35	-6.0	-3.0	8.0
4000	22	-0.18	8.70	-6.5	0.0	4.0
6000	22	-0.45	6.47	-4.5	-1.0	2.5
M512	20	0.30	5.39	-4.0	-0.5	3.3
D4	20	2.00	6.84	-2.0	3.0	6.0
D1	20	-0.90	4.18	-3.5	0.0	3.0
LEFT EAR						
500	20	-1.70	7.00	-6.0	-3.0	2.0
1000	21	2.29	8.16	-3.0	2.0	9.0
2000	22	-0.18	5.92	-4.0	0.0	4.0
4000	21	0.00	8.12	-4.0	0.0	5.0
6000	20	-2.90	7.85	-7.5	-1.0	1.5
M512	20	0.20	5.60	-4.0	0.0	5.0
D4	21	2.29	9.30	-6.0	2.0	10.0
D1	21	-0.38	4.22	-4.0	0.0	3.0
BETTER EAR						
500	22	-1.64	8.27	-4.5	-1.0	4.0
1000	22	1.27	8.81	-5.0	2.0	6.5
2000	22	-0.09	6.52	-4.5	0.0	4.0
4000	22	-0.55	9.99	-6.5	0.0	6.0
6000	22	-1.27	7.00	-6.0	-2.0	2.5
M512	22	0.05	6.31	-4.3	0.0	5.0
D4	22	1.82	8.26	-4.0	2.0	6.0
WORSE EAR						
500	18	-0.33	5.54	-4.0	-2.0	1.0
1000	19	1.68	6.51	-2.0	2.0	6.0
2000	22	-0.91	6.13	-4.5	-2.0	2.5
4000	21	-0.38	7.31	-3.0	0.0	4.0
6000	20	-2.30	6.10	-6.0	-2.0	1.5
M512	18	0.00	4.43	-2.5	-1.0	3.3
D4	19	2.63	8.87	-4.0	2.0	12.0
LEFT-RIGHT DIFFERENCES						
500	18	-2.44	7.05	-7.0	-3.0	6.0
1000	19	1.37	5.42	-2.0	0.0	4.0
2000	22	0.64	6.21	-4.0	0.0	4.5
4000	21	-0.10	8.80	-4.0	0.0	4.0
6000	20	-2.50	8.85	-8.0	-4.0	3.5
M512	18	0.11	4.51	-3.0	-1.0	4.3

TABLE 39 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 7 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	19	-0.95	6.54	-6.0	-2.0	4.0
1000	19	0.00	5.66	-6.0	2.0	6.0
2000	19	-1.05	6.58	-8.0	-2.0	4.0
4000	19	-1.05	4.82	-4.0	-2.0	2.0
6000	19	-0.53	8.24	-4.0	-2.0	2.0
M512	19	-0.58	4.76	-2.0	0.0	1.0
D4	19	1.05	4.13	-2.0	2.0	4.0
D1	19	-0.32	5.78	-2.0	0.0	2.0
LEFT EAR						
500	14	-2.43	10.87	-6.5	0.0	3.0
1000	16	-0.25	9.60	-6.0	2.0	7.5
2000	16	-1.13	7.97	-5.5	1.0	4.0
4000	15	-3.20	10.39	-6.0	-2.0	2.0
6000	15	-2.53	11.94	-6.0	-4.0	8.0
M512	14	-0.79	8.70	-2.0	1.5	4.3
D4	15	3.87*	5.26	0.0	2.0	8.0
D1	16	-0.50	3.61	-2.0	-2.0	2.0
BETTER EAR						
500	19	-2.11	7.53	-6.0	0.0	2.0
1000	19	0.42	6.62	-6.0	0.0	6.0
2000	19	-1.26	5.42	-4.0	-2.0	2.0
4000	19	-1.58	6.27	-6.0	-2.0	2.0
6000	19	-0.84	7.07	-4.0	-2.0	4.0
M512	19	-0.84	5.34	-2.0	0.0	1.0
D4	19	2.00	4.99	-2.0	2.0	6.0
WORSE EAR						
500	14	-2.14	9.20	-6.0	-1.0	2.0
1000	16	-0.87	7.12	-5.5	2.0	4.0
2000	16	-1.13	7.73	-7.5	1.0	5.5
4000	15	-2.53	6.95	-6.0	-2.0	2.0
6000	15	-2.13	12.41	-8.0	-2.0	6.0
M512	14	-0.79	7.14	-2.3	0.5	3.0
D4	15	2.53*	4.50	2.0	2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	14	-1.57	8.49	-4.5	-1.0	4.0
1000	16	-0.75	9.06	-7.5	1.0	5.5
2000	16	0.37	7.94	-6.0	0.0	7.5
4000	15	-2.80	9.25	-6.0	-2.0	2.0
6000	15	-2.67	10.16	-4.0	-2.0	2.0
M512	14	-1.14	6.02	-4.0	0.5	2.5

*   .01 < p $\leq$ .05

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TABLE 40 - DESCRIPTIVE STATISTICS OF SIX-MONTH
            INCREMENTS IN AUDITORY THRESHOLD OF
            BOYS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	-2.08	8.24	-8.0	0.0	3.0
1000	25	-2.32	7.34	-8.0	0.0	4.0
2000	25	-0.16	5.47	-4.0	0.0	4.0
4000	25	-1.20	7.02	-5.0	-2.0	3.0
6000	25	-0.72	6.16	-6.0	0.0	4.0
M512	25	-1.44	5.04	-5.5	0.0	2.5
D4	25	-1.12	8.39	-6.0	-2.0	4.0
D1	25	-0.40	4.40	-4.0	-2.0	4.0
LEFT EAR						
500	25	-0.88	6.91	-3.0	0.0	3.0
1000	25	-2.56 *	5.31	-6.0	-2.0	0.0
2000	25	-1.04	6.19	-3.0	0.0	4.0
4000	25	-3.36 *	6.99	-8.0	-2.0	2.0
6000	25	-1.68	7.18	-6.0	-2.0	2.0
M512	25	-1.40	4.43	-3.0	-2.0	2.5
D4	25	0.80	6.61	-3.0	0.0	7.0
D1	25	0.64	5.41	-2.0	0.0	4.0
BETTER EAR						
500	25	-1.04	5.89	-5.0	0.0	3.0
1000	25	-2.08	5.31	-6.0	-2.0	1.0
2000	25	-0.80	5.72	-5.0	0.0	4.0
4000	25	-3.04 *	7.26	-7.0	-2.0	1.0
6000	25	-1.28	4.61	-4.0	0.0	0.0
M512	25	-1.20	4.24	-4.5	-1.0	1.5
D4	25	0.96	6.11	-4.0	0.0	6.0
WORSE EAR						
500	25	-1.92	8.55	-7.0	0.0	3.0
1000	25	-2.80 *	5.92	-5.0	-2.0	0.0
2000	25	-0.40	3.92	-4.0	0.0	4.0
4000	25	-1.52	5.39	-6.0	-2.0	3.0
6000	25	-1.12	6.25	-6.0	-2.0	4.0
M512	25	-1.68	4.53	-4.5	-1.0	2.0
D4	25	-1.28	7.14	-7.0	0.0	5.0
LEFT-RIGHT DIFFERENCES						
500	25	1.20	6.81	-4.0	0.0	7.0
1000	25	-0.24	8.15	-5.0	0.0	6.0
2000	25	-0.88	8.08	-4.0	0.0	4.0
4000	25	-2.16	8.44	-8.0	-4.0	4.0
6000	25	-0.96	10.38	-8.0	0.0	6.0
M512	25	0.00	4.85	-2.0	0.0	3.0

*   .01 < p ≤ .05

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TABLE 41 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 8 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR
500	26	-0.92	8.56	-8.0	1.0	6.0
1000	27	-1.70	8.03	-6.0	0.0	4.0
2000	27	-0.89	10.13	-6.0	-2.0	4.0
4000	27	-1.70	7.29	-6.0	0.0	4.0
6000	27	-2.44	8.64	-8.0	-2.0	2.0
M512	26	-0.85	6.98	-7.3	-0.5	3.0
D4	27	0.00	6.97	-4.0	2.0	4.0
D1	27	0.37	4.93	-4.0	0.0	4.0
LEFT EAR
500	25	-1.28	9.91	-10.0	-2.0	6.0
1000	25	-2.72	8.14	-6.0	-2.0	3.0
2000	25	-1.28	5.47	-6.0	-2.0	3.0
4000	25	-2.64	7.91	-10.0	-2.0	3.0
6000	25	-1.44	7.99	-7.0	-2.0	1.0
M512	25	-1.80	5.48	-6.5	-3.0	3.5
D4	25	-0.08	9.96	-5.0	2.0	7.0
D1	25	0.64	4.46	-3.0	0.0	3.0
BETTER EAR
500	26	-1.15	9.02	-10.0	-2.0	6.0
1000	27	-2.74	7.71	-6.0	-2.0	4.0
2000	27	-1.04	4.45	-4.0	-2.0	2.0
4000	27	-2.96*	6.85	-8.0	-2.0	2.0
6000	27	-1.70	7.70	-6.0	-2.0	0.0
M512	26	-1.62	5.43	-6.0	-1.5	3.0
D4	27	0.22	8.78	-6.0	0.0	6.0
WORSE EAR
500	25	-1.36	8.56	-8.0	2.0	5.0
1000	25	-2.00	8.35	-6.0	0.0	3.0
2000	25	-2.16	8.44	-6.0	0.0	2.0
4000	25	-1.28	7.14	-5.0	0.0	3.0
6000	25	-2.24	8.63	-8.0	0.0	2.0
M512	25	-1.64	6.53	-6.5	-1.0	2.0
D4	25	-0.72	8.14	-4.0	0.0	4.0
LEFT-RIGHT DIFFERENCES
500	25	-0.08	7.27	-5.0	0.0	4.0
1000	25	-0.96	4.05	-4.0	0.0	2.0
2000	25	0.48	8.53	-4.0	0.0	4.0
4000	25	-0.64	8.60	-8.0	0.0	6.0
6000	25	0.32	7.04	-6.0	0.0	5.0
M512	25	-0.16	3.80	-3.0	-1.0	3.0

* .01 < p ≤ .05

TABLE 42 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	24	-0.08	7.79	-2.0	0.0	4.0
1000	24	-0.67	6.97	-5.5	-3.0	4.0
2000	24	1.00	6.04	-3.5	0.0	5.5
4000	24	1.42	8.18	-3.5	1.0	7.5
6000	24	-1.08	6.07	-4.0	-1.0	1.5
M512	24	0.04	5.30	-3.7	-1.5	6.0
D4	24	-2.08	7.99	-7.5	0.0	2.0
D1	24	0.83	4.21	-1.5	0.0	3.5
LEFT EAR						
500	22	-0.18	6.11	-4.0	0.0	2.5
1000	22	-0.09	6.28	-4.5	0.0	4.5
2000	23	-1.91	4.80	-6.0	-2.0	2.0
4000	23	0.26	7.94	-6.0	0.0	6.0
6000	22	0.27	9.04	-6.0	1.0	6.0
M512	22	-0.73	4.40	-5.3	0.0	2.3
D4	22	0.09	5.61	-4.0	0.0	4.0
D1	22	-0.45	5.65	-2.0	0.0	2.0
BETTER EAR						
500	24	-0.08	5.73	-2.0	0.0	2.0
1000	24	-0.67	5.68	-4.0	0.0	4.0
2000	24	-0.83	5.47	-4.0	0.0	2.0
4000	24	0.67	7.43	-5.5	0.0	5.5
6000	24	-0.92	6.27	-5.5	-1.0	3.0
M512	24	-0.54	4.14	-3.7	0.0	2.0
D4	24	-1.33	6.77	-6.0	0.0	4.0
WORSE EAR						
500	22	-0.27	7.84	-2.5	0.0	2.5
1000	22	-0.09	7.29	-6.0	-1.0	6.0
2000	23	-0.26	5.63	-6.0	0.0	4.0
4000	23	1.04	7.31	-4.0	0.0	4.0
6000	22	-0.09	7.50	-6.0	0.0	6.0
M512	22	-0.27	5.21	-4.0	-0.5	3.3
D4	22	-0.55	6.77	-6.0	-2.0	4.5
LEFT-RIGHT DIFFERENCES						
500	22	-0.09	5.50	-4.0	0.0	2.5
1000	22	0.09	5.29	-4.0	0.0	4.5
2000	23	-3.22*	5.68	-10.0	-2.0	2.0
4000	23	-1.57	8.61	-8.0	-2.0	4.0
6000	22	1.18	9.50	-4.5	1.0	10.0
M512	22	-0.86	3.33	-3.0	0.0	1.2

*   .01 < p $\leq$ .05

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TABLE 43 – DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 9 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	19	-0.32	6.44	-6.0	-2.0	4.0
1000	20	1.00	5.09	-2.0	2.0	4.0
2000	20	-1.00	4.66	-2.0	-2.0	2.0
4000	20	-0.90	7.80	-7.5	0.0	4.0
6000	20	-0.10	9.37	-3.5	0.0	5.5
M512	19	-0.05	3.52	-3.0	0.0	2.0
D4	20	1.90	7.72	-6.0	1.0	7.5
D1	20	-0.80	3.86	-2.0	-1.0	1.5
LEFT EAR						
500	17	-0.12	6.73	-5.0	0.0	7.0
1000	18	3.78 *	6.36	-0.5	5.0	8.0
2000	19	0.53	6.03	-4.0	0.0	6.0
4000	18	1.67	6.52	-4.0	1.0	6.5
6000	18	1.44	7.38	-2.5	0.0	7.0
M512	17	1.06	4.49	-1.5	0.0	5.5
D4	17	0.94	5.92	-3.0	0.0	6.0
D1	18	-1.89	3.97	-4.5	-2.0	2.0
BETTER EAR						
500	19	0.84	7.19	-4.0	-2.0	8.0
1000	20	1.80	5.69	-2.0	1.0	6.0
2000	20	-0.10	4.08	-4.0	0.0	3.5
4000	20	1.20	5.78	-3.5	2.0	6.0
6000	20	0.30	6.17	-2.0	0.0	4.0
M512	19	0.95	4.34	-2.0	0.0	5.0
D4	20	0.60	7.05	-4.0	0.0	6.0
WORSE EAR						
500	17	-1.41	5.28	-6.0	-2.0	1.0
1000	18	2.89 *	5.23	-0.5	2.0	6.5
2000	19	-0.42	5.40	-4.0	-2.0	2.0
4000	18	-0.78	7.00	-6.5	0.0	4.0
6000	18	0.11	8.72	-4.0	0.0	4.5
M512	17	0.00	3.18	-2.5	1.0	2.0
D4	17	2.59	7.54	-4.0	0.0	10.0
LEFT-RIGHT DIFFERENCES						
500	17	1.18	5.75	-4.0	0.0	5.0
1000	18	3.00	7.04	-1.5	2.0	8.5
2000	19	1.37	6.83	-2.0	2.0	6.0
4000	18	2.89	4.36	-4.0	2.0	6.5
6000	18	1.56	10.30	-4.0	1.0	8.5
M512	17	1.65	4.20	-1.0	0.0	3.5

* .01 < p $\leq$ .05

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TABLE 44 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	0.16	4.54	-2.0	0.0	3.0
1000	25	0.40	4.12	-2.0	2.0	4.0
2000	25	-0.80	4.28	-4.0	-2.0	2.0
4000	25	-1.12	7.03	-6.0	-2.0	5.0
6000	25	-1.60	7.30	-5.0	-2.0	3.0
M512	25	-0.20	3.08	-3.0	0.0	2.0
D4	25	1.52	7.73	-2.0	2.0	6.0
D1	25	-0.48	2.90	-2.0	0.0	2.0
LEFT EAR						
500	21	-0.95	7.53	-7.0	0.0	6.0
1000	24	-0.08	5.12	-4.0	0.0	3.5
2000	24	-0.33	5.80	-4.0	1.0	3.5
4000	24	0.75	6.07	-4.0	1.0	4.0
6000	24	0.17	9.00	-5.5	0.0	6.5
M512	21	-0.67	4.92	-4.0	0.0	2.0
D4	24	-0.83	5.17	-4.0	-2.0	1.5
D1	24	0.17	3.86	-1.5	0.0	2.0
BETTER EAR						
500	25	-0.72	6.08	-7.0	0.0	5.0
1000	25	0.48	4.05	-2.0	0.0	4.0
2000	25	-0.56	5.58	-5.0	0.0	4.0
4000	25	-0.80	5.80	-4.0	0.0	4.0
6000	25	-1.12	6.43	-5.0	-2.0	4.0
M512	25	-0.28	3.76	-2.5	0.0	2.0
D4	25	1.28	7.00	-4.0	0.0	7.0
WORSE EAR						
500	21	0.29	5.23	-3.0	0.0	4.0
1000	24	-0.17	4.93	-6.0	1.0	4.0
2000	24	-0.67	3.67	-4.0	0.0	2.0
4000	24	0.42	5.21	-4.0	0.0	4.0
6000	24	-0.33	7.29	-4.0	0.0	3.5
M512	21	-0.38	3.56	-3.0	0.0	3.5
D4	24	-0.58	4.31	-2.0	-2.0	2.0
LEFT-RIGHT DIFFERENCES						
500	21	-1.14	6.86	-6.0	-2.0	3.0
1000	24	-0.42	4.53	-3.5	-1.0	2.0
2000	24	0.67	5.58	-3.5	0.0	5.5
4000	24	2.25	9.55	-3.5	4.0	7.5
6000	24	1.83	11.65	-4.0	0.0	10.0
M512	21	-0.62	3.15	-3.0	0.0	2.0

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TABLE 45 - DESCRIPTIVE STATISTICS OF SIX-MONTH
           INCREMENTS IN AUDITORY THRESHOLD
           OF GIRLS 10 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	21	0.10	7.06	-4.0	-2.0	4.0
1000	21	1.33	7.11	-5.0	2.0	4.0
2000	21	-0.57	7.65	-6.0	-2.0	3.0
4000	21	-0.95	8.80	-7.0	0.0	5.0
6000	21	-1.81	7.92	-9.0	0.0	4.0
M512	21	0.19	4.95	-3.5	1.0	2.5
D4	21	2.29	9.51	-4.0	0.0	11.0
D1	21	-0.19	4.09	-4.0	0.0	3.0
LEFT EAR						
500	19	0.42	9.39	-6.0	-2.0	8.0
1000	20	-2.50	11.07	-12.0	-3.0	6.5
2000	20	-0.10	7.58	-5.0	0.0	2.0
4000	19	-1.16	8.20	-6.0	-2.0	4.0
6000	20	-4.00	8.58	-4.0	-4.0	0.0
M512	19	-0.16	6.91	-5.0	1.0	4.0
D4	19	-1.05	8.44	-10.0	-2.0	4.0
D1	20	2.10*	4.02	0.0	2.0	5.5
BETTER EAR						
500	21	-0.57	8.18	-6.0	-2.0	5.0
1000	21	0.19	7.87	-6.0	0.0	5.0
2000	21	-0.38	5.89	-4.0	0.0	2.0
4000	21	-1.24	6.97	-6.0	-2.0	2.0
6000	21	-3.62	8.45	-8.0	-2.0	2.0
M512	21	-0.38	5.74	-4.5	-1.0	3.5
D4	21	1.43	7.70	-3.0	2.0	7.0
WORSE EAR						
500	19	0.63	7.63	-6.0	-2.0	6.0
1000	20	-1.30	8.44	-8.0	-7.0	3.5
2000	20	-0.70	7.93	-6.0	-1.0	2.0
4000	19	-0.32	5.63	-4.0	0.0	4.0
6000	20	-2.10	6.76	-4.0	-2.0	3.0
M512	19	-0.16	5.80	-5.0	-1.0	4.0
D4	19	-0.63	7.43	-8.0	0.0	4.0
LEFT-RIGHT DIFFERENCES						
500	19	0.53	6.83	-4.0	0.0	4.0
1000	20	-3.30	10.12	-9.0	-3.0	4.5
2000	20	0.70	8.44	-3.5	0.0	7.0
4000	19	-1.47	11.05	-8.0	0.0	6.0
6000	20	-1.90	9.79	-11.5	-3.0	7.0
M512	19	-0.21	4.85	-4.0	0.0	3.0

* .01 < p ≤ .05

TABLE 46 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	24	-1.08	4.93	-3.5	-1.0	3.5
1000	25	-0.08	4.45	-2.0	0.0	2.0
2000	25	-0.80	7.07	-4.0	-2.0	5.0
4000	25	-1.12	6.08	-4.0	0.0	2.0
6000	25	-1.12	10.28	-6.0	-2.0	6.0
M512	24	-0.79	3.09	-3.0	-1.0	2.0
D4	25	1.04	6.71	-3.0	0.0	5.0
D1	25	0.48	3.07	-2.0	0.0	3.0
LEFT EAR						
500	24	-0.83	5.72	-5.5	-1.0	2.0
1000	25	1.04	5.04	-2.0	0.0	6.0
2000	25	-1.36	4.07	-4.0	0.0	2.0
4000	25	-2.72*	6.37	-6.0	-2.0	0.0
6000	25	-1.28	7.21	-7.0	0.0	4.0
M512	24	-0.29	3.24	-2.8	-1.0	2.0
D4	25	3.76	8.78	-1.0	4.0	9.0
D1	25	-0.16	3.41	-3.0	0.0	2.0
BETTER EAR						
500	25	-0.32	4.35	-2.0	0.0	2.0
1000	25	0.48	4.48	-2.0	0.0	4.0
2000	25	-0.72	4.35	-3.0	0.0	2.0
4000	25	-1.60	6.58	-5.0	0.0	0.0
6000	25	-1.84	6.08	-6.0	0.0	3.0
M512	25	-0.20	2.69	-2.0	0.0	1.0
D4	25	2.08	8.24	-2.0	2.0	7.0
WORSE EAR						
500	23	-1.57	4.13	-4.0	-2.0	2.0
1000	25	0.48	3.57	-2.0	0.0	2.0
2000	25	-1.44	5.82	-4.0	-2.0	3.0
4000	25	-2.24	5.64	-5.0	-2.0	0.0
6000	25	-0.56	9.21	-8.0	2.0	6.0
M512	23	-1.04*	2.08	-3.0	-1.0	0.0
D4	25	2.72	7.30	-2.0	2.0	7.0
LEFT-RIGHT DIFFERENCES						
500	23	-0.17	8.04	-8.0	0.0	4.0
1000	25	1.12	6.08	-3.0	0.0	4.0
2000	25	-0.56	6.84	-5.0	0.0	3.0
4000	25	-1.60	4.86	-4.0	0.0	2.0
6000	25	-0.16	12.05	-8.0	2.0	8.0
M512	23	0.39	4.05	-2.0	0.0	2.0

* .01 < p ≤ .05

TABLE 47 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 11 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	23	0.78	5.74	-2.0	0.0	4.0
1000	23	-1.13	8.20	-6.0	0.0	4.0
2000	23	0.87	7.00	-4.0	0.0	4.0
4000	23	-0.52	6.72	-8.0	0.0	6.0
6000	23	-1.57	7.58	-6.0	-2.0	4.0
M512	23	0.04	4.58	-3.0	-1.0	3.0
D4	23	-0.61	8.89	-6.0	-4.0	8.0
D1	23	0.78	5.52	-2.0	2.0	2.0
LEFT EAR						
500	23	-0.78	6.29	-4.0	-2.0	2.0
1000	23	-1.57	6.35	-6.0	0.0	2.0
2000	23	0.70	7.74	-2.0	2.0	6.0
4000	23	-0.87	9.87	-6.0	-2.0	4.0
6000	23	2.70	8.88	-4.0	6.0	10.0
M512	23	-0.48	4.62	-3.0	0.0	2.0
D4	23	-0.70	10.96	-4.0	0.0	4.0
D1	23	0.61	3.74	-2.0	0.0	4.0
BETTER EAR						
500	23	0.61	5.34	-2.0	0.0	4.0
1000	23	-0.87	5.18	-4.0	0.0	2.0
2000	23	0.61	5.77	-4.0	2.0	4.0
4000	23	-0.35	6.46	-6.0	0.0	4.0
6000	23	-0.43	6.93	-4.0	0.0	4.0
M512	23	0.17	3.89	-2.0	-1.0	2.0
D4	23	-0.52	6.50	-6.0	-2.0	4.0
WORSE EAR						
500	23	-0.61	5.64	-2.0	0.0	2.0
1000	23	-1.83	8.53	-8.0	0.0	4.0
2000	23	0.96	8.24	-4.0	2.0	6.0
4000	23	-1.04	8.78	-6.0	-2.0	4.0
6000	23	1.57	8.13	-4.0	2.0	8.0
M512	23	-0.52	5.20	-4.0	-1.0	3.0
D4	23	-0.78	10.88	-8.0	2.0	6.0
LEFT-RIGHT DIFFERENCES						
500	23	-1.57	6.41	-4.0	0.0	2.0
1000	23	-0.43	6.69	-4.0	-2.0	6.0
2000	23	-0.17	8.78	-4.0	0.0	6.0
4000	23	-0.35	10.59	-8.0	0.0	8.0
6000	23	4.26	10.61	0.0	6.0	10.0
M512	23	-0.57	3.51	-3.0	-1.0	3.0

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TABLE 48 - DESCRIPTIVE STATISTICS OF SIX-MONTH
            INCREMENTS IN AUDITORY THRESHOLD
            OF BOYS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	25	-2.08	5.49	-6.0	0.0	2.0
1000	25	-1.76	5.11	-5.0	-2.0	2.0
2000	25	1.28	5.88	-2.0	0.0	4.0
4000	25	-1.28	6.73	-6.0	0.0	4.0
6000	25	-1.28	7.35	-6.0	-4.0	3.0
M512	25	-0.64	3.71	-2.0	0.0	1.5
D4	25	-0.48	6.81	-6.0	-2.0	5.0
D1	25	-0.08	3.39	-2.0	0.0	2.0
LEFT EAR						
500	24	-1.50	5.96	-4.0	0.0	2.0
1000	24	-1.00	4.13	-2.0	-1.0	2.0
2000	24	1.08	6.10	-3.5	2.0	6.0
4000	24	-1.58	7.64	-8.0	-1.0	3.5
6000	24	-2.00	6.78	-7.5	-2.0	3.5
M512	24	-0.46	4.01	-2.0	0.0	2.8
D4	24	0.58	8.03	-4.0	-1.0	5.5
D1	24	0.33	3.10	-2.0	0.0	2.0
BETTER EAR						
500	25	-1.36	5.38	-4.0	0.0	2.0
1000	25	-1.04	4.73	-4.0	-2.0	2.0
2000	25	0.32	4.61	-4.0	0.0	5.0
4000	25	-1.64	6.43	-7.0	-2.0	3.0
6000	25	-0.96	6.35	-6.0	-2.0	3.0
M512	25	-0.64	3.85	-2.5	0.0	2.0
D4	25	0.80	6.24	-5.0	0.0	5.0
WORSE EAR						
500	24	-2.25	5.54	-5.5	0.0	2.0
1000	24	-1.75*	4.10	-4.0	-2.0	2.0
2000	24	1.75	6.02	-1.5	2.0	4.0
4000	24	-1.00	6.10	-7.0	0.0	4.0
6000	24	-2.33	6.26	-6.0	-4.0	2.0
M512	24	-0.83	3.52	-2.5	0.0	1.0
D4	24	-0.75	5.43	-5.5	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	24	0.67	5.23	-4.0	0.0	4.0
1000	24	1.08	3.73	-2.0	1.0	3.5
2000	24	-0.17	7.87	-4.0	0.0	5.5
4000	24	-0.25	8.97	-5.5	-1.0	6.0
6000	24	-0.75	8.46	-4.0	0.0	3.5
M512	24	0.46	3.24	-1.0	0.5	2.0

*   .01 < $p \leq$ .05

TABLE 49 - DESCRIPTIVE STATISTICS OF SIX-MONTH
             INCREMENTS IN AUDITORY THRESHOLD
             OF GIRLS 12 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	22	0.91	6.81	-2.5	1.0	6.0
1000	23	1.48	5.33	-2.0	0.0	6.0
2000	23	1.13	5.75	-4.0	0.0	6.0
4000	23	0.87	8.50	-6.0	2.0	6.0
6000	23	2.26	9.27	-4.0	0.0	12.0
M512	22	1.14	4.51	-1.2	0.0	3.3
D4	23	0.61	8.28	-6.0	0.0	8.0
D1	23	-0.70	5.45	-4.0	-2.0	2.0
LEFT EAR						
500	22	2.36	18.64	-6.0	0.0	10.5
1000	22	4.55	18.94	-4.5	0.0	11.5
2000	22	1.09	10.97	-6.5	-1.0	4.5
4000	22	2.55	11.99	-3.5	0.0	10.5
6000	22	1.45	13.37	-10.0	-1.0	12.0
M512	22	2.64	14.86	-5.3	0.0	6.0
D4	22	2.00	12.48	-8.5	0.0	10.0
D1	22	-1.82	8.28	-4.5	0.0	2.5
BETTER EAR						
500	22	0.91	7.63	-4.0	1.0	4.5
1000	23	1.30	6.51	-2.0	0.0	6.0
2000	23	-0.09	6.67	-4.0	2.0	4.0
4000	23	1.22	7.13	-6.0	0.0	8.0
6000	23	2.17	10.07	-6.0	2.0	8.0
M512	22	0.82	5.28	-3.3	0.5	4.3
D4	23	0.09	7.27	-6.0	0.0	8.0
WORSE EAR						
500	22	2.36	16.88	-4.5	-1.0	9.0
1000	22	4.73	17.83	-2.0	0.0	7.0
2000	22	1.73	8.84	-4.5	0.0	4.5
4000	22	2.18	10.47	-6.0	1.0	6.5
6000	22	1.45	11.53	-8.5	-1.0	7.5
M512	22	3.05	13.24	-3.3	0.0	5.0
D4	22	2.55	11.86	-4.5	1.0	8.5
LEFT-RIGHT DIFFERENCES						
500	22	1.45	18.07	-2.0	0.0	4.5
1000	22	2.91	19.56	-4.5	0.0	6.5
2000	22	0.09	11.01	-6.0	-1.0	3.0
4000	22	1.82	14.70	-6.0	-1.0	10.5
6000	22	-0.36	11.56	-7.0	0.0	6.5
M512	22	1.59	14.90	-2.0	0.0	4.5

TABLE 50 - DESCRIPTIVE STATISTICS OF SIX-MONTH.
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	23	-1.30	5.80	-4.0	-2.0	0.0
1000	23	0.17	4.30	-2.0	0.0	2.0
2000	23	-2.17*	4.51	-4.0	-2.0	2.0
4000	23	-1.74	9.23	-10.0	-2.0	4.0
6000	23	-2.78	7.90	-8.0	-2.0	4.0
M512	23	-1.13	3.71	-3.0	-1.0	0.0
D4	23	1.91	7.80	-4.0	0.0	10.0
D1	23	-0.17	3.46	-2.0	0.0	2.0
LEFT EAR						
500	22	-0.36	7.50	-6.0	-1.0	2.5
1000	22	-1.73	6.66	-6.0	-3.0	1.0
2000	23	-0.52	6.88	-6.0	-2.0	2.0
4000	23	1.04	9.12	-6.0	2.0	4.0
6000	23	-0.96	8.20	-8.0	0.0	4.0
M512	22	-0.91	6.07	-4.0	-3.0	1.2
D4	22	-2.73	8.34	-7.0	-2.0	4.0
D1	22	0.64	4.07	-2.0	0.0	4.0
BETTER EAR						
500	23	-0.96	6.18	-6.0	-2.0	2.0
1000	23	-1.57	5.66	-6.0	-2.0	0.0
2000	23	-0.78	5.07	-4.0	0.0	2.0
4000	23	0.17	7.93	-4.0	0.0	4.0
6000	23	-2.17	6.26	-8.0	-2.0	2.0
M512	23	-1.17	5.01	-4.0	-2.0	2.0
D4	23	-1.74	6.30	-6.0	-2.0	0.0
WORSE EAR						
500	22	-0.64	6.72	-6.0	-1.0	4.0
1000	22	0.18	5.31	-4.0	0.0	2.5
2000	23	-1.91	6.16	-4.0	-2.0	2.0
4000	23	-0.87	9.14	-6.0	2.0	4.0
6000	23	-1.57	8.78	-8.0	0.0	4.0
M512	22	-0.73	4.84	-4.0	-1.0	0.2
D4	22	1.18	7.75	-4.0	0.0	5.0
LEFT-RIGHT DIFFERENCES						
500	22	1.00	4.73	-2.0	0.0	4.0
1000	22	-2.00	4.98	-5.0	-3.0	2.5
2000	23	1.65	6.97	-4.0	2.0	10.0
4000	23	2.78	8.28	-2.0	0.0	6.0
6000	23	1.83	8.44	-4.0	2.0	6.0
M512	22	0.18	3.19	-2.0	0.0	2.0

*   .01 < p ≤ .05

TABLE 51 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 13 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	36	-0.39	7.28	-6.0	0.0	4.0
1000	36	-1.22	5.84	-4.0	-2.0	2.0
2000	36	-1.72*	4.81	-6.0	-2.0	2.0
4000	36	-0.61	6.06	-6.0	0.0	3.5
6000	36	-0.33	9.09	-6.0	0.0	6.0
M512	36	-1.11	4.58	-4.8	-1.5	1.8
D4	36	-0.61	7.06	-6.0	0.0	4.0
D1	36	0.39	4.35	-2.0	0.0	3.5
LEFT EAR						
500	36	-1.89	9.10	-7.5	-3.0	4.0
1000	36	-1.56	8.70	-8.0	-1.0	5.5
2000	35	-1.37	5.63	-6.0	0.0	2.0
4000	36	0.06	9.24	-6.0	2.0	6.0
6000	36	-1.17	10.24	-7.5	-2.0	6.0
M512	35	-1.80	6.01	-6.0	-3.0	2.0
D4	36	-1.61	9.14	-8.0	-3.0	4.0
D1	36	0.06	5.27	-2.0	0.0	3.5
BETTER EAR						
500	36	-0.94	7.43	-6.0	-1.0	4.0
1000	36	-1.11	5.98	-6.0	-1.0	2.0
2000	36	-1.39	4.30	-4.0	0.0	2.0
4000	36	-0.06	6.56	-6.0	2.0	4.0
6000	36	-0.67	8.94	-8.0	0.0	5.5
M512	36	-1.14	4.55	-4.8	-0.5	2.0
D4	36	-1.06	7.27	-6.0	-2.0	4.0
WORSE EAR						
500	36	-1.33	8.24	-6.0	-3.0	4.0
1000	36	-1.67	8.22	-6.0	-4.0	4.0
2000	35	-1.77	5.63	-6.0	-2.0	2.0
4000	36	-0.50	8.03	-5.5	0.0	4.0
6000	36	-0.83	8.29	-4.0	-1.0	5.5
M512	35	-1.83	5.66	-5.0	-2.0	2.0
D4	36	-1.17	8.09	-8.0	-2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	36	-1.50	7.55	-5.5	-2.0	2.0
1000	36	-0.33	7.21	-4.0	0.0	5.5
2000	35	0.51	5.39	-2.0	2.0	6.0
4000	36	0.67	8.57	-4.0	0.0	6.0
6000	36	-0.83	10.86	-9.5	-1.0	6.0
M512	35	-0.86	4.85	-3.0	0.0	2.0

*   .01 < p ≤ .05

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TABLE 52 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	37	-0.16	6.77	-5.0	0.0	4.0
1000	37	-1.03	6.10	-4.0	0.0	2.0
2000	37	-0.22	5.01	-4.0	0.0	4.0
4000	37	0.92	7.10	-3.0	0.0	5.0
6000	37	0.27	6.13	-2.0	0.0	4.0
M512	37	-0.35	4.04	-2.5	-1.0	2.5
D4	37	-1.95	9.32	-8.0	-2.0	4.0
D1	37	-0.11	3.62	-2.0	0.0	2.0
LEFT EAR						
500	37	-0.22	7.16	-4.0	0.0	4.0
1000	37	-0.43	7.27	-4.0	0.0	3.0
2000	37	0.27	5.19	-2.0	0.0	4.0
4000	37	0.76	7.46	-4.0	0.0	5.0
6000	37	1.03	7.21	-5.0	0.0	7.0
M512	37	-0.16	5.24	-3.5	1.0	3.0
D4	37	-1.19	8.05	-6.0	0.0	4.0
D1	37	-0.65	3.50	-2.0	0.0	1.0
BETTER EAR						
500	37	-0.05	7.34	-3.0	0.0	4.0
1000	37	-0.22	6.56	-2.0	0.0	2.0
2000	37	0.16	4.86	-2.0	0.0	4.0
4000	37	1.24	6.31	-1.0	0.0	5.0
6000	37	0.86	5.69	-2.0	0.0	6.0
M512	37	0.03	4.76	-3.5	0.0	3.0
D4	37	-1.46	7.11	-6.0	-2.0	4.0
WORSE EAR						
500	37	-0.32	5.26	-4.0	0.0	2.0
1000	37	-1.24	6.17	-5.0	0.0	3.0
2000	37	-0.11	5.01	-2.0	0.0	4.0
4000	37	0.43	6.78	-4.0	0.0	6.0
6000	37	0.43	6.45	-4.0	0.0	4.0
M512	37	-0.57	4.09	-3.5	-1.0	2.0
D4	37	-1.68	8.43	-7.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	37	-0.05	6.67	-4.0	0.0	4.0
1000	37	0.59	6.07	-2.0	0.0	4.0
2000	37	0.49	5.32	-3.0	0.0	4.0
4000	37	-0.16	8.26	-6.0	0.0	5.0
6000	37	0.76	8.62	-4.0	0.0	7.0
M512	37	0.38	3.29	-1.0	0.0	2.5

TABLE 53 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 14 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	49	-0.94	6.48	-5.0	0.0	4.0
1000	49	-1.84*	6.03	-4.0	0.0	2.0
2000	49	-1.76*	5.59	-6.0	-2.0	2.0
4000	49	-1.76	6.36	-6.0	0.0	2.0
6000	49	0.53	8.16	-5.0	0.0	6.0
M512	49	-1.33*	3.98	-3.5	0.0	1.0
D4	49	-0.08	7.66	-5.0	0.0	6.0
D1	49	0.29	3.61	-2.0	0.0	2.0
LEFT EAR						
500	49	-0.41	5.77	-4.0	0.0	4.0
1000	49	-0.73	5.24	-4.0	0.0	2.0
2000	49	-0.04	4.41	-3.0	0.0	4.0
4000	49	-1.06	6.52	-6.0	-2.0	4.0
6000	49	-0.61	8.76	-6.0	0.0	6.0
M512	49	-0.41	3.54	-3.0	0.0	2.0
D4	49	0.33	7.55	-4.0	2.0	6.0
D1	49	-0.20	4.03	-2.0	0.0	3.0
BETTER EAR						
500	49	-0.41	5.61	-4.0	0.0	4.0
1000	49	-1.10	4.92	-4.0	0.0	1.0
2000	49	-0.78	4.20	-4.0	0.0	2.0
4000	49	-0.78	5.47	-6.0	0.0	2.0
6000	49	0.86	7.36	-3.0	2.0	4.0
M512	49	-0.73	3.07	-3.0	-1.0	1.0
D4	49	-0.33	6.46	-4.0	0.0	3.0
WORSE EAR						
500	49	-0.94	6.07	-4.0	0.0	4.0
1000	49	-1.47	5.70	-4.0	0.0	2.0
2000	49	-1.02	4.71	-4.0	0.0	2.0
4000	49	-2.04*	5.58	-6.0	-2.0	2.0
6000	49	-0.94	7.77	-6.0	0.0	5.0
M512	49	-1.02	4.02	-4.0	0.0	2.0
D4	49	0.57	7.30	-4.0	0.0	6.0
LEFT-RIGHT DIFFERENCES						
500	49	0.53	5.18	-4.0	0.0	4.0
1000	49	1.10	6.21	-4.0	0.0	5.0
2000	49	1.71	6.26	-2.0	0.0	6.0
4000	49	0.69	8.13	-6.0	0.0	6.0
6000	49	-1.14	9.28	-7.0	0.0	4.0
M512	49	1.00*	3.32	-1.0	1.0	3.0

* .01 < p ≤ .05

TABLE 54 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR
500	51	-0.67	6.83	-6.0	0.0	4.0
1000	51	0.31	6.44	-4.0	0.0	4.0
2000	51	0.27	5.09	-2.0	0.0	2.0
4000	51	-0.31	5.92	-4.0	0.0	2.0
6000	51	-0.55	6.08	-6.0	0.0	4.0
M512	51	-0.02	4.26	-3.0	0.0	3.0
D4	51	0.63	6.91	-2.0	0.0	4.0
D1	51	0.04	5.13	-2.0	0.0	4.0
LEFT EAR
500	51	-0.86	6.70	-4.0	-2.0	4.0
1000	51	0.47	6.42	-4.0	0.0	4.0
2000	51	0.47	5.95	-4.0	0.0	4.0
4000	51	-0.59	6.91	-4.0	0.0	4.0
6000	51	0.55	8.11	-4.0	0.0	6.0
M512	51	0.14	4.80	-3.0	0.0	3.0
D4	51	1.06	8.55	-4.0	0.0	4.0
D1	51	0.04	3.11	-2.0	0.0	2.0
BETTER EAR
500	51	-1.02	6.19	-4.0	0.0	2.0
1000	51	-0.35	6.53	-4.0	0.0	2.0
2000	51	-0.12	4.16	-2.0	0.0	2.0
4000	51	-0.08	6.26	-4.0	0.0	4.0
6000	51	-0.39	6.27	-6.0	0.0	4.0
M512	51	-0.49	4.05	-3.0	-1.0	2.0
D4	51	-0.27	7.82	-6.0	0.0	4.0
WORSE EAR
500	51	-0.51	5.92	-4.0	0.0	4.0
1000	51	1.14	5.80	-2.0	0.0	4.0
2000	51	0.86	5.30	-2.0	0.0	2.0
4000	51	-0.82	5.98	-6.0	0.0	2.0
6000	51	0.39	6.93	-4.0	0.0	6.0
M512	51	0.45	4.42	-2.0	0.0	3.0
D4	51	1.96	7.06	-4.0	2.0	6.0
LEFT-RIGHT DIFFERENCES
500	51	-0.20	7.45	-4.0	0.0	4.0
1000	51	0.16	5.71	-4.0	0.0	4.0
2000	51	0.20	8.74	-4.0	-2.0	6.0
4000	51	-0.27	6.71	-6.0	-2.0	6.0
6000	51	1.10	7.97	-6.0	2.0	8.0
M512	51	0.06	3.98	-2.0	0.0	2.0

TABLE 55 - DESCRIPTIVE STATISTICS OF SIX-MONTH
           INCREMENTS IN AUDITORY THRESHOLD
           OF GIRLS 15 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	53	-0.53	7.11	-6.0	0.0	6.0
1000	53	-0.19	5.93	-4.0	0.0	3.0
2000	53	0.34	4.65	-4.0	0.0	4.0
4000	53	-0.49	7.17	-6.0	0.0	3.0
6000	53	-0.34	8.49	-6.0	0.0	6.0
M512	53	-0.15	4.11	-3.0	0.0	2.0
D4	53	0.30	8.31	-6.0	0.0	7.0
D1	53	-0.57	3.73	-2.0	0.0	2.0
LEFT EAR						
500	53	-1.02	5.76	-6.0	0.0	3.0
1000	53	0.34	4.94	-4.0	0.0	4.0
2000	53	0.60	3.73	-2.0	0.0	3.0
4000	53	-1.32	7.51	-5.0	0.0	4.0
6000	53	0.13	9.70	-6.0	0.0	6.0
M512	53	-0.09	3.83	-3.0	0.0	3.0
D4	53	1.66	8.44	-4.0	2.0	7.0
D1	53	0.04	3.77	-2.0	0.0	2.0
BETTER EAR						
500	53	-1.02	5.17	-6.0	0.0	3.0
1000	53	0.23	4.20	-2.0	0.0	3.0
2000	53	0.45	3.57	-2.0	0.0	2.0
4000	53	-0.42	6.78	-5.0	0.0	4.0
6000	53	0.42	8.46	-6.0	0.0	8.0
M512	53	-0.11	3.57	-2.5	0.0	2.0
D4	53	0.64	6.58	-4.0	0.0	4.0
WORSE EAR						
500	53	-0.53	6.74	-4.0	0.0	6.0
1000	53	-0.08	5.05	-4.0	0.0	2.0
2000	53	0.49	4.09	-3.0	0.0	4.0
4000	53	-1.40	7.32	-4.0	0.0	2.0
6000	53	-0.62	8.88	-8.0	0.0	6.0
M512	53	-0.04	3.85	-3.0	0.0	2.0
D4	53	1.32	7.64	-4.0	0.0	7.0
LEFT-RIGHT DIFFERENCES						
500	53	-0.49	6.11	-4.0	0.0	4.0
1000	53	0.53	7.61	-4.0	0.0	5.0
2000	53	0.26	5.25	-4.0	0.0	4.0
4000	53	-0.83	8.14	-6.0	0.0	6.0
6000	53	0.47	8.32	-8.0	0.0	6.0
M512	53	0.06	3.70	-2.0	0.0	2.0

TABLE 56 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	49	0.20	5.26	-4.0	0.0	4.0
1000	49	-0.16	6.01	-4.0	0.0	4.0
2000	49	0.24	5.13	-2.0	0.0	4.0
4000	49	-0.37	6.24	-4.0	0.0	4.0
6000	49	1.02	6.62	-4.0	0.0	6.0
M512	49	0.06	3.63	-2.0	0.0	3.5
D4	49	0.20	6.65	-6.0	0.0	6.0
D1	49	0.24	4.43	-3.0	0.0	4.0
LEFT EAR						
500	49	-0.49	6.23	-4.0	0.0	4.0
1000	49	0.04	6.76	-6.0	0.0	4.0
2000	49	0.69	5.25	-2.0	0.0	4.0
4000	49	0.33	7.22	-6.0	2.0	6.0
6000	49	0.37	8.08	-4.0	0.0	6.0
M512	49	0.02	4.66	-3.5	0.0	2.0
D4	49	-0.29	7.38	-6.0	-2.0	4.0
D1	49	0.16	4.34	-2.0	0.0	4.0
BETTER EAR						
500	49	0.08	5.37	-4.0	0.0	4.0
1000	49	0.57	6.08	-4.0	0.0	3.0
2000	49	0.86	4.40	-2.0	0.0	4.0
4000	49	-0.41	5.52	-4.0	0.0	3.0
6000	49	0.86	6.24	-3.0	2.0	6.0
M512	49	0.49	4.14	-2.0	0.0	3.0
D4	49	0.98	6.43	-2.0	2.0	4.0
WORSE EAR						
500	49	-0.37	5.46	-4.0	-2.0	4.0
1000	49	-0.69	5.82	-4.0	-2.0	4.0
2000	49	0.08	4.98	-2.0	0.0	4.0
4000	49	0.37	6.41	-4.0	0.0	4.0
6000	49	0.53	7.27	-6.0	0.0	6.0
M512	49	-0.33	3.63	-2.5	0.0	1.0
D4	49	-1.06	6.10	-6.0	-2.0	4.0
LEFT-RIGHT DIFFERENCES						
500	49	-0.69	6.13	-6.0	-2.0	5.0
1000	49	0.20	6.52	-4.0	0.0	4.0
2000	49	0.45	6.75	-4.0	0.0	4.0
4000	49	0.69	8.43	-6.0	0.0	8.0
6000	49	-0.65	9.35	-8.0	-2.0	6.0
M512	49	-0.06	3.67	-3.0	-1.0	2.5

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TABLE 57 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 16 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	47	-1.23	4.65	-4.0	-2.0	2.0
1000	47	-1.32	5.30	-4.0	0.0	2.0
2000	47	-1.66*	4.50	-4.0	0.0	0.0
4000	47	-2.49**	5.50	-6.0	-2.0	0.0
6000	47	-2.38*	7.39	-6.0	0.0	2.0
M512	47	-1.32**	3.32	-4.0	-1.0	1.0
D4	47	1.17	7.19	-2.0	2.0	6.0
D1	47	0.85	4.19	-2.0	0.0	4.0
LEFT EAR						
500	47	-0.85	5.00	-4.0	0.0	4.0
1000	47	-1.49*	4.62	-4.0	0.0	2.0
2000	47	-1.23	4.64	-6.0	0.0	2.0
4000	47	-0.30	9.08	-6.0	0.0	4.0
6000	47	-1.79	6.24	-6.0	-2.0	2.0
M512	47	-1.09	3.84	-5.0	-1.0	2.0
D4	47	-1.19	10.19	-6.0	2.0	4.0
D1	47	-0.21	3.42	-2.0	0.0	2.0
BETTER EAR						
500	47	-1.23	4.36	-4.0	0.0	0.0
1000	47	-1.36*	3.76	-4.0	0.0	2.0
2000	47	-1.40*	3.87	-2.0	0.0	0.0
4000	47	-1.60*	5.16	-4.0	0.0	0.0
6000	47	-2.30**	5.64	-6.0	-2.0	0.0
M512	47	-1.23*	3.20	-3.0	-1.0	1.0
D4	47	0.23	5.73	-2.0	2.0	4.0
WORSE EAR						
500	47	-0.85	4.56	-4.0	0.0	2.0
1000	47	-1.45	5.14	-6.0	-2.0	2.0
2000	47	-1.49*	4.50	-6.0	0.0	2.0
4000	47	-1.19	8.83	-6.0	-2.0	2.0
6000	47	-1.87	6.93	-6.0	0.0	2.0
M512	47	-1.15*	3.53	-4.0	-1.0	2.0
D4	47	-0.26	9.41	-6.0	2.0	6.0
LEFT-RIGHT DIFFERENCES						
500	47	0.38	5.50	-2.0	0.0	4.0
1000	47	-0.17	5.92	-6.0	-2.0	4.0
2000	47	0.43	6.41	-4.0	0.0	4.0
4000	47	2.19	9.87	-4.0	2.0	8.0
6000	47	0.60	8.65	-6.0	0.0	6.0
M512	47	0.15	3.96	-1.0	0.0	3.0

*   .01 < p ≤ .05

**   p ≤ .01

TABLE 58 - DESCRIPTIVE STATISTICS OF SIX-MONTH.
INCREMENTS IN AUDITORY THRESHOLD
OF BOYS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	32	-1.69	6.33	-5.5	-1.0	2.0
1000	32	-1.44	5.66	-5.5	-1.0	2.0
2000	32	-0.81	4.06	-4.0	-1.0	2.0
4000	32	-2.19*	5.60	-6.0	-1.0	2.0
6000	32	-3.56**	6.85	-8.0	-3.0	0.0
M512	32	-1.16	3.73	-3.7	-1.5	1.0
D4	32	0.75	6.96	-4.0	1.0	6.0
D1	32	0.56	4.01	-2.0	0.0	2.0
LEFT EAR						
500	32	-0.56	4.32	-4.0	0.0	2.0
1000	32	-1.13	4.54	-4.0	-2.0	2.0
2000	32	-0.75	6.92	-4.0	-2.0	3.5
4000	32	-1.94	8.42	-6.0	0.0	4.0
6000	32	-2.25	10.63	-10.0	-3.0	4.0
M512	32	-0.72	4.11	-3.0	-1.0	1.8
D4	32	0.81	7.62	-4.0	0.0	5.5
D1	32	-1.31	4.27	-4.0	-2.0	2.0
BETTER EAR						
500	32	-1.25	4.30	-4.0	-1.0	2.0
1000	32	-1.44	5.21	-5.5	-2.0	1.5
2000	32	-0.94	4.60	-4.0	0.0	2.0
4000	32	-2.25	6.73	-7.5	-1.0	2.0
6000	32	-2.31	7.28	-7.5	-2.0	2.0
M512	32	-1.22	3.68	-4.0	-1.0	1.8
D4	32	0.81	7.46	-4.0	0.0	6.0
WORSE EAR						
500	32	-1.00	4.95	-4.0	0.0	2.0
1000	32	-1.13	4.00	-4.0	-2.0	2.0
2000	32	-0.62	4.96	-4.0	-1.0	2.0
4000	32	-1.87	6.30	-6.0	-2.0	2.0
6000	32	-3.56*	9.00	-10.0	-4.0	1.5
M512	32	-0.72	3.01	-2.0	-1.0	1.0
D4	32	0.75	6.05	-4.0	2.0	3.5
LEFT-RIGHT DIFFERENCES						
500	32	1.13	6.56	-3.5	0.0	5.0
1000	32	0.31	5.97	-4.0	0.0	4.0
2000	32	0.06	7.94	-5.5	0.0	2.0
4000	32	0.25	8.44	-6.0	0.0	7.5
6000	32	1.31	11.94	-7.5	0.0	10.0
M512	32	0.50	4.56	-2.0	0.0	2.0

* .01 < p ≤ .05

** p ≤ .01

TABLE 59 - DESCRIPTIVE STATISTICS OF SIX-MONTH
INCREMENTS IN AUDITORY THRESHOLD
OF GIRLS 17 YEARS OLD

FREQUENCY (HZ)	N	MEAN	SD	25	MEDIAN	75
RIGHT EAR						
500	20	-2.30*	4.32	-4.0	-2.0	0.0
1000	20	-0.20	4.85	-4.0	0.0	3.5
2000	20	-2.60	6.16	-7.0	-2.0	1.5
4000	20	-4.00*	7.62	-8.0	-4.0	2.0
6000	20	-1.30	8.24	-6.0	2.0	4.0
M512	20	-1.75	3.89	-5.8	-1.5	1.0
D4	20	3.80*	7.02	0.0	4.0	6.0
D1	20	-0.70	4.65	-4.0	0.0	2.0
LEFT EAR						
500	20	-1.00	6.07	-4.0	0.0	2.0
1000	20	-0.90	4.70	-4.0	0.0	2.0
2000	20	-1.60	5.53	-5.5	-2.0	2.0
4000	20	-0.50	6.08	-2.0	0.0	4.0
6000	20	-1.20	8.04	-5.5	-1.0	3.5
M512	20	-1.15	4.48	-4.5	-1.0	2.0
D4	20	-0.40	6.82	-5.0	0.0	2.0
D1	20	0.50	3.24	-2.0	0.0	2.0
BETTER EAR						
500	20	-1.00	5.68	-4.0	0.0	2.0
1000	20	-0.70	4.78	-4.0	0.0	2.0
2000	20	-1.00	5.56	-4.0	0.0	2.0
4000	20	-2.30	5.85	-5.0	0.0	2.0
6000	20	-0.20	7.51	-3.5	0.0	4.0
M512	20	-0.85	4.57	-4.5	0.0	2.8
D4	20	1.60	5.97	0.0	0.0	4.0
WORSE EAR						
500	20	-2.30*	4.37	-4.0	-2.0	1.5
1000	20	-0.40	4.33	-4.0	0.0	2.0
2000	20	-3.20**	5.00	-7.0	-4.0	-0.5
4000	20	-2.20	6.68	-7.5	0.0	3.5
6000	20	-2.30	7.49	-9.0	-2.0	1.5
M512	20	-1.85*	3.27	-3.7	-2.0	0.7
D4	20	1.80	6.29	0.0	1.0	3.5
LEFT-RIGHT DIFFERENCES						
500	20	1.30	5.44	-4.0	0.0	5.5
1000	20	-0.70	5.20	-4.0	-1.0	2.0
2000	20	1.00	9.17	-2.0	2.0	6.0
4000	20	3.50	7.78	-2.0	4.0	8.0
6000	20	0.10	11.15	-9.5	-1.0	9.0
M512	20	0.50	4.49	-1.0	0.0	2.8

*   .01 < p ≤ .05

**   p ≤ .01

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TABLE 60 -SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN
AGE AND 6- MONTH AUDITORY THRESHOLD INCREMENTS
IN BOYS AND GIRLS

Frequency (Hz)	n	Boys Correlation Coefficients	n	Girls Correlation Coefficients
Right ear				
500	360	0.03	353	-0.04
1000	361	-0.03	358	-0.04
2000	363	-0.02	359	-0.05
4000	363	-0.03	357	-0.08
6000	363	-0.01	356	0.04
M512	360	0.00	353	-0.07
D4	361	-0.00	356	0.05
Left ear				
500	348	-0.00	341	-0.02
1000	354	-0.05	345	-0.04
2000	360	-0.04	346	-0.06
4000	357	-0.02	344	-0.02
6000	354	0.03	344	-0.04
M512	348	-0.03	341	-0.06
D4	354	-0.04	342	-0.02
Better Ear				
500	363	0.01	353	-0.02
1000	363	-0.04	358	-0.02
2000	363	0.00	359	-0.02
4000	363	0.00	357	-0.04
6000	363	0.06	356	0.05
M512	363	-0.01	353	-0.05
D4	363	-0.02	356	0.02
Worse Ear				
500	345	0.03	341	-0.03
1000	352	-0.06	345	-0.06
2000	360	-0.05	346	-0.07
4000	357	-0.05	344	-0.06
6000	354	-0.01	344	-0.05
M512	345	0.01	340	-0.07
D4	352	0.00	342	0.01
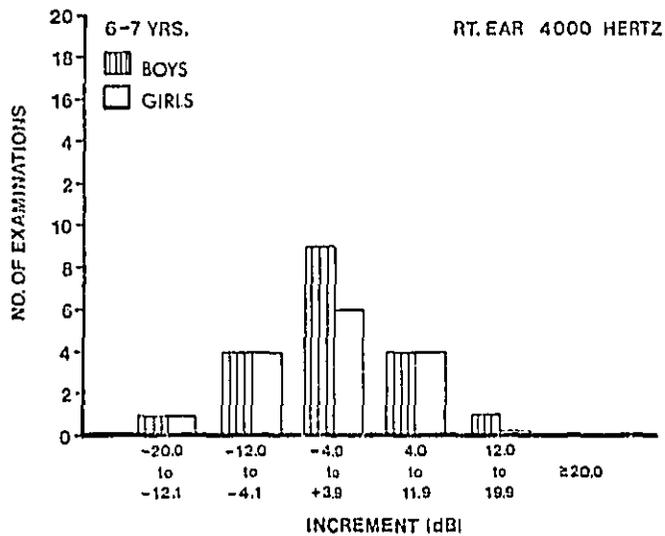
FIGURE 38 —FREQUENCY DISTRIBUTION OF SIX—MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 6-7 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR
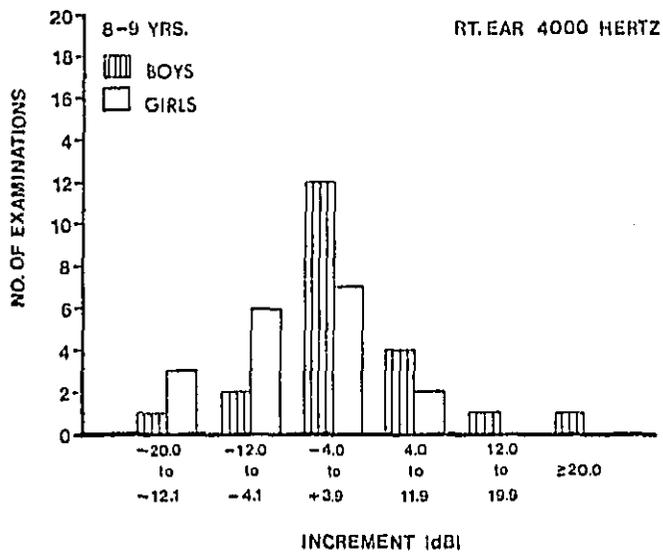
FIGURE 39 —FREQUENCY DISTRIBUTION OF SIX—MONTH INCREMENTS (dB) FOR EXAMINATIONS OF CHILDREN AGED 8-9 YEARS MEASURED AT 4000 Hz IN THE RIGHT EAR
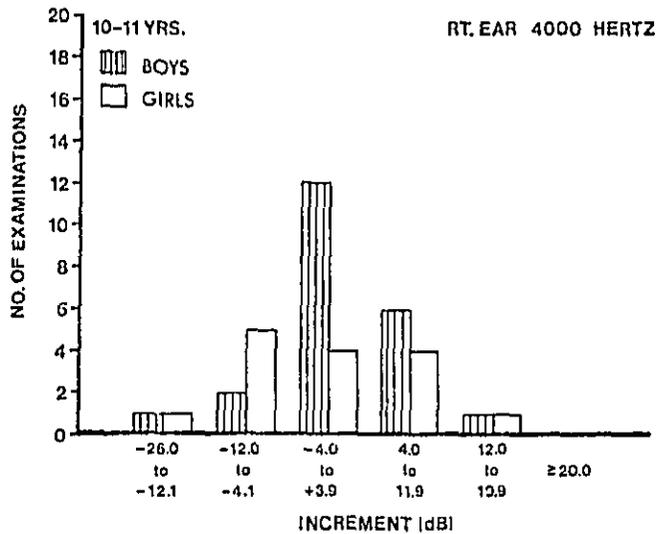
FIGURE 40   -FREQUENCY DISTRIBUTION OF SIX-MONTH   INCREMENTS
(dB) FOR EXAMINATIONS OF CHILDREN AGED 10-11 YEARS
MEASURED AT 4000 Hz IN THE RIGHT EAR
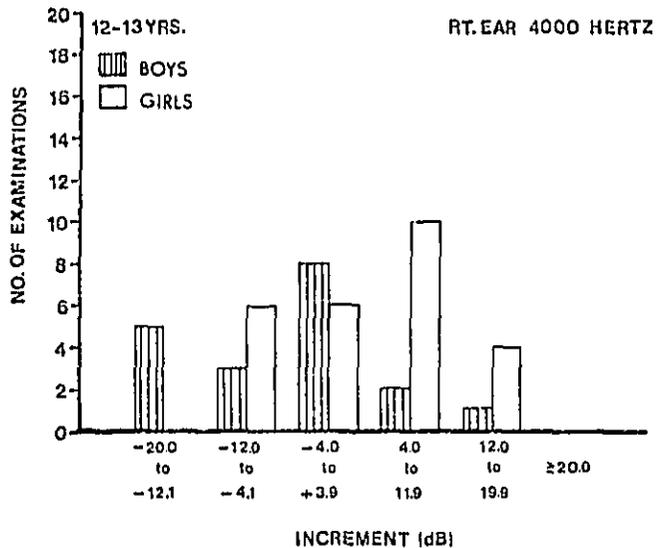
FIGURE 41   -FREQUENCY DISTRIBUTION OF SIX-MONTH   INCREMENTS
(dB) FOR EXAMINATIONS OF CHILDREN AGED 12-13 YEARS
MEASURED AT 4000 Hz IN THE RIGHT EAR

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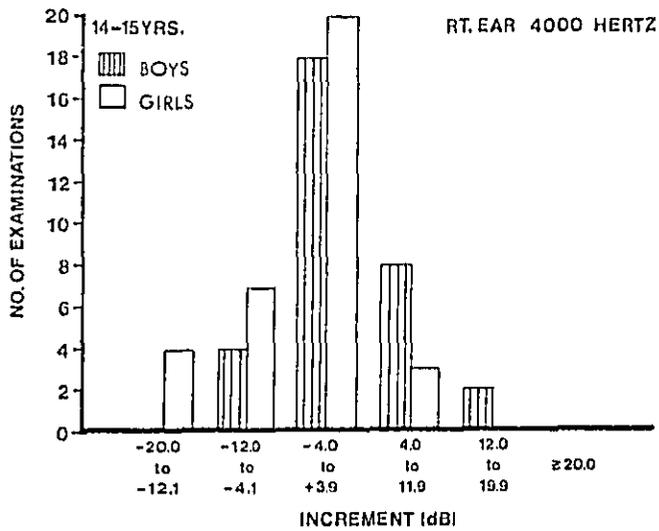
FIGURE 42 —FREQUENCY DISTRIBUTION OF SIX–MONTH INCREMENTS
(dB) FOR EXAMINATIONS OF CHILDREN AGED 14–15 YEARS
MEASURED AT 4000 Hz IN THE RIGHT EAR
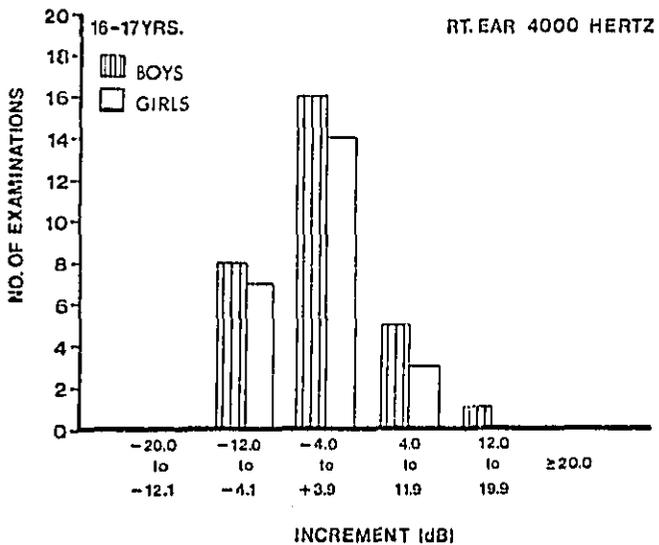
FIGURE 43 —FREQUENCY DISTRIBUTION OF SIX–MONTH INCREMENTS
(dB) FOR EXAMINATIONS OF CHILDREN AGED 16–17 YEARS
MEASURED AT 4000 Hz IN THE RIGHT EAR

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The apparent tendency for the left ear to hear better than the right may be an artifact of our testing procedure. As the right ear is always tested first, better performance due to practice and familiarity with the tone might be expected for the left ear.

The lateral differences seen in the mean auditory thresholds are not present in the mean increments (Tables 36 through 59]. Only two lateral differences in increments are significant, no more than expected by chance.

NOISE EXPOSURE

At each examination a detailed questionnaire was completed regarding noise exposure. Different questionnaires were administered on the first examination and on subsequent examinations (Roche et al., 1976]. The responses to the noise exposure questions were weighted differentially to allow a quantitative noise assessment for each question. The individual question scores were then summed to provide a single total noise score. Three other scores were derived (chain saw, gun, and event) to evaluate particular events that might be important in a participant's noise exposure. The scoring systems that are used have been described previously (Roche et al., 1977].

Noise exposure is considered separately for the questionnaires taken on the first visit, representing the total previous noise exposure history; and questionnaires completed on subsequent six-monthly visits, representing noise exposure for the appropriate preceding interval. The major differences between the total noise exposure history and the interval noise exposure history are in the phraseology of the questions regarding the time periods of noise exposure. The various noise exposure scores were, with few exceptions, calculated in an identical manner for the total noise exposure histories and the interval noise exposure histories.

The summary statistics, including the ranges of scores for each noise-related question, and the derived scores from noise history questionnaires, are given in Table 61 for boys and girls. With few exceptions, the distributions of the scores are significantly skewed, being truncated at zero. This, of course, is why the means and medians are not coincident, and why many of the medians are zero. For data of this nature, only non-parametric statistical approaches are appropriate. There are no apparent sex differences in median scores. In most cases there is little difference between the maximum score for any item for girls compared to that for boys. Boys do have a notably higher maximum score for the gun question (No. 18), compared to that of the girls. However, the derived gun score, calculated differently from that of question 18, indicates that girls and boys had the same maximum. However, the mean for the boys (30.8) is considerably greater than that for the girls (12.6). The maximum total score is markedly greater in boys than girls. although the means and medians show only small sex differences.

TABLE 61 -NOISE HISTORY SCORES FOR CHILDREN 6-17 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
B O Y S					
(9)home	0.1	0.4	0.0	0.0	2.0
(10)T.V.	0.2	0.7	0.0	0.0	4.0
(11)stereo	1.7	1.6	1.6	0.0	6.6
(12)instrument	0.7	1.3	0.0	0.0	7.0
(13)live rock	0.0	0.2	0.0	0.0	2.0
(15)motor bikes	1.8	2.2	2.0	0.0	10.0
(16)eng/firewks.	2.1	16.7	0.0	0.0	190.0
(18)guns	0.2	1.8	0.0	0.0	20.5
(23)tools	3.2	2.8	3.3	0.0	10.0
(24)machinery	0.6	1.2	0.0	0.0	4.0
Chain saw	0.9	2.8	0.0	0.0	10.0
Gun	30.8	46.1	0.0	0.0	100.0
Event	3.4	1.6	3.0	0.0	7.0
Total	12.0	18.7	10.0	0.0	212.0
G I R L S					
(9)home	0.2	0.6	0.0	0.0	2.0
(10)T.V.	0.0	0.2	0.0	0.0	1.2
(11)stereo	1.6	1.4	1.5	0.0	8.0
(12)instrument	0.7	1.2	0.0	0.0	5.3
(13)live rock	0.0	0.3	0.0	0.0	3.2
(15)motor bikes	1.7	2.0	0.0	0.0	10.0
(16)eng/fire wks.	0.0	0.4	0.0	0.0	3.6
(18)guns	0.0	0.0	0.0	0.0	0.0
(23)tools	2.3	1.9	1.7	0.0	6.7
(24)machinery	0.4	1.0	0.0	0.0	4.0
Chain saw	0.8	2.8	0.0	0.0	10.0
Gun	12.6	33.3	0.0	0.0	100.0
Event	3.1	1.6	3.0	0.0	8.0
Total	8.1	5.0	7.3	0.0	25.7

Based on data from appoximately 136 boys and 121 girls.
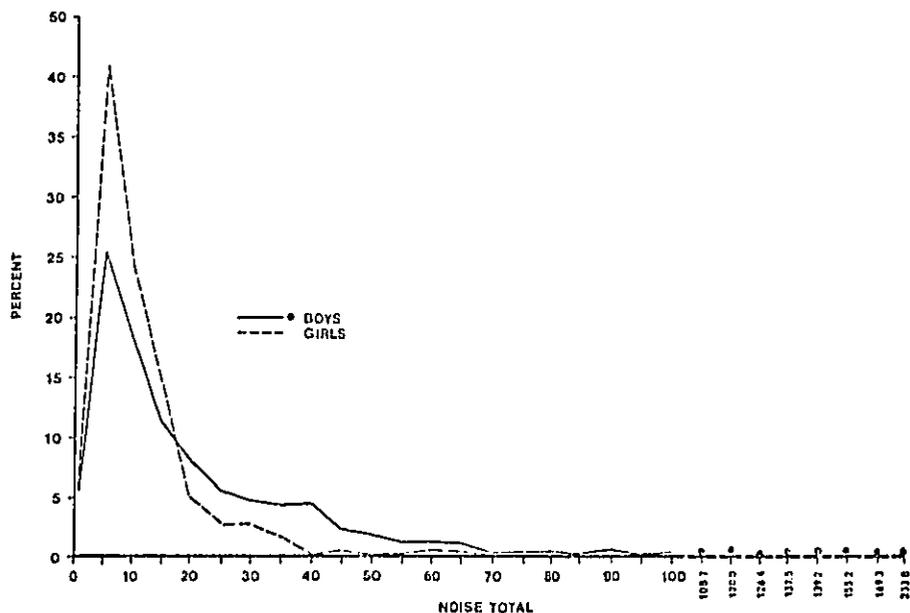
FIGURE 44   -PERCENTAGE DISTRIBUTIONS OF TOTAL NOISE SCORES FOR
              ALL EXAMINATIONS OF BOYS AND GIRLS FROM TOTAL NOISE
              EXPOSURE HISTORIES

        The summary statistics for the scores from the interval noise
exposure histories are given for 6 to 11 and 12 to 17 year old
boys and girls in Tables 62 and 63. The ranges of scores for
interval noise exposure are generally greater than the
corresponding scores from the total noise exposure histories,
although the general pattern of scores is similar in both noise
exposure histories. Sex differences are most clearly seen in
both age groups in the maximum scores for each item; the boys
generally having higher maximum scores than the girls, especially
for questions 16 (fireworks) and 23 (power tools), and the chain
saw and gun scores. Exceptions to this pattern are the maximum
scores for question 12, concerning playing an instrument.

        Percentiles for total noise scores in boys and girls from the
total noise histories are given in Table 64 and for the interval
noise histories in Table 65; the latter is broken down by age
groups.

        The total noise scores obtained from the interval noise exposure
histories are compared for boys and girls in Figure 44. The
similarly skewed character of the two curves can be seen,
although the greater range of the noise scores for the boys is
evident.

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TABLE 62 - INTERVAL NOISE SCORES FOR CHILDREN
              6-11 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
B O Y S					
(9) home	0.0	0.2	0.0	0.0	2.0
(10) T.V.	1.0	1.3	0.7	0.0	9.0
(11) stereo	2.2	1.5	2.3	0.0	9.2
(12) instrument	0.1	0.3	0.0	0.0	2.5
(13) live rock	0.0	0.0	0.0	0.0	0.0
(15) motor bikes	1.0	1.5	0.0	0.0	6.0
(16) eng/fire wks.	1.6	7.8	0.0	0.0	90.0
(18) guns	2.3	6.2	0.0	0.0	47.5
(23) tools	2.3	6.6	0.0	0.0	63.3
(24) machinery	0.2	0.6	0.0	0.0	3.0
Chain saw	0.2	1.0	0.0	0.0	10.0
Gun	0.6	7.2	0.0	0.0	100.0
Event	2.0	1.5	2.0	0.0	7.0
Total	13.0	14.6	7.5	0.0	108.7
G I R L S					
(9) home	0.0	0.2	0.0	0.0	2.0
(10) T.V.	0.9	1.2	0.5	0.0	6.0
(11) stereo	2.0	1.4	2.3	0.0	5.3
(12) instrument	0.4	1.6	0.0	0.0	18.0
(13) live rock	0.0	0.0	0.0	0.0	0.4
(15) motor bikes	0.6	1.0	0.0	0.0	3.0
(16) eng/fire wks.	0.7	3.6	0.0	0.0	30.0
(18) guns	0.3	1.8	0.0	0.0	14.8
(23) tools	0.8	1.9	0.0	0.0	11.7
(24) machinery	0.1	0.4	0.0	0.0	3.0
Chain saw	0.1	0.6	0.0	0.0	7.8
Gun	0.0	0.0	0.0	0.0	0.0
Event	1.6	1.2	2.0	0.0	5.0
Total	8.2	6.4	6.6	0.0	36.6

Based on data from approximately 207 boys and 169 girls.

TABLE 63 - INTERVAL NOISE SCORES FOR CHILDREN
            12-17 YEARS

Question	Mean	S.D.	Median	Minimum	Maximum
B O Y S					
(9) home	0.0	0.1	0.0	0.0	1.0
(10) T.V.	0.8	1.1	0.5	0.0	9.0
(11) stereo	3.2	1.6	3.1	0.0	8.5
(12) instrument	3.2	1.6	3.1	0.0	8.5
(13) live rock	0.0	0.3	0.0	0.0	2.8
(15) motor bikes	1.3	1.9	0.0	0.0	10.0
(16) eng/fire wks.	6.3	20.9	0.0	0.0	210.0
(18) guns	3.1	7.6	0.0	0.0	54.0
(23) tools	10.1	15.9	4.7	0.0	113.7
(24) machinery	0.4	1.0	0.0	0.0	4.0
Chain saw	0.7	2.8	0.0	0.0	20.0
Gun	4.1	20.3	0.0	0.0	130.0
Event	2.7	1.5	3.0	0.0	7.0
Total	27.4	29.0	17.9	0.0	233.8
G I R L S					
(9) home	0.0	0.1	0.0	0.0	2.0
(10) T.V.	0.8	0.9	0.5	0.0	6.0
(11) stereo	3.0	1.3	2.8	0.0	6.6
(12) instrument	1.3	2.0	0.4	0.0	14.0
(13) live rock	0.0	0.1	0.0	0.0	1.6
(15) motor bikes	1.0	1.7	0.0	0.0	8.0
(16) eng/fire wks.	1.1	7.4	0.0	0.0	110.0
(18) guns	0.8	4.1	0.0	0.0	47.2
(23) tools	2.9	5.9	0.0	0.0	40.0
(24) machinery	0.2	0.7	0.0	0.0	4.0
Chain saw	0.2	1.3	0.0	0.0	11.8
Gun	0.7	8.2	0.0	0.0	103.0
Event	1.8	1.5	2.0	0.0	7.0
Total	12.9	11.6	9.8	0.0	115.3

Based on data from approximately 288 boys and 309 girls

TABLE 64 – PERCENTILES FOR TOTAL NOISE SCORES
FROM TOTAL NOISE EXPOSURE HISTORIES
OF BOYS AND GIRLS 6-17 YEARS OF AGE

	Percentiles				
Questionnaire	10	25	50	75	90
Boys (n=136)	1.9	5.3	10.0	15.1	21.0
Girls (n=121)	2.2	4.9	7.3	10.7	15.1

TABLE 65 – PERCENTILES FOR TOTAL NOISE SCORES FROM
INTERVAL NOISE EXPOSURE HISTORIES OF
BOYS AND GIRLS 6-17 YEARS OF AGE

			Percentiles			
	N	10	25	50	75	90
Boys						
6-7 years	61	1.5	3.4	5.6	10.7	19.9
8-9 years	76	2.3	4.4	7.3	14.1	28.7
10-11 years	70	3.8	7.0	12.3	22.0	44.7
12-13 years	67	4.6	8.4	14.2	26.4	41.2
14-15 years	112	5.1	8.6	16.1	37.4	53.6
16-17 years	109	5.3	12.3	25.8	41.9	66.4
Girls						
6-7 years	52	0.6	2.5	5.3	9.9	16.8
8-9 years	61	2.8	4.3	6.8	10.3	15.1
10-11 years	56	3.5	5.8	7.3	12.0	19.5
12-13 years	80	3.7	6.4	10.1	14.2	26.6
14-15 years	136	4.1	6.6	10.5	17.3	30.7
16-17 years	93	3.2	4.5	8.6	15.1	22.0

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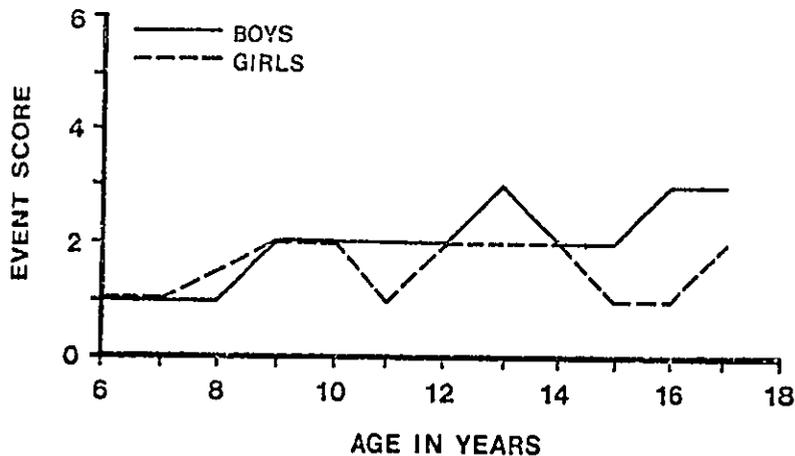
FIGURE 45   -MEDIAN EVENT SCORES FROM INTERVAL NOISE EXPOSURE
              HISTORIES FOR BOYS AND GIRLS

        The extreme points for the interval noise exposure scores
represent boys with unusually high scores. These extreme scores
result primarily from exploding a large number of firecrackers
(question 16), or noise exposure from operating, or being near,
power tools (question 23), particularly gasoline lawn mowers.

        The event score was devised in an attempt to quantify noise
exposure through identifying the number of different types of
events that may be important sources of noise exposure for a
child. As shown in Tables 61 through 63, there is little
difference between boys and girls in the number of important
noise events experienced. The interval data show higher total
event scores for boys after 14 years. This can be seen in Figure
45 which presents median event scores obtained from interval
noise exposure histories at each age for boys and girls.

        Although there appear to be neither systematic sex differences nor
age trends in median event scores from the interval noise
exposure histories in the preadolescent years, there seems to be
a small, but definite, sex difference beginning by the age of 10
years; after this age, boys have consistently higher median event
scores than girls.

        The total noise scores and the total event scores are
imprecise and susceptible to large errors in estimating the sound
levels resulting from various activities. One person's exposure

to a "loud stereo" or "loud vehicle" may be 10, 20 or more dB
higher than that of another person giving the same response
to the question. For this reason, an alternative method of
analysis was devised. Information contained in the questionnaire
was used to group participants into those reporting exposure to
a particular category of noise and those who were not exposed
to that noise. The means and medians of each group were compared.
The nine categories selected are the components of the total event
score. While these categories are arbitrary, they are considered
to be the most likely sources of noise exposure; these are
summarized below:

Flight Pattern - Participant lives within 100 feet of a high
traffic road or under an airport flight pattern.

Loud TV - Participant considers the TV is usually loud when he
or she watches it.

Loud Music - Participant considers the volume of a radio or
stereo system is loud, as opposed to medium or quiet, when he or
she is listening to it.

Amplified Musical Instrument - Participant plays an amplified
musical instrument.

Loud Vehicles - Participant is often near or involved with
motorcycling, motorboating, drag or auto racing, go-carting,
minibiking, etc.

Fireworks - Participant had been within 50 feet of exploding
firecrackers or small gas engines.

Power Tools - Participants were near others using power tools,
such as drills, saws, gasoline lawn mowers, etc.

Farm Machinery - Participants used or were often near farm
machinery.

The percentage of boys and girls 6-to-11 or 12-to 17-years-old
who reported exposure to the various noise source categories are
summarized in Figures 46 and 47, respectively. For most noise
categories, a slightly higher percentage of children in the 12-17 year
age group reported exposure than in the younger age group.
However, there is very little difference between the two age
groups in the proportion exposed to any noise category. The only
exceptions were loud TV in girls, in which a larger proportion of
younger girls were exposed, and farm machinery in which a larger
proportion of young boys reported exposure. Another noise event
more frequent in younger children is riding a bus to school (not
in Figures). Sixty-nine percent of boys and 67 percent of girls
6 to 11 years old ride buses, while 49 percent of boys and 54
percent of girls in the older age group ride school buses.

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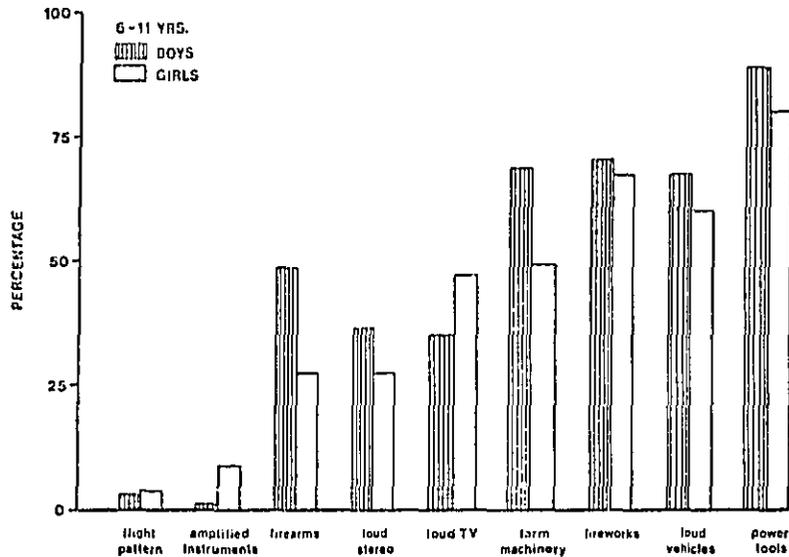
FIGURE 46 — PROPORTION OF BOYS AND GIRLS 6-11 YEARS OLD REPORTING EXPOSURE TO SPECIFIC NOISE EVENTS
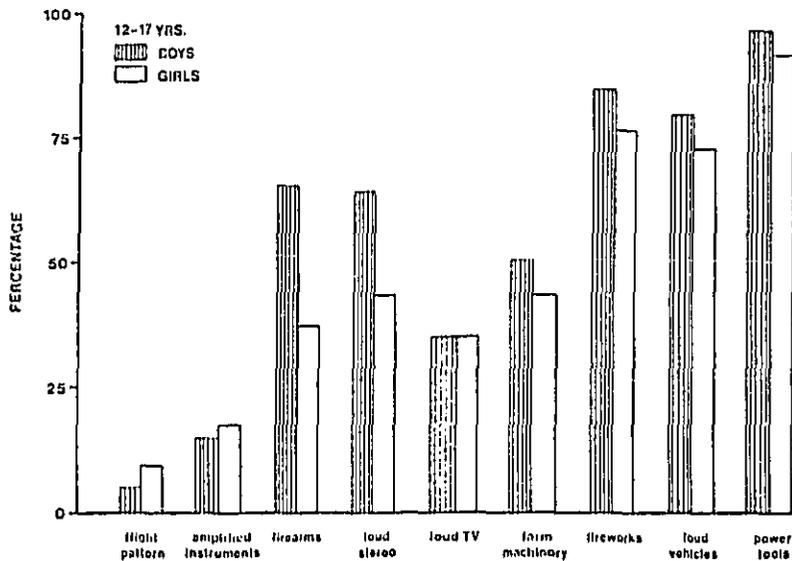
FIGURE 47 — PROPORTION OF BOYS AND GIRLS 12-17 YEARS OLD REPORTING EXPOSURE TO SPECIFIC NOISE EVENTS

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TABLE 66 - SPEARMAN RANK CORRELATION COEFFICIENTS
(r_s) BETWEEN AGE AND NOISE SCORES

Noise Scores

Period	Type	Boys		Girls	
		n	r	n	r
Total	Total	130	0.48 **	119	0.16
Total	Event	130	0.57 **	118	0.23 *
Interval	Total	518	0.44 **	500	0.18 **
Interval	Event	517	0.29 **	500	0.00

* $.01 < p \leq .05$

** $p \leq .01$

Sex differences are relatively small for most categories. A
larger proportion of boys report exposure to firearms, loud
stereo and farm machinery than girls, while a higher percentage
of girls reported exposure to amplified musical instruments and,
in the younger age group, to loud TV.

The median total noise scores obtained from the interval
noise exposure histories (Figure 48) indicate consistent sex
differences and age trends. For boys and girls, the median total
noise scores from the interval histories tend to increase with
age. At most ages, boys have greater median total noise scores
than girls, the differences becoming most pronounced after the
age of 10 years, when the boys' medians increase rapidly. The
difference between boys and girls becomes greatest at 16 years of
age, when it is about 18 points.

The age trend in noise exposure as measured by Spearman rank
correlation coefficients, is evident in total noise exposure
histories (Table 66). The correlations in boys are all highly
significant and tend to be considerably higher (.3 to .6) than in
girls (0 to .02).

A number of questions on the interval noise questionnaire are
"flagged" primarily to indicate changes in the activity patterns
of the participant and his family that may be related to noise
exposure. The percentage of children with "flagged" responses to
questions from the interval noise exposure history are given in
Table 67. The precise questions asked are found in Appendix C of
Roche et al. (1977). The data in Table 67 generally indicate
the changes in jobs, hobbies, recreation, etc., that
are possibly noise related.

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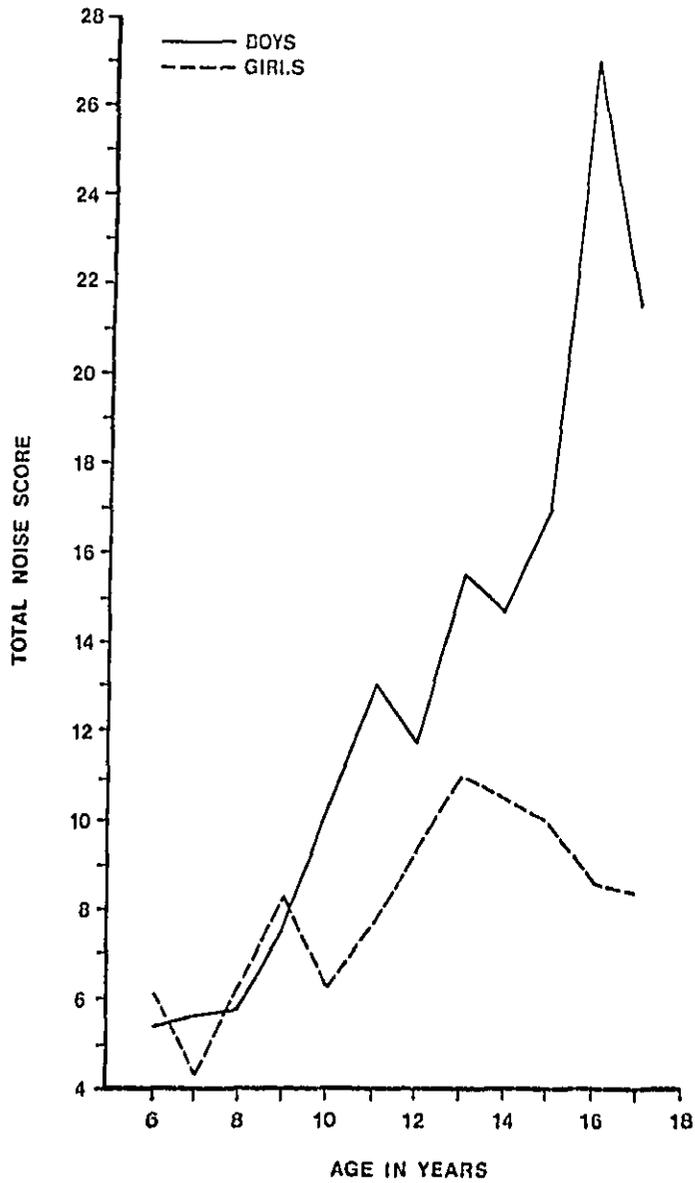
FIGURE 48 —MEDIAN TOTAL NOISE SCORES FROM INTERVAL NOISE EXPOSURE HISTORIES FOR BOYS AND GIRLS

TABLE 67 - PERCENTAGE OF EXAMINATIONS WITH SPECIFIC
             QUESTIONS "FLAGGED" ON INTERVAL NOISE
             EXPOSURE HISTORIES

	Question	Percentage of Children
17	family hobbies-noise relevant changes	4.5
19	participant's job-noise relevant change	10.3
20	father's job-noise relevant change	1.6
21	mother's job-noise relevant change	1.4
22	new hobbies-noise relevant activity	8.2
26	hearing protectors - worn for activities other than shooting	4.4

Based on data from about 1016 examinations

CHILDREN WITH UNUSUAL HEARING LOSS OVER A SIX-MONTH
INTERVAL DURING THE FIRST TWO YEARS OF THE STUDY

Hearing loss during the period studied is indicated by
large positive increments in thresholds. Children were
selected who had threshold increments greater than the 90th
percentile (Tables 36-58) for at least four frequencies,
considering both ears; there were four such children.

No. 594. This 16-year-old girl had six-month increments
of 10 and 12 dB at 2000 Hz and 4000 Hz, respectively in the
right ear, and increments of 12, 20, and 18 dB at 2000 Hz,
4000 Hz, and 6000 Hz, respectively in the left ear. Her
increments at the other frequencies did not differ greatly
from those in the rest of the sample. She had a cold, but
no ear problems at the time of the second examination, and
had rather normal otoscopic findings. Her total noise scores
were moderate; 8.9 and 16.9, for her first and second visits

respectively. For the latter visit, most of the noise exposure
came from loud television, and being close to gasoline lawn-
mowers and electric power tools (lawn edgers, drills, etc.)
during the six-month interim. During the past 3 years, this
participant has shown a slight improvement in hearing ability.
Her noise scores have been markedly irregular; the average
across periods is close to the average for all girls. Recently
her main sources of noise exposure have been radio, motorboats,
waterskiing and a gas lawnmower.

No. 697. This 11-year-old girl had a hearing loss at each
frequency except 6000 Hz. The six-month increments of 12 and
16 dB at 1000 and 500 Hz, respectively in the right ear, and
12 dB at 500 Hz in the left ear are above the 90th percentiles
for those frequencies. In addition, increments of 10 dB at
4000 Hz in the right ear, and 8 dB at 1000 Hz in the left ear
equal the 90th percentiles at those frequencies. The otological
inspections indicated meatal abnormalities, particularly for the
left ear. There was no indication that interim general health
was responsible for the hearing loss. The girl's total noise
scores (total period and interval) for the first two examinations
were 8.7 and 3.3, which approximate the 75th and 25th percentiles
respectively for total noise distribution. Her responses to
questionaires indicated she had some exposure to gun fire
but probably not sufficient to affect her hearing.

This participant has continued to show a marked hearing
loss until the most recent visit when there was a marked
improvement at all frequencies. Her exposure to noise during
the past 3 years has been slightly greater than average. The
main sources of noise exposure are minibikes and go-carts
(less than 1 hour per week) and riding in school bus (20 minutes
each way).

No. 801. This 10-year-old boy had increments of 22, 14,
18, and 16 dB at 1000, 2000, 4000 and 6000 Hz, respectively,
in the right ear; and 10 dB at 1000 and 2000 Hz in the left
ear between his first and second examinations. The other
increments showed little change except an 8 dB decrease at 500
Hz in the right ear. His otological inspection was normal ex-
cept that a cone of light was not seen at either visit. During
the second examination, the boy talked frequently throughout
the testing procedure, somehow cut his finger on the arm of
the chair, and apparently was very sleepy (9:00 a.m.), yawning
between talking and worrying about the small cut. It was con-
cluded that the marked hearing losses indicated by the boy's
increments were artifactual due to inattention, distraction,
etc., during the second visit. His total noise scores (total
period and interval) at the visits were very low, 2.0 and 3.7,
respectively. However, there have not been marked changes in
auditory thresholds during the last three years. His noise
exposure levels continue to be very low.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS, RESULTS FROM
OTOLOGICAL INSPECTIONS, AND GENERAL HEALTH AT TIME OF TEST

In Table 3 were presented the rating codes used for
describing the otological and general health of the participants
at the time of their examinations. In order to test whether
these factors are associated with alterations in hearing acuity,
t-tests were performed comparing the mean thresholds at each
frequency for all examinations indicating normal findings, with
those indicating abnormal findings. These comparisons are
summarized in Tables 68 through 73. There are few children
with abnormal tragi, and there is no indication from the differ-
ences in the mean thresholds that there is a significant asso-
ciation between abnormal tragi and thresholds (Table 68);
although the thresholds in the abnormal ears tend to be higher
than those of the normal ears.

Differences between normal and abnormal ears, with reference
to the meatus, ear drum, and visualizing the cone of light are
statistically significant (p < 0.05), with the exception of
6000 Hz in the right ear (Tables 69 through 71). The reason
for this consistent exception is unknown.

Significant differences between normal and abnormal ears
regarding ear drum color (Table 72) are less regular than those
of the other otological findings. Nevertheless, the mean
thresholds in ears with normal drum color are always less than
those with abnormal findings and the differences are significant
(p < 0.05) at 500, 2000 and 6000 Hz in the right ear, and at
500, 1000 and 2000 Hz in the left ear. Similarly, for participants

TABLE 68 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS
OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL
INSPECTIONS OF THE TRAGUS[1]

RIGHT EAR

Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	1095	-0.60	6	-0.33	-0.27	0.93
1000	1102	-1.30	6	-1.33	0.03	0.99
2000	1104	-2.06	6	-0.33	-1.76	0.58
4000	1103	0.31	6	4.00	-3.69	0.28
6000	1100	0.43	6	4.00	-3.57	0.35

LEFT EAR

500	1067	-1.85	6	-0.67	-1.18	0.72
1000	1076	-2.25	6	-1.33	-0.92	0.80
2000	1083	-2.79	6	1.00	-3.79	0.29
4000	1078	0.36	6	2.67	-2.31	0.56
6000	1074	0.96	6	2.67	-1.71	0.68

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 69 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS
OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL
INSPECTIONS OF THE MEATUS[1]

RIGHT EAR

Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	760	-1.01	341	0.30	-1.31	0.01
1000	767	-1.56	341	-0.72	-0.84	0.08
2000	768	-2.40	342	-1.27	-1.13	0.02
4000	767	-0.22	342	1.57	-1.79	0.00
6000	764	0.14	342	1.13	-0.99	0.10

LEFT EAR

500	776	-2.55	296	0.00	-2.55	0.00
1000	785	-2.89	296	-0.54	-2.35	0.00
2000	788	-3.37	300	-1.18	-2.19	0.00
4000	784	-0.37	299	2.35	-2.72	0.00
6000	782	0.20	297	3.03	-2.83	0.00

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 70 – AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS
OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL
INSPECTIONS OF THE EAR DRUM[1]

RIGHT EAR

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
500	897	-0.99	200	1.14	-2.13	0.00
1000	904	-1.50	200	-0.37	-1.13	0.05
2000	906	-2.30	200	-0.99	-1.31	0.03
4000	905	0.03	200	1.54	-1.51	0.02
6000	902	0.27	200	1.16	-0.89	0.22

LEFT EAR

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
500	866	-2.46	198	0.75	-3.21	0.00
1000	875	-2.67	198	-0.39	-2.28	0.00
2000	880	-3.30	200	-0.57	-2.73	0.00
4000	874	-0.22	201	2.80	-3.02	0.00
6000	873	0.53	198	2.89	-2.36	0.00

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 71 – AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS
OF CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL
INSPECTIONS OF THE EAR DRUM CONE OF LIGHT[1]

RIGHT EAR

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
500	675	-1.03	426	0.08	-1.11	0.02
1000	679	-1.68	429	-0.70	-0.98	0.04
2000	680	-2.39	430	-1.53	-0.86	0.06
4000	680	-0.17	429	1.12	-1.29	0.01
6000	677	0.25	429	0.76	-0.51	0.37

LEFT EAR

Frequency (Hz)	Normal N	Normal Mean	Abnormal N	Abnormal Mean	Difference	Significance
500	669	-2.47	402	-0.81	-1.66	0.00
1000	678	-2.65	402	-1.56	-1.09	0.05
2000	682	-3.27	405	-1.97	-1.30	0.02
4000	678	-0.17	404	1.27	-1.44	0.02
6000	676	0.41	402	1.93	-1.52	0.02

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 72 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATIONS OF
CHILDREN WITH NORMAL AND ABNORMAL OTOLOGICAL INSPECTIONS
OF EAR DRUM COLOR[1]

RIGHT EAR

Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	738	-1.09	253	0.32	-1.41	0.01
1000	740	-1.72	255	-0.37	-1.35	0.01
2000	740	-2.31	257	-1.72	-0.60	0.29
4000	739	0.03	257	1.18	-1.15	0.06
6000	739	0.22	256	0.84	-0.62	0.36

LEFT EAR

	N	Mean	N	Mean		
500	717	-2.33	253	-0.98	-1.35	0.03
1000	721	-2.57	254	-1.44	-1.13	0.08
2000	728	-2.77	255	-2.53	-0.24	0.70
4000	725	0.40	254	0.96	-0.56	0.43
6000	722	0.61	253	2.04	-1.43	0.05

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

TABLE 73 - AUDITORY THRESHOLDS (dB) COMPARING EXAMINATION OF
CHILDREN WITH NORMAL AND ABNORMAL GENERAL HEALTH
HISTORIES[1]

RIGHT EAR

Frequency (Hz)	Normal		Abnormal		Difference	Significance
	N	Mean	N	Mean		
500	844	-1.00	210	0.35	-0.65	0.02
1000	848	-1.55	213	-0.76	-0.79	0.17
2000	850	-2.40	213	-1.00	-1.40	0.02
4000	850	0.03	212	0.82	-0.79	0.21
6000	847	0.14	212	1.36	-1.22	0.09

LEFT EAR

	N	Mean	N	Mean		
500	776	-2.48	234	-0.62	-1.86	0.00
1000	785	-2.70	234	-1.42	-1.28	0.05
2000	790	-3.32	236	-1.68	-1.64	0.01
4000	785	0.01	236	0.48	-0.47	0.50
6000	783	0.69	234	1.21	-0.52	0.48

[1]See Table 3. Codes other than 0 or 9 are considered abnormal.

CORRELATION COEFFICIENT (r_s)

Legend:
— 4000 HERTZ
—·—·— 1000 HERTZ
———— 500 HERTZ

AGE GROUPS (YRS.): 6-7, 8-9, 10-11, 12-13, 14-15, 16-17
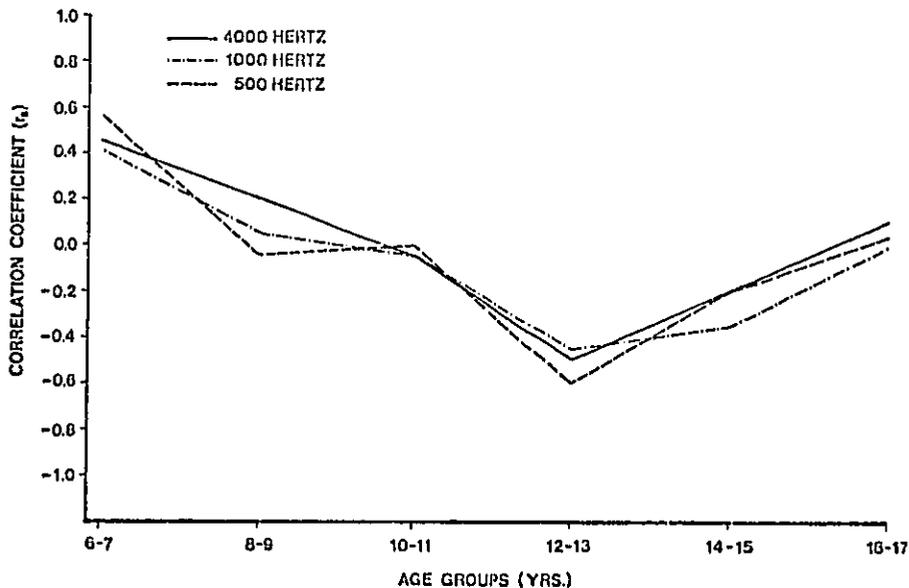
FIGURE 49   -SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN
                   AUDITORY THRESHOLDS AND STATURE IN THE WORSE EAR
                   OF GIRLS

indicating normal general health responses, the mean thresholds
are systematically lower than those with abnormal general health
(Table 73); these differences reach significance (p < 0.05)
at 4 of the 10 frequencies.

          ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS AND
                    SIZE AND MATURATION

STATURE

     To evaluate associations between auditory thresholds and
size, stature was correlated with the auditory thresholds in
the better and worse ears, partialling out age (Table 74). The
only statistically significant association is with girls' better
ear threshold at 2000 Hz (-0.17), while the other correlations
in each sex fluctuate about zero. Given the total number of
correlations calculated (28), and the lack of any definite pattern,
there is little from this analysis to suggest any association
between stature and auditory thresholds.

     Because it is possible that age is not a linear covariate
of stature and auditory thresholds, correlations between stature
and auditory thresholds were calculated within two-year age
groups. For boys, correlations approximated zero across the

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TABLE 74 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN STATURE AND AUDITORY THESHOLDS
WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=346)	Girls (n=318)
Better Ear		
500	-0.07	-0.04
1000	0.01	-0.04
2000	0.01	-0.17 **
4000	0.05	-0.05
6000	-0.01	-0.02
M512	-0.01	-0.08
D4	-0.06	0.02

Frequency (Hz)	Boys (n=335)	Girls (n=308)
Worse Ear		
500	-0.05	-0.03
1000	0.02	-0.01
2000	-0.01	-0.11
4000	-0.07	-0.05
6000	-0.03	-0.01
M512	0.00	-0.06
D4	0.08	0.04

** $p \leq .01$

age groups. For girls, however, an interesting trend was apparent
at all frequencies, especially in the worse ear. The correlations
for selected frequencies are presented in Figure 49; similar
patterns are seen at other frequencies. In the youngest age
group (6 to 7 years) stature is significantly and positively
correlated (p < 0.001) with thresholds, that is, taller girls
tend to have worse hearing than relatively shorter girls. The
correlations systematically decrease with age until about the
end of pubescence (12 to 13 years), when the correlations are
significantly negative (p < 0.001), that is, taller girls have
relatively better hearing than shorter girls in this age group.
After this age, the correlations increase again approaching
and slightly exceeding zero. While it is not unusual for
correlations between variables to decrease markedly during
pubescence because of differences in maturational rate, that
the pattern of correlations changes qualitatively (i.e., from
positive to negative) is unexpected. Further, if this pattern
were maturational, one would expect to see a similar pattern
in boys about two years after it occurs in girls; this is not
the case.

SKELETAL AGE

Relative skeletal age was used as one measure of maturity.
This is the difference between skeletal age and chronological
age (skeletal age less chronological age) expressed in years.
The skeletal age employed is the mean of the bone-specific skel-
etal ages of the hand-wrist obtained using the Greulich-Pyle
atlas (1959). When all ages were included and age was partialled
from both variables (Table 75), the correlations were near zero,
although there was a slight tendency to negative values in the
boys indicating that more mature boys might have lower thresholds.
Corresponding correlations within two-year age groups (Tables 76
through 81) showed a generally similar pattern, except that
the correlations were positive at most frequencies
for girls aged 6-7, and 8-9 years. There were, however, signif-
icant negative correlations for girls aged 12-13 years. The
correlations for girls showed a marked tendency to be positive
to 11 years and negative at older ages.

Correlations were calculated also between auditory thresholds
and skeletal age with the effects of stature removed (Tables 82-
89). There are few significant correlations except for positive
values in boys from 10 to 13 years, and in girls from 8 to 9
years. In general, the correlations tend to be larger in boys
than girls and tend to be positive indicating that more mature
children tend to have higher thresholds. This pattern is more
marked in the data from the left ear than from the right ear,
but there is little difference in the strength of the associations
in their pattern when findings from the better and worse ears
are compared.

MENARCHE

Age at menarche was obtained by inquiry each 6 months from
the Fels participants. Correlations between auditory thresholds

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TABLE 75 - SPEARMAN RANK CORRELATION COEFFICIENTS
(r_S) BETWEEN RELATIVE SKELETAL AGE AND
AUDITORY THRESHOLDS WITH THE EFFECTS
OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	280	-0.05	249	-0.02
1000	281	-0.05	253	0.03
2000	281	0.07	254	0.08
4000	281	0.05	253	0.07
6000	280	-0.12 *	252	0.06
M512	280	-0.01	249	0.01
D4	281	-0.11	252	-0.08
Worse Ear				
500	268	-0.06	239	-0.04
1000	273	-0.05	243	0.06
2000	276	0.07	245	0.03
4000	276	-0.04	243	0.05
6000	272	-0.11	242	-0.03
M512	268	0.00	239	0.01
D4	273	-0.06	241	-0.02

* .01 < p ≤ .05

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TABLE 76 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 6-7 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	37	-0.10	25	0.30
1000	37	-0.07	27	0.26
2000	37	-0.18	28	0.03
4000	37	0.10	27	0.64 **
6000	37	-0.32	26	0.41 *
M512	37	-0.14	25	0.09
D4	37	-0.16	26	-0.48 *
Worse Ear				
500	29	-0.16	20	0.38
1000	32	-0.04	22	0.49 *
2000	35	-0.09	23	0.55 **
4000	35	-0.06	22	0.50 *
6000	31	-0.25	21	0.40
M512	29	-0.10	20	0.52 *
D4	32	-0.01	21	-0.31

* .01 < p ≤ .05

** p ≤ .01

TABLE 77 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 8-9 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	36	-0.10	55	0.13
1000	36	-0.20	56	0.17
2000	36	0.11	56	0.36 **
4000	36	0.02	56	0.24
6000	36	0.02	56	0.32 *
M512	36	-0.07	55	0.25
D4	36	-0.25	56	-0.05
Worse Ear				
500	35	-0.17	51	0.33 *
1000	35	-0.18	53	0.40 **
2000	35	0.04	54	0.43 **
4000	35	-0.21	53	0.20
6000	35	0.05	53	0.28 *
M512	35	-0.11	51	0.45 **
D4	35	-0.15	52	0.29 *

* .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 78 - SPEARMAN RANK CORRELATION COEFFICIENTS (rs)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 10-11 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	55	-0.08	50	0.06
1000	55	0.05	50	0.04
2000	55	0.29 *	50	0.24
4000	55	0.08	50	-0.06
6000	55	-0.13	50	0.10
M512	55	0.15	50	0.13
D4	55	-0.10	50	-0.02
Worse Ear				
500	52	-0.15	50	0.14
1000	54	-0.05	50	0.06
2000	54	0.17	50	0.15
4000	54	0.09	50	0.04
6000	54	-0.14	50	0.13
M512	52	-0.10	50	0.15
D4	54	-0.09	50	-0.06

* .01 < p $\leq$ .05

TABLE 79 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 12-13 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	53	0.37 **	64	-0.45 **
1000	53	0.26	65	-0.33 **
2000	53	0.44 **	65	-0.33 **
4000	53	0.28 *	65	-0.30 *
6000	53	0.15	65	-0.37 **
M512	53	0.43 **	64	-0.43 **
D4	53	-0.13	65	0.03
Worse Ear				
500	53	0.42 **	64	-0.56 **
1000	53	0.33 *	64	-0.35 **
2000	53	0.45 **	64	-0.51 **
4000	53	0.16	64	-0.33 **
6000	53	0.18	64	-0.53 **
M512	53	0.54 **	64	-0.56 **
D4	53	0.06	64	-0.01

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 80 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 14-15 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	47	-0.17	30	0.17
1000	47	-0.09	30	0.16
2000	47	-0.02	30	0.41 *
4000	47	-0.03	30	0.30
6000	47	-0.25	30	0.21
M512	47	-0.13	30	0.21
D4	47	0.06	30	-0.18
Worse Ear				
500	47	-0.06	30	0.09
1000	47	-0.05	30	0.18
2000	47	0.04	30	0.42 *
4000	47	-0.13	30	0.16
6000	47	-0.31 *	30	0.17
M512	47	-0.02	30	0.23
D4	47	0.09	30	-0.03

* $.01 < p \leq .05$

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TABLE 81 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH IN CHILDREN 16-17 YEARS OF AGE

Frequency (Hz)	Boys		Girls	
	n	r	n	r
Better Ear				
500	38	-0.10	23	-0.20
1000	38	-0.14	23	0.01
2000	38	-0.23	23	-0.15
4000	38	0.02	23	-0.13
6000	38	-0.25	23	-0.41
M512	38	-0.16	23	-0.17
D4	38	-0.05	23	0.12
Worse Ear				
500	38	-0.17	23	-0.20
1000	38	-0.14	23	-0.24
2000	38	-0.09	23	-0.58 **
4000	38	-0.14	23	-0.05
6000	38	-0.10	23	-0.50 *
M512	38	-0.13	23	-0.39
D4	38	0.12	23	-0.06

* $.01 < p \leq .05$

** $p \leq .01$

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TABLE 82 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND RIGHT
EAR AUDITORY THRESHOLDS (dB) WITH THE
EFFECTS OF STATURE PARTIALLED FROM BOTH
(6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	r	8-9 yrs. n	r	10-11 yrs. n	r
Right Ear-Boys
500	35	-0.19	36	-0.19	54	-0.03
1000	36	-0.12	36	-0.22	55	-0.01
2000	37	-0.13	36	0.07	55	0.34 **
4000	37	-0.15	36	0.00	55	0.35 **
6000	36	-0.26	36	0.11	55	0.15
M512	35	-0.22	36	-0.12	54	0.11
D4	36	-0.08	36	-0.28	55	-0.38 **
Right Ear-Girls
500	25	0.09	54	0.39**	43	-0.09
1000	27	0.37	55	0.47**	43	0.00
2000	28	0.23	55	0.33**	43	0.13
4000	27	0.31	55	0.21	43	-0.06
6000	26	0.36	55	0.13	43	0.01
M512	25	0.20	54	0.49**	43	0.04
D4	26	-0.09	55	0.19	43	-0.03

** P <.01

TABLE 83 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND RIGHT
EAR AUDITORY THRESHOLDS (dB) WITH THE
EFFECTS OF STATURE PARTIALLED FROM BOTH
(12-17 YEARS)

Frequency (Hz)	12-13 yrs. n	r	14-15 yrs. n	r	16-17 yrs. n	r
Right Ear-Boys						
500	49	0.50**	45	-0.14	35	-0.21
1000	49	0.19	45	-0.20	35	-0.20
2000	49	0.52**	45	-0.08	35	-0.08
4000	49	0.37**	45	-0.28	35	-0.11
6000	49	0.38**	45	-0.23	35	-0.06
M512	49	0.56**	45	-0.11	35	-0.15
D4	49	-0.23	45	0.18	35	0.00
Right Ear-Girls						
500	63	-0.17	27	0.12	22	-0.04
1000	64	0.00	27	0.07	22	0.16
2000	64	-0.06	27	0.22	22	-0.18
4000	64	0.06	27	0.27	22	0.14
6000	64	-0.09	27	-0.09	22	-0.17
M512	63	-0.11	27	0.17	22	0.04
D4	64	-0.04	27	-0.07	22	-0.11

** P <.01

TABLE 84 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND LEFT EAR
AUDITORY THRESHOLDS (dB) WITH THE EFFECTS
OF STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequence (Hz)	6-7 yrs. n	6-7 yrs. r	8-9 yrs. n	8-9 yrs. r	10-11 yrs. n	10-11 yrs. r
Left Ear-Boys						
500	31	0.09	35	−0.03	53	−0.07
1000	33	0.00	35	−0.06	54	−0.02
2000	35	0.05	35	0.08	54	0.36 **
4000	35	0.18	35	0.15	54	−0.06
6000	32	−0.16	35	0.01	54	−0.07
M512	31	0.04	35	0.03	53	0.19
D4	33	−0.14	35	−0.24	54	−0.05
Left Ear-Girls						
500	20	0.14	50	0.18	43	0.22
1000	22	0.21	52	0.12	43	0.00
2000	23	0.01	53	0.36 **	43	0.25
4000	22	0.63	52	0.21	43	0.00
6000	21	0.39	52	0.21	43	0:06
M512	20	0.18	50	0.28 *	43	0.21
D4	21	−0.59 **	51	−0.01	43	−0.04

* P < .05

** P < .01

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TABLE 85 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND LEFT EAR
AUDITORY THRESHOLDS (dB) WITH THE EFFECTS
OF STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs.		14-15 yrs.		16-17 yrs.	
	n	r	n	r	n	r
Left Ear-Boys						
500	49	0.31 *	45	-0.16	35	-0.11
1000	49	0.18	45	-0.07	35	-0.11
2000	49	0.30 *	45	0.11	35	-0.20
4000	49	0.25	45	-0.02	35	-0.06
6000	49	0.31 *	45	-0.18	35	-0.10
M512	49	0.32 *	45	-0.06	35	-0.13
D4	49	-0.16	45	0.03	35	0.06
Left Ear-Girls						
500	63	-0.27 *	27	0.04	22	-0.07
1000	63	-0.12	27	-0.01	22	-0.15
2000	63	-0.13	27	0.25	22	-0.04
4000	63	-0.17	17	0.04	22	0.05
6000	63	-0.17	27	0.05	22	-0.36
M512	63	-0.19	27	0.07	22	-0.08
D4	63	0.13	27	-0.05	22	-0.07

* $.01 < p \leq .05$

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TABLE 86 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND BETTER EAR
AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF
STATURE PARTIALLED FROM BOTH (6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	6-7 yrs. r	8-9 yrs. n	8-9 yrs. r	10-11 yrs. n	10-11 yrs. r
Better Ear-Boys						
500	37	-0.06	36	-0.04	55	-0.03
1000	37	0.00	36	-0.11	55	0.02
2000	37	-0.11	36	0.12	55	0.38 **
4000	37	0.07	36	0.19	55	0.11
6000	37	-0.26	36	0.03	55	0.07
M512	37	-0.04	36	0.00	55	0.21
D4	37	-0.03	36	-0.31	55	-0.17
Better Ear-Girls						
500	25	0.09	54	0.19	43	0.04
1000	27	0.21	55	0.22	43	0.03
2000	28	-0.09	55	0.43 **	43	0.31 *
4000	27	0.61 **	55	0.17	43	-0.04
6000	26	0.38 *	55	0.22	43	0.01
M512	25	0.01	54	0.29 *	43	0.16
D4	26	-0.55 **	55	0.06	43	-0.02

* .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 87 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN RELATIVE SKELETAL AGE AND BETTER EAR
AUDITORY THRESHOLDS (dB) WITH THE EFFECTS OF
STATURE PARTIALLED FROM BOTH (12-17 YEARS)

Frequency (Hz)	12-13 yrs.		14-15 yrs.		16-17 yrs.	
	n	r	n	r	n	r
Better Ear-Boys						
500	49	0.47 **	45	-0.18	35	-0.14
1000	49	0.19	45	-0.13	35	-0.20
2000	49	0.37 **	45	0.02	35	-0.25
4000	49	0.35 **	45	-0.14	35	-0.01
6000	49	0.39 **	45	-0.17	35	-0.17
M512	49	0.39 **	45	-0.13	35	-0.19
D4	49	-0.21	45	0.11	35	-0.07
Better Ear-Girls						
500	63	-0.18	27	0.08	22	0.02
1000	64	-0.03	27	0.09	22	-0.23
2000	64	-0.11	27	0.22	22	-0.09
4000	64	-0.10	27	0.20	22	0.10
6000	64	-0.09	27	-0.04	22	-0.14
M512	63	-0.13	27	0.04	22	-0.11
D4	64	0.06	27	-0.15	22	-0.13

** $p \leq .01$

TABLE 88 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND WORSE
EAR AUDITORY THRESHOLD (dB) WITH THE
EFFECTS OF STATURE PARTIALLED FROM BOTH
(6-11 YEARS)

Frequency (Hz)	6-7 yrs. n	r	8-9 yrs. n	r		10-11 yrs. n	r	
Worse Ear-Boys								
500	29	-0.03	35	-0.16		52	-0.13	
1000	32	-0.11	35	-0.13		54	0.00	
2000	35	0.02	35	0.03		54	0.37	**
4000	35	0.02	35	-0.09		54	0.27	*
6000	31	-0.21	35	0.03		54	0.03	
M512	29	-0.13	35	-0.03		52	0.11	
D4	32	-0.24	35	-0.16		54	-0.25	
Worse Ear-Girls								
500	20	0.24	50	0.37 **	43	0.07		
1000	22	0.47	52	0.36 **	43	0.00		
2000	23	0.42 *	53	0.39 **	43	0.19		
4000	22	0.52 **	52	0.24	43	-0.01		
6000	21	0.40	52	0.15	43	0.16		
M512	20	0.43	50	0.47 **	43	0.11		
D4	21	-0.34	41	0.18	43	-0.07		

* .01 <p $\leq$ .05

** p $\leq$ .01

TABLE 89 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN RELATIVE SKELETAL AGE AND WORSE
EAR AUDITORY THRESHOLD (dB) WITH THE
EFFECTS OF STATURE PARTIALLED FROM BOTH
(12-17 YEARS)

Frequency (Hz)	12-13 yrs.		14-15 yrs.		16-17 yrs.	
	n	r	n	r	n	r
Worse Ear-Boys						
500	49	0.44 **	45	-0.11	35	-0.21
1000	49	0.24	45	-0.13	35	-0.14
2000	49	0.45 **	45	0.09	35	-0.11
4000	49	0.30 *	45	-0.14	35	-0.13
6000	49	0.35 *	45	-0.25	35	0.00
M512	49	0.51 **	45	-0.06	35	-0.14
D4	49	-0.16	45	0.05	35	0.10
Worse Ear-Girls						
500	63	-0.29 *	27	0.08	22	-0.09
1000	63	-0.09	27	0.11	22	0.13
2000	63	-0.16	27	0.29	22	-0.21
4000	63	-0.03	27	0.09	22	0.18
6000	63	-0.16	27	0.02	22	-0.37
M512	63	-0.16	27	0.15	22	-0.01
D4	63	-0.01	27	0.01	22	0.10

*   .01< p≤ .05

** p ≤ .01

at the last examination before menarche and age at menarche were calculated after removing the effects of age from each variable (Table 90). The coefficients are usually positive indicating that girls who are late to reach menarche tend to have higher thresholds but few of the coefficients are significant.

Corresponding correlations using thresholds obtained at the first examination after menarche were not significant and the majority were positive (Table 91).

Correlations were calculated between auditory thresholds and age at menarche with stature partialled from both (Tables 92 and 93); this procedure has the effect of separating growth from maturity. There are few significant correlations (16/112), but these are positive and indicate more rapidly maturing girls at 12-13 years and 16-17 years tend to have higher thresholds, irrespective of stature. The small samples in the 10-11 year groups occur because few girls reached menarche so early.

Correlations were calculated within age groups between auditory thresholds and stature, partialling out skeletal age and age at menarche (Tables 94 and 95); this has the effect of separating maturational effects associated with the skeleton and with the reproductive system from stature. For 12- and 13-year-old girls these correlations are significantly negative, indicating these girls who are relatively tall have lower thresholds, i.e., better hearing, than shorter girls, irrespective of maturity status.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS AND NOISE SCORES

To investigate associations between noise and hearing acuity, auditory thresholds were correlated with the noise score from the interval noise history covering the previous 6-month period. For these analyses, the "worse ear" threshold was considered the more important because noise-induced hearing loss is more likely to be apparent in the worse ear and, accordingly, associations with noise are more likely to be demonstrated in the worse ear. Correlations between interval noise scores and auditory thresholds for all examinations are presented for better and worse ear in Table 96 for boys; the correlations are all low and negative. Because of the large sample involved, 9 of the 14 correlations for boys are significant (p < 0.05). These associations indicate the higher noise scores are associated with better hearing (lower thresholds). In girls, all of the correlations but one (D4, better ear) approximate zero and are not significant.

TABLE 90 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN THE LAST AUDITORY THRESHOLD BEFORE
MENARCHE AND AGE OF MENARCHE WITH THE EFFECTS
OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Right Ear r	Left Ear r	Better Ear r	Worse Ear r
Girls (n=18)				
500	0.07	0.05	0.03	0.09
1000	0.22	0.12	0.01	0.29
2000	-0.03	0.07	0.20	-0.07
4000	-0.11	-0.04	-0.23	-0.01
6000	0.16	0.59 **	0.16	0.52 *
M512	0.09	0.18	0.18	0.18
D4	0.27	0.19	0.11	0.30

* .01 < p $\leq$ .05

** p < .01

TABLE 91 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN THE FIRST AUDITORY THRESHOLD AFTER
MENARCHE AND AGE AT MENARCHE WITH THE EFFECTS
OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Right Ear r	Left Ear r	Better Ear r	Worse Ear r
Girls (n=62)				
500	0.06	0.20	0.13	0.17
1000	0.09	0.16	0.18	0.08
2000	-0.11	-0.03	-0.05	-0.10
4000	0.04	0.18	0.15	0.09
6000	0.09	0.14	0.17	0.09
M512	0.01	0.10	0.10	0.03
D4	0.05	-0.09	-0.01	-0.05

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TABLE 92 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) IN GIRLS BETWEEN RIGHT AND LEFT EAR AUDITORY THRESHOLDS AND AGE AT MENARCHE WITH THE EFFECTS OF STATURE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r
Right Ear								
500	7	0.14	47	0.14	32	0.11	32	0.14
1000	7	-0.43	48	-0.03	32	0.12	32	0.27
2000	7	0.21	48	0.35*	32	-0.25	32	0.18
4000	7	0.04	48	-0.05	32	-0.08	32	0.09
6000	7	0.68	48	0.29*	32	0.30	32	0.11
M512	7	-0.14	47	0.22	32	0.00	32	0.25
D4	7	-0.04	48	0.04	32	0.16	32	0.06
Left Ear								
500	7	0.21	47	0.30*	32	0.22	32	0.55**
1000	7	0.32	47	0.24	32	0.27	32	0.43*
2000	7	0.07	47	0.13	32	-0.01	32	0.28
4000	7	0.50	47	0.12	32	0.08	32	0.53**
6000	7	-0.14	47	0.36*	32	0.17	32	0.35
M512	7	0.21	47	0.26	32	0.16	32	0.49**
D4	7	-0.21	47	0.02	32	0.12	32	-0.34

* .01 < p ≤ .05

** p ≤ .01

TABLE 93 SPEARMAN RANK CORRELATION COEFFICIENTS (rs) IN GIRLS
            BETWEEN BETTER AND WORSE EAR AUDITORY THRESHOLDS AND
            AGE AT MENARCHE WITH THE EFFECTS OF STATURE PARTIALLED
            FROM BOTH

Frequency (Hz)	10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r
Better Ear								
500	7	0.07	47	0.18	32	0.18	32	0.24
1000	7	0.21	48	0.08	32	0.10	32	0.33
2000	7	-0.21	48	0.22	32	-0.08	32	0.26
4000	7	0.18	48	0.13	32	-0.03	32	0.28
6000	7	0.54	48	0.45**	32	0.25	32	0.12
M512	7	0.07	47	0.22	32	0.11	32	0.29
D4	7	0.07	48	-0.08	32	0.12	32	-0.17
Worse Ear								
500	7	0.43	47	0.32*	32	0.12	32	0.43*
1000	7	-0.43	47	0.17	32	0.19	32	0.38*
2000	7	0.29	47	0.32*	32	-0.21	32	0.27
4000	7	0.43	47	-0.02	32	0.04	32	0.38*
6000	7	0.00	47	0.31*	32	0.24	32	0.25
M512	7	-0.14	47	0.31*	32	0.05	32	0.47**
D4	7	-0.32	47	0.16	32	0.13	32	-0.24

*   .01 <p $\leq$.05

** p $\leq$.01

TABLE 94 SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) IN GIRLS BETWEEN RIGHT AND LEFT EAR AUDITORY THRESHOLDS AND STATURE WITH THE EFFECTS OF AGE AT MENARCHE AND RELATIVE SKELETAL AGE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Right Ear								
500	4	0.40	40	-0.47**	23	-0.28	19	-0.12
1000	4	0.40	41	-0.57**	23	-0.30	19	-0.28
2000	4	0.80	41	-0.34*	23	-0.25	19	-0.23
4000	4	0.40	41	-0.23	23	-0.09	19	-0.12
6000	4	-0.40	41	-0.19	23	-0.23	19	-0.12
M512	4	0.40	40	-0.55**	23	-0.39	19	-0.25
D4	4	-0.40	41	-0.25	23	0.03	19	-0.09
Left Ear								
500	4	-0.20	40	-0.33*	23	-0.23	19	-0.27
1000	4	0.80	40	-0.47**	23	-0.51*	19	-0.18
2000	4	0.80	40	-0.34*	23	-0.35	19	-0.49*
4000	4	-0.20	40	-0.05	23	-0.32	19	-0.34
6000	4	-0.40	40	-0.27	23	-0.12	19	-0.05
M512	4	0.40	40	-0.43**	23	-0.44*	19	-0.36
D4	4	0.20	40	-0.31	23	-0.16	19	0.35

* .01 < p ≤ .05

** p ≤ .01

TABLE 95 SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) IN GIRLS
BETWEEN BETTER AND WORSE EAR AUDITORY THRESHOLDS AND
STATURE WITH THE EFFECTS OF AGE AT MENARCHE AND
RELATIVE SKELETAL AGE PARTIALLED FROM BOTH

Frequency (Hz)	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Better Ear								
500	4	0.40	40	-0.35*	23	-0.22	19	-0.19
1000	4	0.40	41	-0.58**	23	-0.56**	19	-0.10
2000	4	0.80	41	-0.38*	23	-0.32	19	-0.39
4000	4	0.40	41	-0.09	23	-0.23	19	-0.26
6000	4	-0.40	41	-0.09	23	-0.16	19	0.14
M512	4	0.40	40	-0.49**	23	-0.41	19	-0.25
D4	4	-0.40	41	-0.34*	23	-0.27	19	0.34
Worse Ear								
500	4	-0.20	40	-0.45**	23	-0.28	19	-0.22
1000	4	0.80	40	-0.52**	23	-0.34	19	-0.35
2000	4	0.80	40	-0.31*	23	-0.35	19	-0.35
4000	4	-0.20	40	-0.23	23	-0.23	19	-0.27
6000	4	-0.40	40	-0.32*	23	-0.16	19	-0.07
M512	4	0.40	40	-0.52**	23	-0.40	19	-0.34
D4	4	0.20	40	-0.25	23	-0.01	19	0.13

* .01 < p ≤ .05

** p ≤ .01

TABLE 96 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN INTERVAL NOISE SCORES AND AUDITORY
THRESHOLDS

Frequency (Hz)	Boys (n=510)	Girls (n=488)
Worse Ear		
500	-0.20 **	-0.02
1000	-0.15 **	0.02
2000	-0.06	0.00
4000	-0.08	0.05
6000	-0.11 *	0.05
M512	-0.18 **	0.01
D4	-0.07	-0.05

Frequency (Hz)	Boys (n=519)	Girls (n=495)
Better Ear		
500	-0.19 **	0.01
1000	-0.15 **	-0.08
2000	-0.06	-0.02
4000	-0.06	0.05
6000	-0.14 **	0.06
M512	-0.16 **	-0.04
D4	-0.09 *	-0.13 **

* $.01 < p \leq .05$

** $p \leq .01$

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While these findings in boys are contrary to a hypothesis of noise-induced hearing loss, it should be remembered that age is associated significantly with noise scores and auditory thresholds, but in opposite directions. Consequently, age was linearly partialled independently from auditory thresholds and noise scores and the age-adjusted variables were correlated (Table 97). Most of the significant correlations in boys between noise scores and thresholds (Table 96) were due to an artifactual age effect. Nevertheless, in boys, the correlations are still negative, although now 2 of 14 are significantly different from zero. For girls, these correlations suggest there may be some noise effect at 500, 4000, and 6000 Hz, although the qualitative sex difference in this association is difficult to explain.

Because of the measurement error inherent in both the derivation of the noise scores and in the auditory thresholds, means for each individual were calculated for these variables across visits. When these age-adjusted mean variables were correlated, no statistically significant association was found (Table 98). The pattern of signs of the correlations (boys negative, girls positive) is generally similar to that for the correlation of the age-adjusted values for each examination (Table 97).

Correlation coefficients between interval noise scores and auditory thresholds for right, left, better, and worse ears, within two-year age groups are presented in Tables 99 through 102. Correlations in boys tend to be low and erratic. The few significant correlations for boys (3/168) are no more than would be expected by chance. In girls, the sign of the correlations are generally similar within an age group, but the sign changes from group to group. While the sign and significance of correlations in girls 8-9 years and 14-15 years suggest higher noise exposure is associated with higher thresholds, the opposite trend occurs at 6-7 years and 10-11 years of age. It is difficult to conceive of a biological phenomena that would change qualitatively in this manner.

To utilize the serial nature of these data, straight lines were fitted by regression to each individual's data for noise score versus age, and for auditory thresholds versus age. The individual slopes (b values) represent the rates of change in the variables. The effects of age were partialled out of these individual slopes by linear regression analyses (using mean age of each individuals's data points), and the age-adjusted results for rates of change in noise scores and thresholds were correlated; these are presented for the worse ear in Table 103. These correlations tend to be negative and are significantly different from zero at 500 Hz in boys and at 6000 Hz in girls. This analysis indicates that, at these frequencies, those children showing more rapid increases in noise exposure tend to gain hearing acuity.

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TABLE 97 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN INTERVAL NOISE SCORES AND AUDITORY
THRESHOLDS WITH THE EFFECTS OF AGE PARTIALLED
FROM BOTH

Frequency (Hz)	Boys (n=515)	Girls (n=486)
Worse Ear		
500	-0.10 *	0.05
1000	-0.07	0.05
2000	-0.01	0.04
4000	-0.05	0.08
6000	-0.08	0.07
M512	-0.10 *	0.07
D4	-0.01	-0.04

Frequency (Hz)	Boys (n=519)	Girls (n=496)
Better Ear		
500	-0.06	0.09 *
1000	-0.05	-0.03
2000	-0.01	0.05
4000	-0.03	0.09 *
6000	-0.06	0.10 *
M512	-0.04	0.05
D4	-0.02	-0.13 **

* $.01 < p \leq .05$

** $p \leq .01$

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TABLE 98 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN MEAN INTERVAL NOISE SCORES AND THE
MEAN OF AUDITORY THRESHOLDS WITH THE EFFECTS
OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=107)	Girls (n=101)
Worse Ear		
500	-0.10	0.03
1000	-0.16	0.05
2000	-0.07	0.05
4000	-0.02	0.10
6000	-0.10	0.17
M512	-0.15	0.07
D4	-0.04	-0.05

Frequency (Hz)	Boys (n=107)	Girls (n=101)
Better Ear		
500	-0.12	0.04
1000	-0.13	-0.12
2000	-0.05	0.03
4000	-0.02	0.10
6000	-0.15	0.13
M512	-0.11	0.00
D4	-0.01	-0.15

*   .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 99 - SPEARMAN RANK CORRELATION COEFFICIENTS (rs) BETWEEN INTERVAL
NOISE SCORES AND RIGHT EAR AUDITORY THRESHOLDS (dB) WITH
THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs		8-9 yrs		10-11 yrs		12-13 yrs		14-15 yrs		16-17 yrs	
	n	r	n	r	n	r	n	r	n	r	n	r
Right Ear - Boys												
500	59	-0.02	77	0.04	71	0.05	68	-0.06	113	-0.18	106	-0.19
1000	59	-0.10	77	0.09	72	0.08	68	0.06	113	0.01	106	-0.19
2000	60	0.10	77	0.11	72	0.15	68	0.06	113	0.10	106	-0.27*
4000	60	0.22	77	-0.07	72	0.04	68	-0.05	113	-0.10	106	-0.19
6000	60	0.04	77	0.02	72	-0.05	68	-0.05	113	-0.10	106	-0.12
M512	59	0.05	77	0.12	71	0.04	68	-0.01	113	-0.06	106	-0.24*
D4	59	-0.28*	77	0.09	72	-0.02	68	0.03	113	0.09	106	0.14
Right Ear - Girls												
500	50	-0.17	60	0.22	56	-0.27*	80	-0.05	136	0.16	94	0.07
1000	51	-0.45**	61	0.08	56	-0.11	80	0.05	136	0.24**	94	-0.05
2000	52	-0.19	61	0.30*	56	-0.24	80	-0.03	136	0.18*	94	0.09
4000	51	-0.07	61	0.20	56	-0.18	80	0.11	136	0.11	94	0.20
6000	50	0.04	61	0.33**	56	-0.08	80	0.18	136	0.11	94	0.02
M512	50	-0.28*	60	0.21	56	-0.28*	80	0.01	136	0.25**	94	0.05
D4	50	-0.28	61	-0.14	56	0.06	80	-0.12	136	0.05	94	-0.23

*   .01 < p ≤ .05

**   p ≤ .01

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TABLE 100 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN
INTERVAL NOISE SCORES AND LEFT EAR AUDITORY THRESHOLDS
(dB) WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Left Ear – Boys												
500	56	-0.04	75	-0.09	69	0.16	66	-0.08	113	-0.13	106	-0.06
1000	57	-0.09	75	0.08	71	0.00	66	0.09	113	-0.02	106	-0.15
2000	59	0.00	76	0.22	71	0.08	67	0.06	113	0.14	106	-0.18
4000	57	-0.09	76	0.08	71	0.12	67	-0.01	113	0.06	106	-0.06
6000	56	-0.18	75	-0.02	71	0.13	67	-0.17	113	-0.03	106	-0.09
M512	56	-0.07	75	0.10	69	0.06	66	0.03	113	-0.04	106	-0.14
D4	57	-0.04	75	0.04	71	-0.05	66	0.07	113	-0.08	106	-0.02
Left Ear – Girls												
500	43	-0.40**	57	0.31*	56	-0.20	80	0.12	136	0.08	94	0.19
1000	45	-0.19	58	0.09	56	-0.03	80	0.12	136	0.04	94	-0.03
2000	45	-0.23	59	0.26*	56	-0.17	80	0.11	136	0.13	94	0.17
4000	44	0.10	58	0.26	55	-0.27*	80	0.17	136	0.10	94	0.00
6000	44	-0.01	58	0.41**	56	-0.12	80	0.23*	136	-0.01	94	-0.04
M512	43	-0.29	57	0.19	56	-0.17	80	0.13	136	0.09	94	0.14
D4	44	-0.22	57	-0.13	55	0.25	80	-0.13	136	-0.10	94	-0.05

*   .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 101- SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN INTERVAL
NOISE SCORES AND BETTER EAR AUDITORY THRESHOLDS (dB) WITH
THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Better Ear - Boys												
500	60	-0.03	77	-0.05	72	0.14	68	-0.05	113	-0.17	106	-0.08
1000	60	-0.01	77	0.05	72	0.04	68	0.00	113	0.01	106	-0.18
2000	60	0.12	77	0.13	72	0.08	68	0.03	113	0.14	106	-0.20
4000	60	0.19	77	0.04	72	0.09	68	-0.04	113	0.02	106	-0.14
6000	60	-0.07	77	-0.09	72	0.05	68	-0.11	113	-0.08	106	-0.12
M512	60	0.01	77	0.07	72	0.09	68	-0.01	113	-0.02	106	-0.18
D4	60	-0.20	77	0.08	72	-0.03	68	-0.05	113	-0.02	106	0.03
Better Ear - Girls												
500	50	-0.23	60	0.31*	56	-0.26*	80	0.06	136	0.13	94	0.16
1000	51	-0.35*	61	0.05	56	-0.05	80	0.06	136	0.04	94	-0.06
2000	52	-0.23	61	0.26*	56	-0.21	80	0.06	136	0.11	94	0.19
4000	51	0.08	61	0.21	56	-0.25	80	0.16	136	0.08	94	0.14
6000	50	-0.01	61	0.38**	56	-0.04	80	0.22*	136	0.04	94	0.05
M512	50	-0.36**	60	0.24	56	-0.20	80	0.09	136	0.13	94	0.10
D4	50	-0.29*	61	-0.08	56	0.23	80	-0.10	136	-0.03	94	-0.20

* .01 < p ≤ .05

** p ≤ .01

TABLE 102 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN INTERVAL
NOISE SCORES AND WORSE EAR AUDITORY THRESHOLDS (dB) WITH
THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Worse Ear - Boys												
500	55	0.00	75	-0.03	68	0.07	66	-0.09	113	-0.18	106	-0.18
1000	56	-0.08	75	0.11	71	0.05	66	0.15	113	-0.04	106	-0.16
2000	59	0.03	76	0.22	71	0.15	67	0.10	113	0.11	106	-0.28
4000	57	-0.01	76	-0.06	71	0.10	67	-0.07	113	-0.05	106	-0.11
6000	56	-0.09	75	0.05	71	0.07	67	-0.12	113	-0.07	106	-0.12
M512	55	-0.02	75	0.13	68	0.04	66	-0.03	113	-0.06	106	-0.25
D4	56	-0.08	75	0.11	71	-0.02	66	0.13	113	0.03	106	0.03
Worse Ear - Girls												
500	43	-0.36*	57	0.21	56	-0.23	80	0.04	136	0.12	94	0.11
1000	45	-0.33*	58	0.08	56	-0.10	80	0.13	136	0.23**	94	-0.03
2000	45	-0.20	59	0.31*	56	-0.28*	80	0.01	136	0.18*	94	0.11
4000	44	-0.09	58	0.30*	55	-0.24	80	0.13	136	0.14	94	0.05
6000	44	0.06	58	0.38**	56	-0.17	80	0.17	136	0.06	94	-0.05
M512	43	-0.31*	57	0.22	56	-0.23	80	0.06	136	0.20*	94	0.10
D4	44	-0.16	57	-0.20	55	0.10	80	-0.11	136	-0.03	94	-0.05

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 103 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN THE SLOPE OF INTERVAL NOISE SCORES
AND THE SLOPE OF AUDITORY THRESHOLDS FOR
THE WORSE EAR WITH THE EFFECTS OF AGE
PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=107)	Girls (n=101)
500	-0.20 *	0.05
1000	-0.18	0.03
2000	-0.11	-0.04
4000	-0.12	-0.10
6000	-0.14	-0.24 *
M512	-0.19	-0.05
D4	-0.07	0.18

* $.01 < p \leq .05$

A slightly different analysis than the previous one is
to correlate auditory thresholds adjusted for the individual's
age change, with noise scores, adjusted for the individual's
age change. This analysis is sensitive to noise-associated
deviations in auditory thresholds from the individual's own
age trend in thresholds. The results are presented in Table 104.
The correlations are effectively zero; the one significant
correlation is slightly more than what would be expected by
chance alone.

To evaluate whether 6-monthly changes in auditory thresholds
(increments) were associated with interval noise scores during
the same period, correlations were calculated between these two
variables, partialling the effects of age. These correlations
are presented by age groups in Tables 105-108. These
correlations are generally low and not significant, except in
girls at 10-11 years. In this group of girls, the correlations
are systematically negative and significant, with the highest
correlation at 4000 Hz. This analysis indicates that higher
noise scores are associated with lower threshold increments,
that is, increases in hearing acuity.

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TABLE 104 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
             BETWEEN WORSE EAR AUDITORY THRESHOLDS
             AND INTERVAL NOISE SCORES WITH THE EFFECT
             OF AGE REMOVED SEPARATELY FOR EACH INDIVIDUAL

Frequency (Hz)	Boys		Girls	
	n	r	n	r
500	510	-0.08	488	-0.05
1000	511	0.01	487	-0.04
2000	519	-0.03	496	-0.05
4000	515	0.11 *	489	-0.07
6000	513	-0.03	486	0.04
M512	506	-0.03	485	0.00
D4	506	-0.01	485	-0.07

* .01 < p $\leq$ .05

      Because the total noise score is a gross estimate of total
noise expsosure, it was considered important to determine if
specific noise events or groups of noise events were associated
with auditory thresholds or changes in thresholds. Table 109
presents the mean thresholds at 4000 Hz in the worse ear for
individuals who have been exposed to a specific noise event
during the previous six-month interval, and the mean thresholds
for individuals not exposed to the same events; significance
of differences between the means are tested by t-tests. The
differences between means (exposed less unexposed) are calculated
so that a positive difference indicates a noise-associated hearing
loss. Statistically significant differences between mean thresh-
olds at 4000 Hz for power tools, farm machines, loud T.V. and loud

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TABLE 105 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN RIGHT
EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL
NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Right Ear												
Boys												
500	31	-0.30	49	-0.07	50	-0.29*	49	0.10	89	-0.15	80	0.03
1000	31	-0.23	49	0.04	51	-0.08	49	0.16	89	0.00	80	0.02
2000	33	-0.28	49	-0.10	51	0.18	49	-0.07	89	0.03	80	-0.10
4000	33	-0.10	49	-0.01	51	-0.05	49	0.27	89	0.08	80	-0.05
6000	33	-0.15	49	0.03	51	0.04	49	0.12	89	0.04	80	0.00
M512	31	-0.33	49	-0.11	50	-0.12	49	0.09	89	-0.07	80	0.00
D4	31	-0.19	49	-0.02	51	-0.05	49	-0.18	89	-0.10	80	0.06
Girls												
500	28	0.15	45	0.22	44	-0.29*	58	0.08	102	0.02	67	-0.01
1000	30	0.01	47	0.17	44	-0.35*	59	0.04	102	0.08	67	-0.12
2000	31	0.15	47	0.12	44	-0.36*	59	-0.05	102	-0.01	67	-0.09
4000	29	-0.05	47	0.21	44	-0.37**	59	0.00	102	0.08	67	0.02
6000	28	0.06	47	-0.01	44	-0.34*	59	0.00	102	-0.09	67	0.09
M512	28	0.23	45	0.19	44	-0.46**	58	0.05	102	0.04	67	-0.10
D4	28	-0.06	47	-0.12	44	0.02	59	0.01	102	-0.08	67	-0.10

* .01 < p ≤ .05

** p ≤ .01

TABLE 106 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S) BETWEEN LEFT
EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL
NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Left Ear												
Boys												
500	27	-0.25	47	0.03	46	0.04	47	0.11	89	-0.09	80	0.09
1000	29	-0.09	47	0.08	50	0.08	47	0.21	89	-0.10	80	0.18
2000	33	-0.33	48	0.09	50	0.33*	48	0.21	89	-0.04	80	0.04
4000	30	-0.38*	48	0.16	50	0.26	48	0.10	89	0.01	80	-0.05
6000	28	-0.39*	47	-0.05	50	-0.04	48	0.02	89	0.10	80	-0.07
M512	27	-0.17	47	0.11	46	0.14	47	0.23	89	-0.10	80	0.13
D4	29	0.18	47	-0.21	50	-0.11	47	0.00	89	-0.06	80	0.18
Girls												
500	21	-0.37	42	0.27	42	-0.23	58	0.18	102	-0.02	67	0.09
1000	23	-0.18	43	0.31*	43	-0.17	58	0.07	102	-0.08	67	-0.08
2000	24	-0.16	44	0.05	43	-0.36*	57	0.08	102	-0.16	67	0.11
4000	23	-0.42*	43	0.15	42	-0.41**	58	0.22	102	0.12	67	0.03
6000	22	-0.17	43	0.02	43	-0.19	58	0.19	102	-0.15	67	0.03
M512	21	-0.30	42	0.26	42	-0.27	57	0.09	102	-0.09	67	0.07
D4	22	0.24	42	0.01	42	0.20	58	-0.12	102	-0.13	67	-0.06

* $.01 < p \leq .05$

** $p \leq .01$

TABLE 107 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN BETTER
EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL
NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	r	8-9 yrs n	r	10-11 yrs n	r	12-13 yrs n	r	14-15 yrs n	r	16-17 yrs n	r
Better Ear												
Boys												
500	33	-0.25	49	0.01	51	-0.11	49	0.03	89	-0.14	80	0.08
1000	33	-0.24	49	0.20	51	-0.08	49	0.07	89	-0.02	80	0.04
2000	33	-0.34*	49	0.12	51	0.32*	49	0.18	89	-0.04	80	-0.12
4000	33	-0.18	49	0.10	51	0.14	49	0.20	89	-0.02	80	-0.08
6000	33	-0.42	49	0.19	51	-0.04	49	0.12	89	0.01	80	-0.01
M512	33	-0.38*	49	0.09	51	0.08	49	0.14	89	-0.11	80	0.01
D4	33	0.03	49	0.01	51	-0.17	49	-0.16	89	-0.09	80	0.10
Girls												
500	28	-0.11	45	0.23	44	-0.34*	58	0.15	102	0.01	67	0.08
1000	30	0.06	47	0.20	44	-0.23	59	0.04	102	-0.04	67	-0.10
2000	31	0.23	47	0.17	44	-0.33*	59	0.10	102	-0.05	67	0.08
4000	29	-0.17	47	0.15	44	-0.31*	59	0.18	102	0.08	67	0.13
6000	28	0.16	47	0.06	44	-0.13	59	0.11	102	-0.13	67	0.00
M512	28	0.01	45	0.23	44	-0.33*	58	0.12	102	0.00	67	-0.03
D4	28	0.20	47	0.01	44	0.15	59	-0.12	102	-0.04	67	-0.21

* .01 < p ≤ .05

TABLE 108 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s) BETWEEN WORSE
EAR 6-MONTHLY AUDITORY THRESHOLD INCREMENTS AND INTERVAL
NOISE SCORES WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	6-7 yrs n	6-7 yrs r	8-9 yrs n	8-9 yrs r	10-11 yrs n	10-11 yrs r	12-13 yrs n	12-13 yrs r	14-15 yrs n	14-15 yrs r	16-17 yrs n	16-17 yrs r
Worse Ear												
Boys												
500	25	-0.27	47	-0.01	45	-0.17	47	0.11	89	-0.10	80	0.03
1000	27	-0.16	47	-0.09	50	0.04	47	0.31*	89	-0.08	80	0.16
2000	33	-0.32	48	-0.10	50	0.24	48	0.09	89	-0.01	80	0.00
4000	30	-0.31	48	0.03	50	0.12	48	0.12	89	0.11	80	-0.05
6000	28	-0.14	47	-0.14	50	0.10	48	-0.04	89	0.17	80	-0.11
M512	25	-0.22	47	-0.10	45	-0.02	47	0.21	89	-0.07	80	0.11
D4	27	0.14	47	-0.15	50	-0.11	47	0.05	89	-0.16	80	0.14
Girls												
500	21	-0.09	42	0.29	42	-0.22	58	0.21	102	-0.01	67	-0.02
1000	23	-0.14	43	0.15	43	-0.21	58	0.04	102	0.00	67	-0.15
2000	24	-0.10	44	-0.04	43	-0.46**	57	-0.05	102	-0.11	67	-0.05
4000	23	-0.41*	43	0.29	42	-0.58**	58	0.04	102	0.13	67	-0.04
6000	22	-0.20	43	-0.09	43	-0.49**	58	0.19	102	-0.13	67	0.05
M512	21	-0.14	42	0.15	42	-0.36*	57	0.07	102	-0.04	67	-0.04
D4	22	0.35	42	-0.14	42	0.19	58	-0.05	102	-0.13	67	-0.03

* .01 < p ≤ .05

** p ≤ .01

TABLE 109 - DESCRIPTIVE STATISTICS FOR AUDITORY
          THRESHOLD LEVELS AT 4000 Hz IN GROUPS
          EXPOSED AND NOT EXPOSED TO SPECIFIC
          NOISE EVENTS

	Difference	Exposed			Unexposed		
Event	$\bar{X}_e - \bar{X}_u$	$\bar{X}_e$	s.d.	n	$\bar{X}_u$	s.d.	n
Fireworks	0.13	-0.67	7.08	180	-0.80	7.19	519
Loud radio	-0.45	-1.12	6.76	154	-0.67	7.27	545
Flight pattern	-1.24	-2.00	-	2	-0.76	7.17	697
Power tools	1.02 **	-0.35	6.94	412	-1.37	7.43	287
Near Firearms	0.02	-0.75	7.20	133	-0.77	7.15	566
Farm machines	.53 *	-0.35	7.45	155	-0.88	7.07	544
Loud T.V.	1.39 **	0.43	6.62	98	-0.96	7.22	601
Amplified inst.	-1.83 **	-2.50	6.30	36	-0.67	7.19	663
Loud vehicles	0.99 **	-0.13	6.24	248	-1.12	7.60	451
Bus	-0.09	-0.87	7.06	428	-0.78	7.30	260

* $.01 < p \leq .05$

** $p \leq .01$

vehicles are consistent with a hypothesis of noise induced hearing loss associated with these events. Nevertheless, those exposed to amplified instruments have lower thresholds than those unexposed to the same event.

It should be recalled that there are definite age trends in exposure to some of these noise events (Figures 46 and 47) and in the thresholds (Tables 8 and 34); consequently, the results in Table 109 may reflect differing age composition in the exposed and unexposed samples, rather than a noise effect _per se_.

It may be argued that while the mean thresholds of those exposed to a noise event do not differ from those of unexposed individuals, the individuals at the extremes of the distributions of each of these groups may differ considerably. Therefore, in Figures 50 through 53 are presented the medians and 95th percentiles of auditory thresholds in the better and worse ears at 4000 Hz within two age groups. It is clear that the direction of differences between median thresholds is not always the same as that between the 95th percentiles. In the better ear (Figures 50 and 51) there are few marked differences between the 95th percentile thresholds of the exposed and unexposed groups, although exposure to farm machinery in 6-11-year-olds, and loud vehicles, power tools, and bus in 12-17-year-olds seem to be associated with relatively higher 95th percentile thresholds than in the unexposed group.

For the worse ear (Figures 52 and 53), the situation is less clear, with unexposed individuals having higher thresholds as often as the exposed individuals.

The previous analyses of noise events have examined associations with single events only. Because this is reflective of a child's real noise exposure, scores of noise were derived from factor analysis representing differentially weighted clusters of mean event scores, based on a child's exposure to these events. The orthogonal groupings of noise events into five factors and their loadings on that factor are presented in Table 110. Correlations between event factor scores and worse ear auditory thresholds are presented in Table 111. For ease of reference, the factors have been named representing chief sources of noise. All of the correlations are low, but in girls, there are significant positive correlations with thresholds and Factors 1, 2 and 4, and in boys, Factor 5. This indicates as the aggregate noise of these event factors increase, thresholds rise, suggesting noise-induced hearing loss for exposed individuals. The opposite is generally true in boys, with significant negative correlations of noise with Factors 1, 3 and 4. The sex difference may result from differing age composition of the boys and girls.

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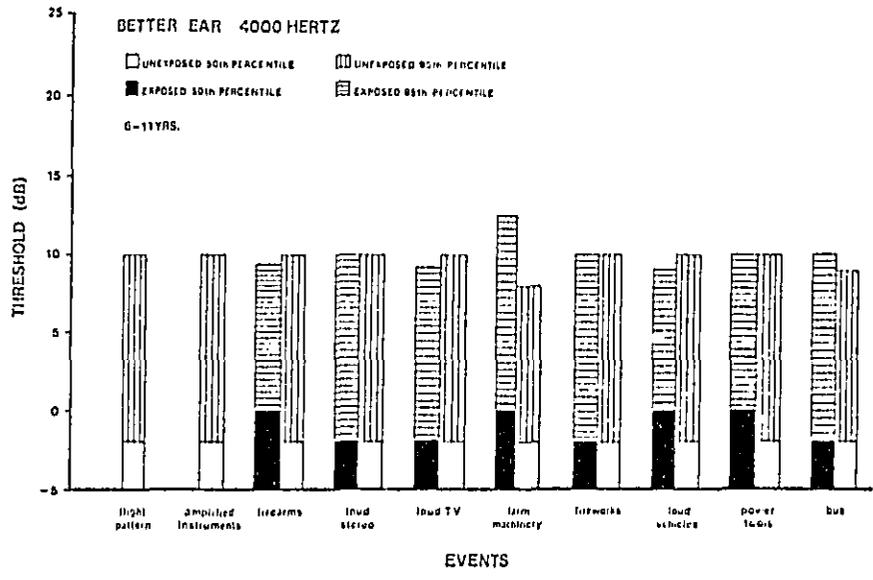
FIGURE 50 —BETTER EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND
95TH PERCENTILES AT 4000 Hz IN 6-11 YEAR OLDS
EXPOSED TO SPECIFIC NOISE EVENTS
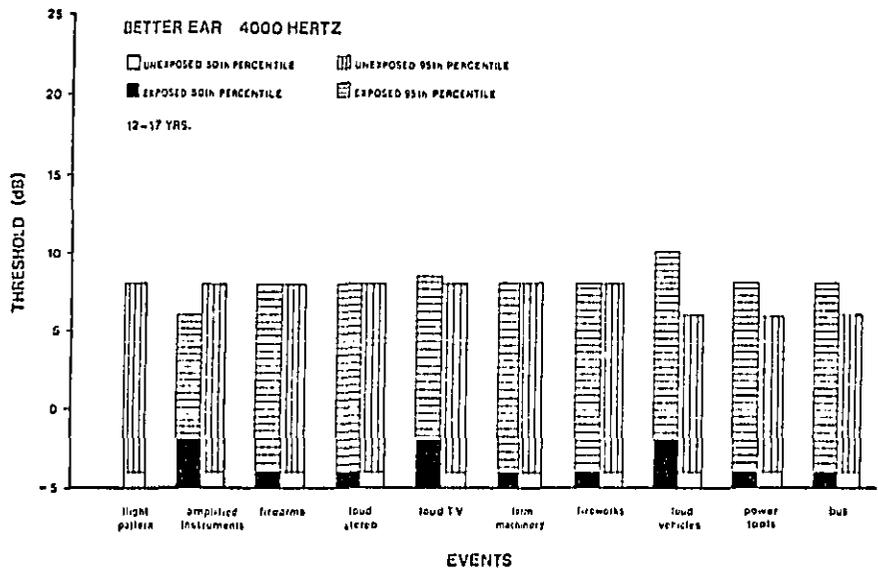
FIGURE 51 —BETTER EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND
95TH PERCENTILES AT 4000 Hz IN 12-17 YEAR OLDS
EXPOSED TO SPECIFIC NOISE EVENTS

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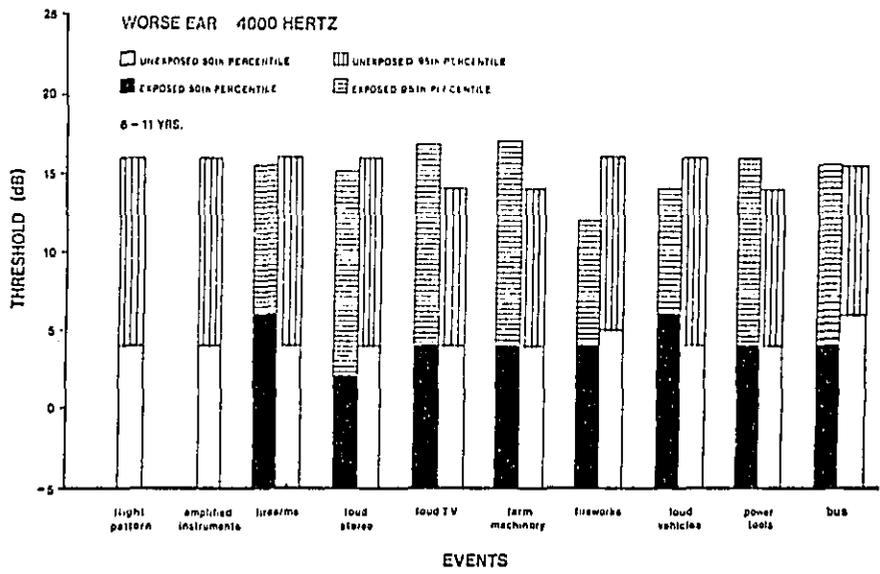
FIGURE 52   —WORSE EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND
             95TH PERCENTILES AT 4000 Hz IN 6-11 YEAR OLDS
   EXPOSED TO SPECIFIC NOISE EVENTS
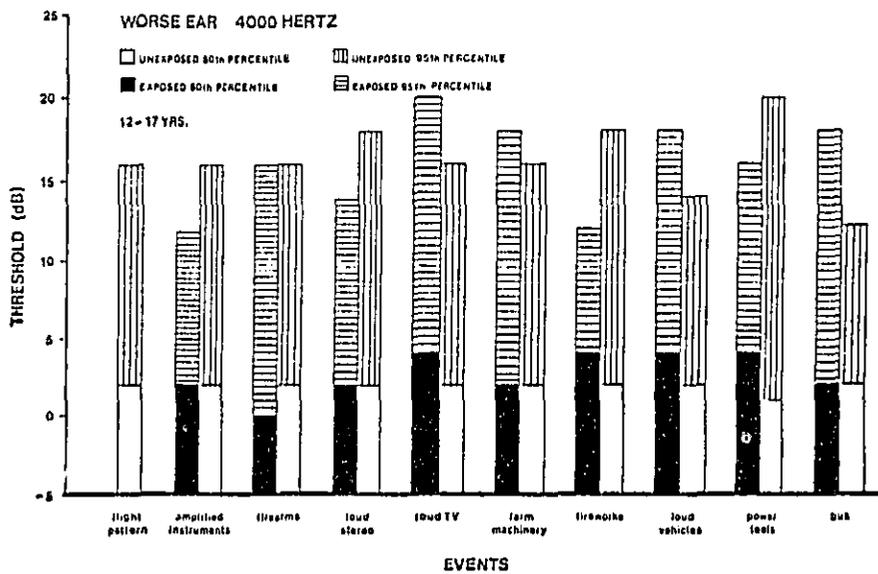
FIGURE 53   —WORSE EAR, AUDITORY THRESHOLD LEVEL MEDIANS AND
             95TH PERCENTILES AT 4000 Hz IN 12-17 YEAR OLDS
             EXPOSED TO SPECIFIC NOISE EVENTS

TABLE 110 - FACTOR ANALYSIS OF MEAN EVENT SCORES
WITH VERIMAX (ORTHOGONAL) ROTATION

FACTOR 1		FACTOR 2	FACTOR 3
Farm machinery	(.71)	Loud T.V. (.93)	Amp. instrument (.92)
Firearms	(.68)		
Power tools	(.59)		
Loud vehicles	(.51)		

FACTOR 4		FACTOR 5
Loud radio	(.71)	Flight patterns (.99)
Fireworks	(.68)	

Correlations were calculated between the same noise event
factor scores and the 6-month threshold increments (Table 112).
The correlations are all effectively zero, and the single signifi-
cant coefficient (boys' D4 and Factor 1) is to be expected by
chance alone.

ASSOCIATIONS BETWEEN AUDITORY THRESHOLDS, BLOOD PRESSURE AND NOISE

Correlations between auditory thresholds and blood pressure
were calculated for all ages combined (Table 113). The coefficients
are near zero in boys and in girls there are significant and
negative correlations for better ear and worse ear that are
about the same at all thresholds. When the effects of age were
removed from both variables, the general pattern changed (Table 114).
The coefficients with systolic pressure tend to be positive and
significant in the boys but negative and significant in the girls.
The coefficients are not large (none exceed 0.2) but the effects
are similar for the better and the worse ear. All the correlations
with diastolic pressure are near zero.

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TABLE 111 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN WORSE EAR AUDITORY THRESHOLD AND
FIVE EVENT NOISE FACTORS

Frequency (Hz)	Factor 1 Machinery	Factor 2 Loud TV	Factor 3 Amp. Instrument	Factor 4 Loud Radio Fire wks.	Factor 5 Flight Pattern
Boys (n=513)					
500	-0.04	0.03	-0.03	-0.15 **	0.14 **
1000	-0.05	0.08	-0.01	-0.07	0.10 *
2000	0.00	-0.01	-0.06	-0.09 *	0.00
4000	0.06	0.07	-0.09 *	-0.08	0.03
6000	0.08	0.01	0.02	-0.14 **	0.06
M512	-0.04	0.04	-0.04	-0.14 **	0.10 *
D4	-0.12 **	0.03	0.10 *	0.01	0.09 *
Girls (n=489)					
500	0.05	0.10 *	-0.03	0.08	0.00
1000	0.04	0.08	0.03	0.04	0.01
2000	0.09 *	0.06	-0.09	0.02	-0.01
4000	0.10 *	0.05	-0.05	0.04	-0.04
6000	0.13 **	0.09	-0.06	0.10 *	0.01
M512	0.07	0.09 *	-0.02	0.05	0.00
D4	-0.08	0.01	0.08	-0.03	0.04

*   .01 < p $\leq$ .05

** p $\leq$ .01

TABLE 112 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN WORSE EAR AUDITORY THRESHOLD INCREMENTS
AND FIVE EVENT SCORE FACTORS

Frequency (Hz)	Factor 1 Machinery	Factor 2 Loud TV	Factor 3 Amp: Instrument	Factor 4 Loud Radio Fire wks.	Factor 5 Flight Pattern
Boys (n=358)					
500	0.05	-0.05	0.03	-0.03	0.03
1000	-0.04	0.09	-0.03	0.03	0.06
2000	0.01	-0.01	0.02	-0.06	0.01
4000	0.09	0.04	-0.08	0.03	-0.02
6000	0.05	0.04	0.09	-0.01	0.02
M512	0.02	0.03	0.01	-0.03	0.04
D4	-0.13 *	0.00	0.05	-0.02	0.06
Girls (n=346)					
500	0.09	0.07	-0.04	0.05	-0.03
1000	0.04	-0.03	-0.01	-0.05	-0.01
2000	0.08	0.00	0.06	0.00	0.00
4000	0.03	0.01	-0.06	-0.06	-0.02
6000	0.06	0.02	-0.03	-0.04	-0.03
M512	0.07	0.02	0.01	-0.01	-0.02
D4	0.00	-0.04	0.05	0.01	0.01

* $.01 < p \leq .05$

TABLE 113 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN AUDITORY THRESHOLDS AND SYSTOLIC
AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE
IN BOYS AND GIRLS

Frequency (Hz)	Boys (n=275) Systolic	Diastolic	Girls (n=276) Systolic	Diastolic
Better ear				
500	-0.10	-0.16 **	-0.33 **	-0.16 **
1000	-0.07	-0.09	-0.27 **	-0.12 *
2000	0.01	-0.04	-0.28 **	-0.15 *
4000	-0.01	-0.08	-0.25 **	-0.15 *
6000	-0.04	0.00	-0.24 **	-0.15 *
M512	-0.08	-0.12 *	-0.34 **	-0.17 **
D4	-0.11	-0.05	0.05	0.07
Worse ear	Boys (n=271)		Girls (n=268)	
500	-0.04	-0.15 *	-0.31 **	-0.15 *
1000	-0.03	-0.07	-0.27 **	-0.16 *
2000	0.01	-0.03	-0.25 **	-0.15 *
4000	0.03	-0.01	-0.25 **	-0.17 **
6000	0.00	-0.02	-0.18 **	-0.08
M512	-0.02	-0.11	-0.32 **	-0.16 **
D4	-0.10	-0.07	0.00	0.04

* $.01 < p \leq .05$

** $p < .01$

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TABLE 114 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN AUDITORY THRESHOLDS AND SYSTOLIC
AND FIFTH PHASE DIASTOLIC BLOOD PRESSURE
WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=275) Systolic	Diastolic	Girls (n=276) Systolic	Diastolic
Better ear				
500	0.06	-0.09	-0.16 **	-0.06
1000	0.11	-0.02	-0.10	-0.03
2000	0.15 *	0.02	-0.10	-0.06
4000	0.14 *	-0.03	-0.10	-0.07
6000	0.09	0.05	-0.12	-0.09
M512	0.10	-0.05	-0.16 **	-0.06
D4	-0.09	-0.03	0.05	0.08
Worse Ear	**Boys (n=271)**		**Girls (n=268)**	
500	0.08	-0.10	-0.16 **	-0.05
1000	0.13 *	-0.01	-0.15 *	-0.08
2000	0.18 **	0.03	-0.12	-0.06
4000	0.14 *	0.03	-0.13 *	-0.09
6000	0.09	0.00	-0.10	-0.04
M512	0.15 *	-0.05	-0.17 **	-0.06
D4	-0.06	-0.05	-0.02	0.04

* .01< p $\leq$ .05

** p $\leq$ .01

Other correlations were calculated using the means across age for the thresholds and blood pressures within individuals (Table 115), in an attempt to minimize measurement error. None of these coefficients is significant in the boys. There are consistently negative coefficients in the girls and many of these are significant, especially those with systolic pressure. These correlations were run also after removing the effects of age from each variable (Table 116). The effects of partialling out age was marked. After this procedure, none of the coefficients for girls are significant although almost all remained negative. Those for the boys are near zero for diastolic pressure but those for systolic pressure are nearly all positive and most are significant. These findings indicate that boys with high systolic pressures tend to have high auditory thresholds although there are no corresponding associations in girls or with diastolic pressure.

Correlations were calculated also between blood pressures and noise scores for all ages combined (Table 117). These are positive and significant for systolic pressure in each sex, but near zero for diastolic pressure. However, when the effects of age are removed from each variable, the correlations are near zero (Table 118).

Corresponding correlations were calculated using the means of serial blood pressures and serial noise scores for individuals. The correlations between these mean scores and pressures are significant for boys but not girls (Table 119). However, when the effects of age are removed from both variables, the coefficents are not significant and they have values near zero (Table 120).

In summary, after removing the effects of age, auditory thresholds and systolic blood pressure tend to be significantly correlated in each sex but positively in boys and negatively in girls. The correlations with diastolic pressure are near zero. Similar findings were obtained when the means of values across age within individuals were used in the correlations. The correlations between blood pressures and noise scores are not significant.

DOSIMETRY

Noise exposure (Leq_{24}) was measured by dosimetry in 100 participants (47 boys; 53 girls). Table 121 gives the descriptive statistics for Leq_{24} in these participants. There was no significant sex difference for Leq_{24}; however, the range of exposure was slightly greater in females, due to more values at lower levels. The sexes did not differ in age (mean about 14.3 years, s.d. 2.9 years). Figure 54 presents a plot of Leq_{24} versus age; linear regression analysis indicated there is no significant change in Leq_{24} with age in either sex.

TABLE 115 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC
BLOOD PRESSURE AND MEAN AUDITORY THRESHOLDS

Frequency (Hz)	Boys (n=72) Systolic	Diastolic	Girls (n=72) Systolic	Diastolic
Better Ear				
500	-0.01	-0.12	-0.37 **	-0.28 *
1000	0.09	-0.01	-0.25 *	-0.21
2000	0.07	-0.02	-0.27 *	-0.23
4000	0.09	-0.10	-0.22	-0.10
6000	-0.02	0.03	-0.29 *	-0.11
M512	0.02	-0.10	-0.33 **	-0.24 *
D4	-0.09	0.04	-0.02	-0.12
Worse Ear				
500	0.08	-0.09	-0.29*	-0.23 *
1000	0.12	0.00	-0.24 *	-0.17
2000	0.04	-0.08	-0.24 *	-0.20
4000	0.09	-0.09	-0.15	-0.20
6000	-0.02	0.01	-0.21	-0.06
M512	0.07	-0.09	-0.31 **	-0.21
D4	-0.06	-0.01	-0.03	0.04

* .01 < p ≤ .05

** p ≤ .01

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TABLE 116 – SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN MEAN SYSTOLIC AND FIFTH PHASE DIASTOLIC
BLOOD PRESSURES AND MEAN AUDITORY THRESHOLDS
WITH THE EFFECTS OF AGE PARTIALLED FROM BOTH

Frequency (Hz)	Boys (n=72) Systolic	Diastolic	Girls (n=72) Systolic	Diastolic
Better Ear				
500	0.27 *	-0.05	-0.17	-0.19
1000	0.37 **	0.06	-0.05	-0.10
2000	0.24 *	0.01	-0.05	-0.07
4000	0.27 *	-0.06	-0.08	0.00
6000	0.13	0.09	-0.20	-0.02
M512	0.29 *	-0.04	-0.13	-0.11
D4	-0.06	0.07	0.04	-0.09
Worse Ear				
500	0.32 **	-0.02	-0.13	-0.16
1000	0.36 **	0.04	-0.06	-0.06
2000	0.24 *	-0.04	-0.06	-0.09
4000	0.19	-0.08	-0.03	-0.09
6000	0.13	0.05	-0.15	0.05
M512	0.30 *	-0.07	-0.14	-0.13
D4	0.06	0.06	0.01	0.04

* .01 < p $\leq$ .05

** p < .01

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TABLE 117 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
         BETWEEN SYSTOLIC AND FIFTH PHASE DIASTOLIC
         BLOOD PRESSURE AND INTERVAL NOISE SCORES

	Boys (n=251)	Girls (n=259)
Systolic	0.35 **	0.19 **
Diastolic	0.08	0.05

** p $\leq$ .01

TABLE 118 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_s)
         BETWEEN SYSTOLIC AND FIFTH PHASE DIASTOLIC
         BLOOD PRESSURE AND INTERVAL NOISE SCORES
         WITH THE EFFECT OF AGE PARTIALLED FROM BOTH

	Boys (n=251)	Girls (n=259)
Systolic	0.12	0.12
Diastolic	-0.01	0.02

TABLE 119 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN MEAN SYSTOLIC AND FIFTH PHASE
DIASTOLIC BLOOD PRESSURE AND MEAN INTERVAL
NOISE SCORES

	Boys (n=70)	Girls (n=70)
Systolic	0.47 **	0.12
Diastolic	0.26 *	0.22

*   .01 < p ≤ .05

** p ≤ .01

TABLE 120 - SPEARMAN RANK CORRELATION COEFFICIENTS (r_S)
BETWEEN MEAN SYSTOLIC AND FIFTH PHASE
DIASTOLIC BLOOD PRESSURE AND MEAN INTERVAL
NOISE SCORES WITH THE EFFECT OF AGE
PARTIALLED FROM BOTH

	Boys (n=70)	Girls (n=70)
Systolic	0.10	-0.09
Diastolic	0.04	0.09

TABLE 121 - DISTRIBUTION STATISTICS FOR NOISE
EXPOSURE (Leq_{24}) MEASURED WITH
DOSIMETERS

	n	$\bar{x}$	s.d.	range	
Boys	47	83.1	5.6	73.0	99.4
Girls	53	82.0	7.2	58.8	102.4
Both Sexes	100	82.5	6.5	58.8	102.4

Four different dosimeters were used at various times
during this study. They were Loomis Laboratories (model 3573),
Bruel and Kjaer (model 4424), General Radio (model 1954-9780),
and Metrosonics (model dB 301). Currently, we are using the
latter two. An analysis of variance coupled with Duncan's multiple
range test indicated significant differences among dosimeters.
As shown in Table 122, the General Radio dosimeter recorded
significantly higher mean Leq_{24} values than the others.

Table 123 presents the means and standard deviations of
the left ear auditory thresholds (in dB) for the boys and girls
for whom there are dosimetry data. There is no significant
difference between the sexes in auditory thresholds at any
frequency; however, at every frequency except 6000 Hz, the
variance of auditory thresholds is greater for females than
males. This is no doubt a sampling artifact, as there is
no indication of sex-associated difference in variance in
the total sample of children.

The relationship between Leq_{24} and auditory thresholds in
the left ear at 1000, 2000, 4000 and 6000 Hz was investigated
using Spearman rank correlation coefficients. There is no
significant correlation between Leq_{24} and any threshold in the
boys. However, in the girls, Leq_{24} and auditory threshold at
4000 Hz are significantly correlated ($r = 0.29$, $p = .04$). The
slope of the linear regression line of Leq_{24} on threshold at
4000 Hz indicates an increase of 0.46 dB in auditory threshold
for each dB increase in Leq_{24}. This is an interesting finding;
however, before too much importance is attached to it, it must
be verified in a larger sample.

FIGURE 54   -PLOT OF Leq$_{(24)}$ RELATIVE TO AGE IN YEARS

TABLE 122 - F VALUES FROM ANALYSIS OF VARIANCE AND RESULTS OF
            DUNCAN'S MULTIPLE RANGE TEST FOR DIFFERENCES AMONG
            DOSIMETERS

	Both Sexes			Boys			Girls		
	n	$\bar{x}$	DMR[1]	n	$\bar{x}$	DMR[1]	n	$\bar{x}$	DMR[1]
General Radio	72	84.4		33	84.6		39	84.1	
Bruel and Kjaer	10	78.6		6	79.2		4	77.8	
Metrosonics	2	78.0		--	----		2	78.0	
Loomis Laboratory	16	76.9		8	79.3		8	74.6	
F Ratio	9.26*			5.58**			5.87**		

* $.01 < p \leq .05$

** $p \leq .01$

[1]Duncan's Multiple Ranges. There are no significant differences
between the values joined by vertical lines.

TABLE 123 - AUDITORY THRESHOLD LEVELS (dB) IN THE LEFT EAR OF 43
            BOYS AND 53 GIRLS WHO PARTICIPATED IN THE MEASUREMENT
            OF 24-HOUR NOISE EXPOSURE (Leq_{24}) USING PORTABLE
            DOSIMETERS

	Boys		Girls		Both Sexes	
Frequency	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
1000 Hz	-4.6	5.3	-1.8	12.0	-3.1	9.7
2000 Hz	-6.0	6.7	-2.8	11.5	-4.3	9.7
4000 Hz	-2.8	6.8	-.73	12.5	-1.7	10.3
6000 Hz	-2.2	9.0	-.53	11.0	-1.3	10.2

CONCLUSION

Environmental noise may have adverse effects on the
auditory thresholds of people of all ages but there are
convincing reasons why the hearing of children should be
examined with particular care. Further, serial studies
offer several advantages over cross-sectional studies.
The major reasons why serial studies of auditory thresholds
in children are needed are:

1. Children may be more susceptible to noise damage
than adults.

2. Children may be exposed to different sources of
noise than adults; some of these may not be recognized
currently as influencing hearing.

3. Hearing loss in a child may have more severe effects
on learning and communication than a similar loss in an adult.

4. Hearing thresholds during childhood may be correlated
with hearing ability in adult life.

5. Some effects found in cross-sectional studies may
not be general trends in all individuals, but either artifacts
of sampling or reflect marked changes in subgroups.

6. A longitudinal study is the only way to determine
whether the effect of noise on an individual's hearing is
temporary or permanent.

7. A longitudinal study, especially in children, allows
one to examine the effect of developmental and growth changes
on hearing levels, and to separate these from environmental
effects.

8. There may be critical periods when hearing
sensitivity is prone to change and serial study is necessary
to document and evaluate these changes.

9. To determine if there are changes in peripheral
blood pressure that may be related to noise exposure and
hearing loss.

This multi-year serial study was undertaken because of
the factors enumerated above and because so little is known
about environmental and developmental effects on hearing in
children. Since the findings reported here represent only
the first three years of data collection, the findings should
be considered preliminary; the study is only beginning to meet
its full potential. Furthermore, because relatively few of
the participants in the study had suitable multiple measurements
of auditory thresholds, most of the present analyses are cross-
sectional rather than longitudinal.

The group constituting the Fels sample has relatively good hearing. The mean and median thresholds at almost all frequencies are 2 to 6 dB lower than those from United States national surveys (Roberts and Federico, 1970; Roberts and Ahuja, 1975) for children of corresponding ages. Probably these differences reflect dissimilarities between the Fels and national samples in many aspects, e.g., geographical, socio-economic, racial factors.

There are indications that some abnormal otological findings may be associated with hearing losses. Also of interest are analyses of auditory thresholds in relation to body size and sexual and skeletal maturity. There is a suggestion of possible developmental correlates because the auditory thresholds decrease during adolescence, especially in girls. Rapidly maturing children tend to have lower thresholds than others although the picture is not entirely clear.

Consistent and sometimes large lateral differences in thresholds occurred. These may be due to testing procedures or, perhaps, represent biological differences; further studies are needed to clarify this. Lateral differences are not present in the increments, which suggests that these differences are likely to be due to testing artifacts.

The older group of children (12 to 17-year-olds) had lower thresholds than the younger group (6 to 11-year-olds): a much larger proportion of the older children were hearing at the lowest possible limit of the audiometer. In addition, there is a significant negative correlation between age and thresholds. This may mean younger children cannot perform the testing task well enough to reach their "true" thresholds; an alternative explanation is that hearing ability may improve during the middle childhood years.

Auditory thresholds tend to be higher at 4000 and 6000 Hz than at the other frequencies tested in each group examined. Similarly, at these frequencies, the mean 6-month increments in thresholds are consistently larger (decline in hearing ability) than at lower frequencies. This finding is consonant with the view that noise might be important with regard to auditory thresholds of children. The higher frequencies (especially 4000 Hz) are the more sensitive to damage by noise, whether permanent or temporary threshold shifts are considered. Therefore, the higher initial thresholds and larger increments at higher frequencies may result from noise exposure.

In general, girls have slightly lower mean thresholds than boys and less variation in threshold measurements at a given age. This may reflect differences in behavior resulting in less noise exposure, and, therefore, less hearing loss due to noise exposure. This explanation is supported by the fact

that threshold differences between boys and girls are larger in the 12- to 17-year-olds than in the 6- to 11-year-olds. Moreover, the median total noise exposure scores show a marked sex difference only in the older group, with boys having the higher total noise exposure. Therefore, if noise is having an adverse effect, older boys should have higher thresholds. This hypothesis is consistent with the present data. Finally, the 6-month increments are larger, in the direction of hearing loss, in the older group and more pronounced in boys. Because the thresholds of girls tend to be lower and less variable than those of boys, the sex differences may reflect less noise exposure in the girls. Certainly the trend of increasing sex differences in mean thresholds with age is in accordance with the trend of increasing sex differences in noise exposure although the correlations between noise exposure scores and auditory thresholds were not significant.

It is clear that participants in the study have a wide range of noise exposure and a wide range of sources of this noise. The noise exposure histories of many participants suggest high levels of noise exposure. The current quantification procedure applied to the noise exposure histories is imprecise. However, the concept should be retained because it allows comparisons that are very difficult to make qualitatively. While the quantitative noise exposure scores from the interval and total noise exposure histories are important measures of noise exposure, the formula by which they are derived may be modified in the future. Empirical modifications based on the distributions of each question score, and relationships with the data from other questions concerning noise, and further dosimeter studies will be helpful in this regard.

The qualitative approach allows the identification of specific noise events that may be significant biologically; therefore, it is very important. The various data concerning noise exposure indicate fireworks and being near firearms were not problems in this sample with respect to noise-induced hearing loss, although the potential for considerable loss from the use of firearms has been demonstrated in other studies. Loud stereo, hi-fi, or radio; loud vehicles; loud television, riding a school bus, and power tools may be associated with some elevation of auditory thresholds in the present sample; such findings in these noise categories indicate the need for further investigation.

The major long-term aims of this study are to determine the pattern of auditory threshold levels in children and to relate changes in these thresholds to developmental and environmental events (particularly noise exposure). While it is too early in the study to establish patterns or unequivocally relate changes to specific events, it is clear from the preliminary findings that the design, sample, and methodology of the study are ideally suited for the attainment of these long-term aims. The preliminary findings of sex and age effects, as well as relationships among thresholds, increments, noise exposure and other related measurements, only hint at the potential of this study to answer important questions that relate to human hearing.

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Additions to "Interval Audiometry Questionnaire" (Appendix C of AMRL-TR-76-110;

Roche et al.,1977) begun in September, 1977.

37. Do you ride a school bus to school?

☐ no ☐ yes
072   073

a) One way? ☐ 074

b) Both ways? ☐ 075

c) Number of days each week? ☐ 076

d) About how many minutes does the ride last one way? ☐☐ 077-78

38. Were auditory thresholds tested on the same day that underwater weighing was done?
     0 = no 1 = yes

☐ 079

☐ 080

| CARD E- col. 1-7 same as D | ⑤ E8

39. Have your habits with regard to riding a bus to school changed since January, 1976? (Please provide details.)

☐ no ☐ yes
E9   E10

40. (For any Participant not having EGG measurments.)
    Blood Pressure: Heart rate/min. :

1. ____ / ____ / ____   ____

2. ☐☐☐ / ☐☐☐ / ☐☐☐   ☐☐☐
   E 11 12 13 / E 14 15 16 / E 17 18 19   E 20 21 22

3. ☐☐☐ / ☐☐☐ / ☐☐☐   ☐☐☐
   E 23 24 25 / E 26 27 28 / E 29 30 31   E 32 33 34

☐ E80

Fels Research Institute   APPENDIX B

Study No. R805

General Radio Dosimeter Form

Participant Name									
Participant No.									
Clan No.									
Test Duration						:			
Participant Residence			1=rural, 2=non-rural						
Dosimeter Type 4=GenRad	4								
Dosimeter No.									
Date Test Start							7	9	
Data 1=good, 2=bad									
Range			1=60-110dB, 2=80-130dB						
Capacity Filled 1=yes, 2=no									
Typical Day 1=yes, 2=no									
If no: 1=louder, 2=quieter, if yes:0									

Participant Age (years)									
Participant Birthdate									
Participant Sex 1=m, 2=f									
Left Ear Hearing 1000 Hz									
Thresholds at 2000 Hz									
Nearest Date 4000 Hz									
6000 Hz									
Leq(24)									
Allowable Level Exceeded				1=yes, 2=no					
Thresholds Date									
Calibration Level	116.5dB at 1000Hz		Calibrations:						
Calibration Time	10 seconds		Before	After					
Measurement Reading					1.				
Battery Check 1=good, 2=low					2.				
Range Check 1=same, 2=not same					3.				
Time Start Test		:			4.				
Time End Test		:			5.				
Activities, sources of noise					Av.				
					Tot.				

Dosimeter Pick-Up Instructions

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Study No. R805

Metrosonics Dosimeter Form

Participant Name													
Participant No.													
Clan No.													
Test Duration									:				
Participant Residence			1=rural, 2=non-rural										
Dosimeter Type 5=Metrosonics	5												
Dosimeter Serial No.		1	1	1	3								
Date Test Start											7	9	
Data 1=good, 2=bad													
Range 3=60-124dB	3												
Capacity Filled 0=not appl.		0											
Typical Day 1=yes, 2=no													
If no: 1=louder, 2=quieter; if yes: 0													
Participant Age (years)													
Participant Birthdate													
Participant Sex 1=m, 2=f													
Left Ear Hearing 1000 Hz													
Thresholds at 2000 Hz													
Nearest Date 4000 Hz													
6000 Hz													
Leq(24)													
Allowable Level Exceeded 0=not appl.							0						
Hearing Thresholds Date													
Calibration Level 114 dB at 1000 Hz													
Calibration Before Test		1=calibrated											
Calibration After Test		1=calibrated, 2=off											
Battery Check 1=good, 2=low													
Time Start Test				:									
Time End Test						:							
Activities, sources of noise													

Dosimeter Pick-Up Instructions

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