THE EFFECTS OF AGE ON PAIN SENSITIVITY

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ABSTRACT OF THESIS

A review of the literature has revealed a scarcity of research on age changes in pain sensitivity. The few experimental studies on this topic are open to question because no attempt has been made to make different age groups comparable with respect to sex, race and socio-economic status.

The purpose of the present investigation was to study the relationship between age and the pain sensitivity of five body areas, namely, forehead, upper arm, forearm, thigh and leg.

Quantitative measurements of the pain thresholds were made on the five body areas by the Hardy, wolff and Goodell dolorimeter using the time method. A group of 171 white males, all of them from skilled and unskilled labor backgrounds and ranging in age from 12 to 83 years, served as experimental subjects. To appraise the effect of socio-economic status on pain sensitivity, a group of 21 college students and graduates were tested in addition to the main experimental group. The college group was compared with a section of the main experimental group of the same age range.

The over-all pain sensitivity, a composite of the sensitivity of the five body areas, was found to remain

constant between the teens and the late fifties and to decline significantly thereafter. The various body areas were found to differ in the rate of decline and the age at which decline begins. The pain threshold of the college group was found to be much higher than that of the corresponding section of the main experimental group.

In the discussion an attempt was made to compare the results of this study with data on age changes in other sense modalities and to suggest factors which might be responsible for the decrease in pain sensitivity.

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CHAPTER I

THE PROBLEM AND INTRODUCTION

I. STATEMENT OF THE PROBLEM

Since the end of World War II, considerable experimental interest has been shown in the effects of age on various sensory processes. Vision and hearing in particular have received an unusual amount of attention. Other senses such as the chemical, kinesthetic and cutaneous also have been studied, but to a much lesser degree. Of these relatively neglected senses, pain sensitivity is one sensory process that has received little experimental attention.

Although experimental work on pain sensitivity as a function of age is meagre, interest in the problem has been with us for many years. Numerous case histories have appeared in the dental and clinical medicine literature suggesting decreased pain sensitivity in old age. These results, however, have never been based on quantitative measurements. More recently several reports, utilizing quantitative measurements of pain sensitivity, have appeared. They are, however, inconclusive, since they have often been based on small samples, and in addition have made no attempt to make different age groups comparable with respect to sex, racial origin, socio-economic status and other variables which may affect pain

sensitivity. Furthermore, data on age changes have been presented as incidental by-products of research on a different problem. No experiment has been carried out to date which has had as its main objective the investigation of age changes in pain sensitivity.

The purpose of the present study is to investigate changes in pain sensitivity with age in five areas of the body, namely, forehead, forearm, upper arm, thigh and leg. Quantitative measurements of pain sensitivity will be carried out using the Hardy, Wolff and Goodell dolorimeter. An attempt will also be made to make the various age groups comparable with respect to several important variables.

II. HISTORICAL BACKGROUND

Introduction

During the last 50 years there has been a gradual increase in the number of old people both in absolute numbers and relative to the population, due to the combined effect of a decline in the birth rate and success in therapeutics. This trend has resulted in an ever increasing interest in the nature and problems of aging. This interest is reflected in such things as the development of geriatrics and gerontology into autonomous disciplines, the establishment of the Division on Maturity and Old Age within the American Psychological Association, the establishment of the

Inter-University Institute in Social Gerontology at the University of Michigan, and the establishment of sections on aging within national institutes of mental health. These developments provide ample evidence for a growing awareness of the importance of reliable information about the biological, psychological and social aspects of aging.

In order to adjust to its environment an organism must be able to obtain information about it. Since the organism's ability to obtain such information depends on the sensitivity of its receptors and its ability to interpret these stimuli correctly, researchers on aging have been very interested in changes in sensory functions with age and the psychological and social consequences of such changes. Since humans obtain most of their information about the environment by vision and hearing, most of the research on age changes in sensory functions has dealt with these two senses. A comprehensive and up-to-date review of the literature on age changes in vision and hearing may be found in the Handbook on Aging and the Individual. (Birren, 1959)

Research on age changes in the chemical, kinesthetic and cutaneous senses has been lagging considerably behind that on vision and hearing both in quantity and quality. There are several reasons for this lag: (a) These senses are relatively unimportant in providing humans with

information about their environment. (b) Many problems about the neurophysiological mechanisms underlying these senses are unsolved and controversial. (c) Effective stimuli of these senses are often difficult to identify, to quantify and to control. The little research that is available indicates a progressive decrease in sensitivity with increasing age. A comprehensive review of the literature on these relatively neglected senses may be found in Birren's (1959) Handbook on Aging and the Individual and Zubek and Solberg's (1954) Human Development.

As stated above, very little research was done on the cutaneous senses. This statement is especially true for pain. In the following section a comprehensive review will be made of what little is known about age changes in pain sensitivity--the topic with which this thesis is concerned.

Age Changes in Pain Sensitivity

Although very little systematic research on age changes in pain sensitivity has been done, clinicians in medicine and dentistry have long believed that pain sensitivity is diminished in old age. Clinical reports suggesting that pain sensitivity decreases with advancing age are very common. However, statistical data rarely, if ever, accompany these reports. Critchley's observations are fairly

representative of those found in clinical reports. In 1931 he wrote: "...It is a common observation that in old age there may be a general diminuation in the acuity of perception as regards the special senses and also in respect of the visceral and cutaneous sensations...Severe thoracic and abdominal disease exists in the aged without pain; an extensive pneumonia or peritonitis can be entirely unsuspected... Minor surgical operations and dental extractions can be carried out with but little pain and discomfort. The catastrophe of coronary thrombosis can take place with none of the agonizing symptoms found in younger individuals..."

In contrast to the wealth of clinical data, research on age changes in pain sensitivity using experimental and differential statistical methods of investigation is very scarce. Furthermore, there has not been a single research project having as its main objective the investigation of age changes in pain sensitivity. The few data on that topic that are available are more or less incidental by-products of research on a different problem, for example, effects of analgesics, pain in neurotics, general variability of the pain threshold etc. Experimental studies of pain sensitivity had to wait for the development of methods whereby noxious stimulation could be quantified and controlled. The development of the Hardy, Wolff and Goodell dolorimeter in the late

1930's provided a reasonably satisfactory solution of that problem. Although quantitative research on age changes in pain sensitivity was possible since about 1940, no serious effort has been made to investigate that problem. The reason for this lack of research may lie in the fact that medical and dental clinicians regarded such research as belaboring the obvious and developmental psychologists were primarily interested in the psychologically more important senses of vision and hearing.

The first attempt to correlate quantitatively measured pain threshold with age was carried out by Wilder, 1940. He was interested in relating pain thresholds to such variables as sex, occupation, obesity and age. Approximately 400 patients at the Mayo clinic were used as subjects. Pain was produced by applying a blood pressure cuff with a roughened metal grating inserted into it on the subject's arm just above the elbow and then tightening the cuff until the subject started to wince. The attitude of the subjects was controlled by avoiding any mention of pain and merely telling them that the test was a routine measurement of blood pressure. The pressure at which the subjects started to wince was taken as the pain reaction threshold. Wilder reported briefly that he found no particular differences between age groups. He does not give any quantitative data

or graphs which would indicate how the pain threshold was distributed among different age groups. When evaluating Wilder's data on age changes in pain sensitivity, it is important to note that Wilder made no attempt to insure that subjects in different age groups were comparable with respect to variables which might affect the pain threshold. Furthermore, Wilder measured the pain reaction threshold, --i.e. the stimulus intensity at which pain became uncomfortable enough to elicit an overt reaction--rather than the pain perception threshold--i.e. the minimum stimulus intensity at which pain is just felt. The pain reaction threshold may be a poor measure, since it depends not only on the sensitivity of the receptor organs but also to some degree on personality factors such as self control and perseverance.

The second study on the relationship between age and pain sensitivity was carried out by Sherman in 1943. The purpose of his study was the investigation of possible correlations of the pain threshold with other variables such as sex, age, thickness of the skin, etc. Pain was produced by applying a blood pressure cuff with roughened metal gratings on the subject's arm and then increasing the cuff pressure until the subject started to wince. Hospital patients were used as subjects. In his discussion of results Sherman mentions briefly the distribution of pain thresholds among different age groups. On basis of their pain reaction

thresholds patients were classified into hyposensitives, normals, and hypersensitives. The percentage of members of each class was calculated and tabulated. On the basis of these data Sherman concluded that there are no definite differences in pain sensitivity between different age groups. The results, however, are open to question, since Sherman gives no information about the cut-off points between the different sensitivity classes, nor does he give any details about the nature of his sample. Sherman's data on age changes in pain sensitivity have all the limitations of those of Wilder. First, the pain reaction rather than the pain perception threshold was measured. Second, no effort was made to make the subjects in different age groups comparable.

The two previous studies were concerned with measurement of pain reaction thresholds. The remaining studies which will be reviewed concern pain perception thresholds. The first of these was carried out in 1943 by Hardy, Wolff and Goodell. Their research was designed mainly to measure the variability of the threshold between subjects, between different body parts of the same subject and between different physiological and psychological conditions. Interest in age changes was only incidental. A group of 200 individuals of both sexes and ranging in age from 10 to 85 years served as subjects. No further specification of the sample was given. Pain per-

ception thresholds were measured on the forehead by the thermal stimulation technique using the Hardy, Wolff and Goodell dolorimeter. The interval method was used (i.e. the threshold was measured in terms of the lowest heat intensity [m cal/cm^2/sec] needed to produce pain within 3 seconds.) In the discussion of their results, the experimenters reported briefly that the pain perception threshold was found to be independent of age, sex, emotional states and fatigue. Unfortunately, Hardy et al give no numerical data or graphs which might indicate how the pain threshold was distributed among various age groups. When evaluating their data on age changes in pain sensitivity, it should be noted that their sample was very heterogenous and that no attempt was made to assure comparability of subjects in different age groups.

Chapman in 1944 also made some incidental observations on pain perception thresholds as a function of age. His main interest was in studying the pain perception of neurotics. However, as a part of his study he employed a control group of 200 normal subjects who were equally divided by sex and which included members from various socio-economic and ethnic groups, ranging in age from 10 to 85 years. Chapman measured the pain perception and the pain reaction thresholds on the forehead with the Hardy, Wolff and Goodell dolorimeter, using the interval method. Age and ethnic

origin were the only variables which yielded significant differences. It was found that dark skinned subjects are more sensitive to pain than fair skinned people (eg. The mean perception thresholds for Negros was 268 m cal/cm^2/sec versus 318 m cal/cm^2/sec for "Northern" white.) In regard to age changes, Chapman found a pain perception threshold of 289 m cal/cm^2/sec for ages 10 to 22, 329 m cal/cm^2/sec for ages 23 to 44 years, and 347 m cal/cm^2/sec for ages 45 to 85 years. The age changes in pain reaction thresholds paralleled these. Thus these data suggest that elderly people are less sensitive to pain than young people. These data on age changes in pain sensitivity form a small part of the result and are mentioned only briefly. In evaluating Chapman's data on age changes in pain sensitivity, it should be noted (a) that Chapman's sample was extremely heterogeneous with respect to sex, race and socio-economic status, and (b) that Chapman made no attempt to make different age groups comparable in these respects. Since there are racial and socio-economic differences in pain threshold it would be necessary to know whether there was any racial or socio-economic bias in the age distribution to evaluate the effects of age per se.

The most recent data on age changes in pain sensitivity were published by Birren, Schapiro and Miller, 1950, in their research on the effects of salicylic acid. The pain perception threshold was measured with the Hardy, Wolff

and Goodell dolorimeter, using the interval method. The study included a control group of 16 subjects ranging in age from 19 to 82 years. The researchers mention briefly that no significant age changes in pain thresholds could be detected. These findings cannot be regarded as conclusive because (a) the sample was extremely small, (b) no description of the control group was given.

The preceding review of the literature has shown that very little systematic research has been done on age changes in the pain threshold. What data are available on that subject are more or less incidental observations resulting from research on a different problem. These observations on age changes in pain sensitivity are almost always described very briefly, seldom exceeding one paragraph. Quantitative data about the pain threshold in different age groups are often absent and the statistical significance of differences between age groups is never examined. Furthermore, no attempts have been made to make sure that subjects in various age groups are comparable in respect to sex, national origin, socio-economic status and other variables which may affect the pain threshold.

The present investigation was designed to overcome these deficiencies. A deliberate attempt was made to make the subjects in various age groups comparable with respect

to sex, race and socio-economic level. Measurements of the pain perception thresholds were taken not only on the forehead but also on both arms, wrists, legs and thighs. The significance of differences in pain thresholds will be examined by statistical methods.

CHAPTER II

THE INVESTIGATION: APPARATUS, SUBJECTS AND PROCEDURE

I. THE PROBLEM

The preceding survey of the literature has revealed a dearth of research on age changes in pain sensitivity. It was because of this paucity of data that the present investigation was carried out. Its main purpose is to throw some light on age changes in the pain sensitivity of various parts of the body as measured by the Hardy, Wolff and Goodell dolorimeter.

II. APPARATUS: THE DOLORIMETER

In this study, pain thresholds were measured by the Hardy, Wolff and Goodell dolorimeter (model ER2 - ES2). Details about its constructions, including circuit diagrams and blue prints, may be found in its Instruction Manual.

The dolorimeter consists of a heat projector and a control box. The heat projector is connected to the control box by means of a long connector cable. The control box, which is connected to the power line, contains all the circuits and control knobs associated with the control of the projector.

The functional part of the dolorimeter is a special 100 watt incandescent lamp. The thermal radiation produced by this lamp, which is focused by a system of mirrors and lenses, leaves the heat projector through a circular aperture. When measuring the pain threshold the experimenter holds the pistol-shaped heat projector in such a way that the rim of its aperture touches the subject's skin. The incandescent lamp will operate when an operating button on the heat projector is pushed.

The radiant heat output of the projector is regulated by a heat setting dial on the control box. Calibration of the dial is from 50 to 500 m cal/cm^2/sec, with calibration points every ten millicalories. The control box is also provided with a time selector switch. With the time selector switch at "3 seconds" the lamp will operate for a period of 3 seconds whenever the operating button is held down. With the time selector switch at "manual" the lamp will operate as long as the operating button is pushed.

With this apparatus the pain threshold can be measured by either the interval method, i.e. in terms of minimum heat intensity required to elicit pain, keeping exposure time constant, or by the time method, i.e. in terms of minimum exposure time at a constant stimulus level needed to produce pain.

III. SUBJECTS

The sample consisted of 171 male subjects ranging in age from 12 to 83 years. The teen age group (12 to 16 years) consisted of junior and senior high school students from the Fort Garry School District. The subjects ranging in age from 17 to 59 years, all of whom were unemployed, were obtained from the local unemployment insurance commission. The subjects 60 years of age and over came from two senior citizens clubs.

The subjects were selected in such a way as to make the experimental sample homogeneous with respect to racial origin and socio-economic status. All subjects were of Northern European descent (Anglo-Saxon, Scandinavian, and Dutch). Furthermore, only subjects with skilled and unskilled labor backgrounds were included in the sample: The age group from 16 to 59 included both skilled laborers such as carpenters, electricians, cooks, plumbers, etc., and unskilled laborers such as caretakers, farmhands, dishwashers, etc. All subjects 60 years of age and over were employed as skilled or unskilled laborers before retirement. The fathers of subjects in the teen age group were also employed in skilled or unskilled occupations.

For purposes of statistical analysis, the subjects were divided into four age groups, namely, 12 to 29, 30 to 44,

45 to 60, and 60 to 83. Table I shows the number of subjects in each age group together with the median age of each of the four groups.

All subjects tested were volunteers who were paid for taking part in the study. Volunteers with spinal injuries or inflamatory skin diseases were not accepted as experimental subjects.

During the course of an exploratory study it was observed that there appeared to be some differences in pain thresholds between subjects of the same age but differing in socio-economic background. In order to appraise the influence of this variable, a group of 21 college students and college graduates, ranging in age from 17 to 29 years, were tested. These subjects came almost exclusively from professional and semi-professional families. The pain sensitivity of this college group was then compared with that of the section of the main experimental group covering the same age range and mean.

TABLE I

DISTRIBUTION OF SUBJECTS BY AGE AND SIZE OF SAMPLE

Age Group	Number of Subjects	Median Age
12 - 29	39	15
30 - 44	37	36
45 - 59	47	52
60 - 83	48	70

IV. PROCEDURE

The experiment was carried out during the winter months. The pain threshold measurements were taken in a room whose temperature was about 25°C. At this temperature the subjects felt comfortably warm, but there was no visible perspiration. The skin surface was first sponged with rubbing alcohol. It was then blackened uniformly with dolorimeter ink--a mixture of poster black, rubbing alcohol and glycerine. No testing was carried out until the blackened areas were thoroughly dry.

The subject was told that the purpose of the study was not to determine his ability to endure pain, but to measure his ability to perceive the first trace of pain. He was also told that when the radiation was turned on, at first he would feel nothing, then he would feel warm and hot, and finally he would feel a slight burning or pricking pain. The subject was instructed to start the stop watch, which he held in his hand out of sight during and between measurements, when the heat was turned on and to stop it at the first trace of pain. In order to make sure that the subject understood the instructions, the experimenter asked him to repeat them in his own words.

During the pain threshold measurements the subject lay on an air mattress. The experimenter held the heat pro-

the subject's blackened skin. The experimenter switched the radiant heat on and off by pressing and releasing the operating button. The heat was kept at a constant level of 150 m cal/cm^2/sec for all skin areas. The pain threshold was measured by the time method, i.e. in terms of the minimum duration of the heat source required to elicit the first trace of pain. Readings were taken to the nearest second.

The pain threshold of the following body areas was measured: (1) the forehead just above the nose; (2) the volar side of both upper arms 10 cms. above the elbow; (3) the volar side of both forearms 5 cms. above the wrists; (4) the lateral side of both thighs 15 cms. above the knee; (5) the lateral side of both legs 7 cms. above the ankle. To eliminate serial and order effects, the order in which these skin areas were stimulated was randomized between subjects. Six measurements were made on the forehead, each trial being separated by a 30 second rest period. Six measurements were also taken on the forearms (3 trials each), upper arms, thighs and legs, with the trials being presented in alternate order from one side of the body to the other. One practice trial preceded the measurements on each of the nine skin areas.

CHAPTER III

THE RESULTS AND DISCUSSION OF RESULTS

I. THE RESULTS

Age Differences in Pain Sensitivity

Figures 1 and 2 and Table II summarize the results on age differences in pain sensitivity. The data were analyzed as a Type 1 mixed design (Lindquist, 1953). The basic assumptions underlying this test of significance, i.e. normal distribution of scores in every age group, homogeneity of variance, and homogeneity of treatment and subject interactions were examined and found valid. The analysis of variance is summarized in Table III. It can be seen that the F ratios for age groups and for body areas are significant at the 0.01 level. The interaction of age and body area was also significant at the .01 level, which indicates that the age curves for pain sensitivity for different body areas are not parallel, that is, the pain sensitivity of different body areas declines at different rates with age. After the analysis of variance was carried out, the significance of differences between individual pairs of age groups was tested by t-tests (2-tailed, 0.01 level.) The only significant differences were between the 60 - 83 group and each of the younger groups.

TABLE II

AGE DIFFERENCES IN PAIN SENSITIVITY
FOR FIVE DIFFERENT BODY AREAS*

Body Area	Age Groups 12-29	30-44	45-59	60-83	Average
Forehead	6.93	7.32	8.69	9.48	8.49
Upper Arm	7.37	7.95	7.33	9.02	8.10
Forearm	8.48	8.72	9.71	10.63	9.68
Thigh	9.01	8.73	8.87	9.65	9.09
Leg	9.07	8.70	8.78	10.29	9.26
Over-all sensitivity	8.17	8.28	8.74	9.80	

*The scores refer to the minimum duration, in seconds, of the heat source required to elicit the first trace of pain.

TABLE III

SUMMARY OF THE ANALYSIS OF VARIANCE

Source	d f.	Sum of Squares	Mean Squares	F
Between Subjects	170	3202.04		
Age Groups (A)	3	375.84	91.95	5.43*
error b	167	2826.20	16.92	
Within Subjects	684	2308.36		
Body area (B)	4	286.77	71.69	24.95*
A x B	12	102.43	8.54	2.97*
error w	668	1919.16	2.87	
Total	854	5510.40		

*Significant at $p < .01$

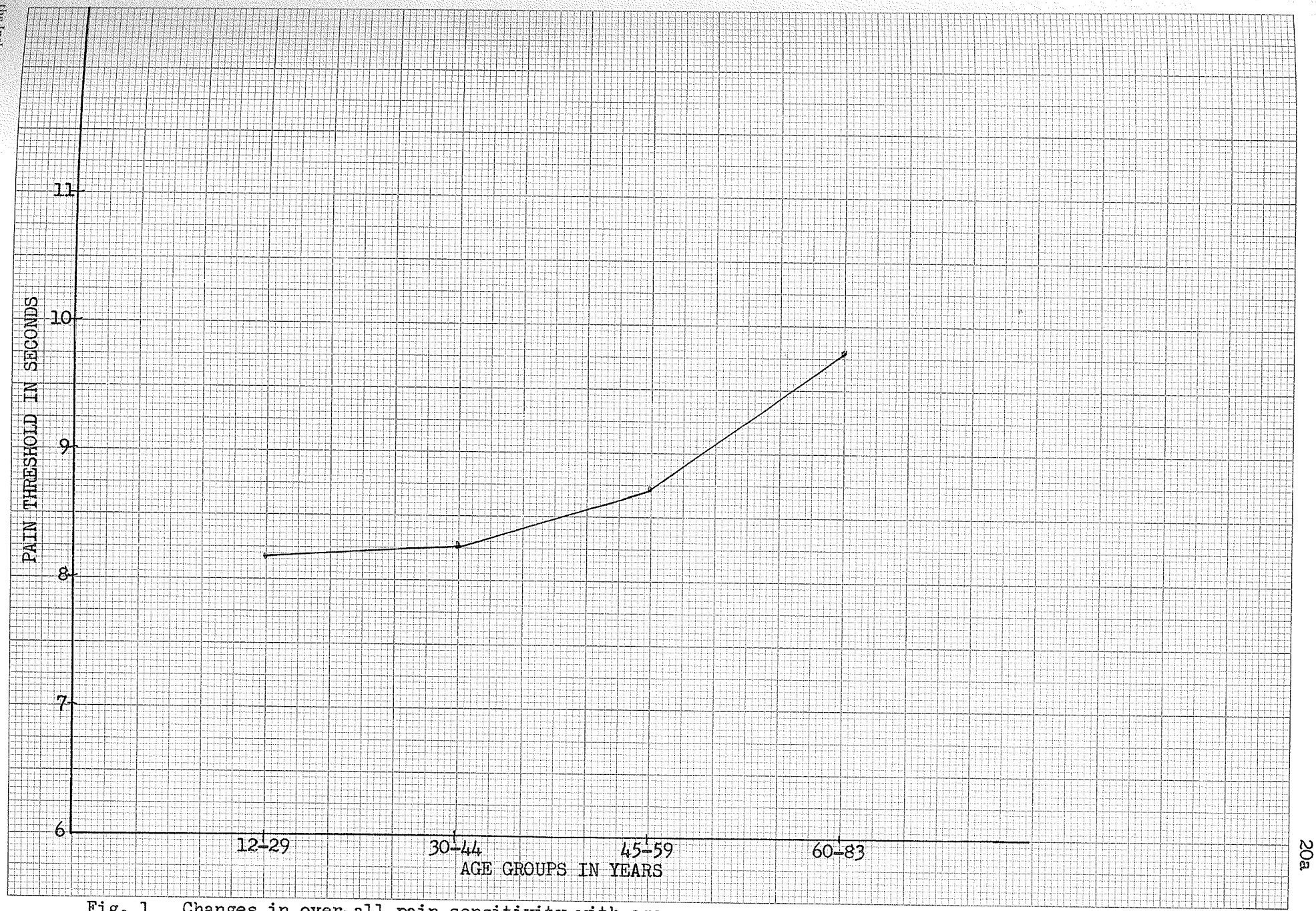

Fig. 1 Changes in over-all pain sensitivity with age.

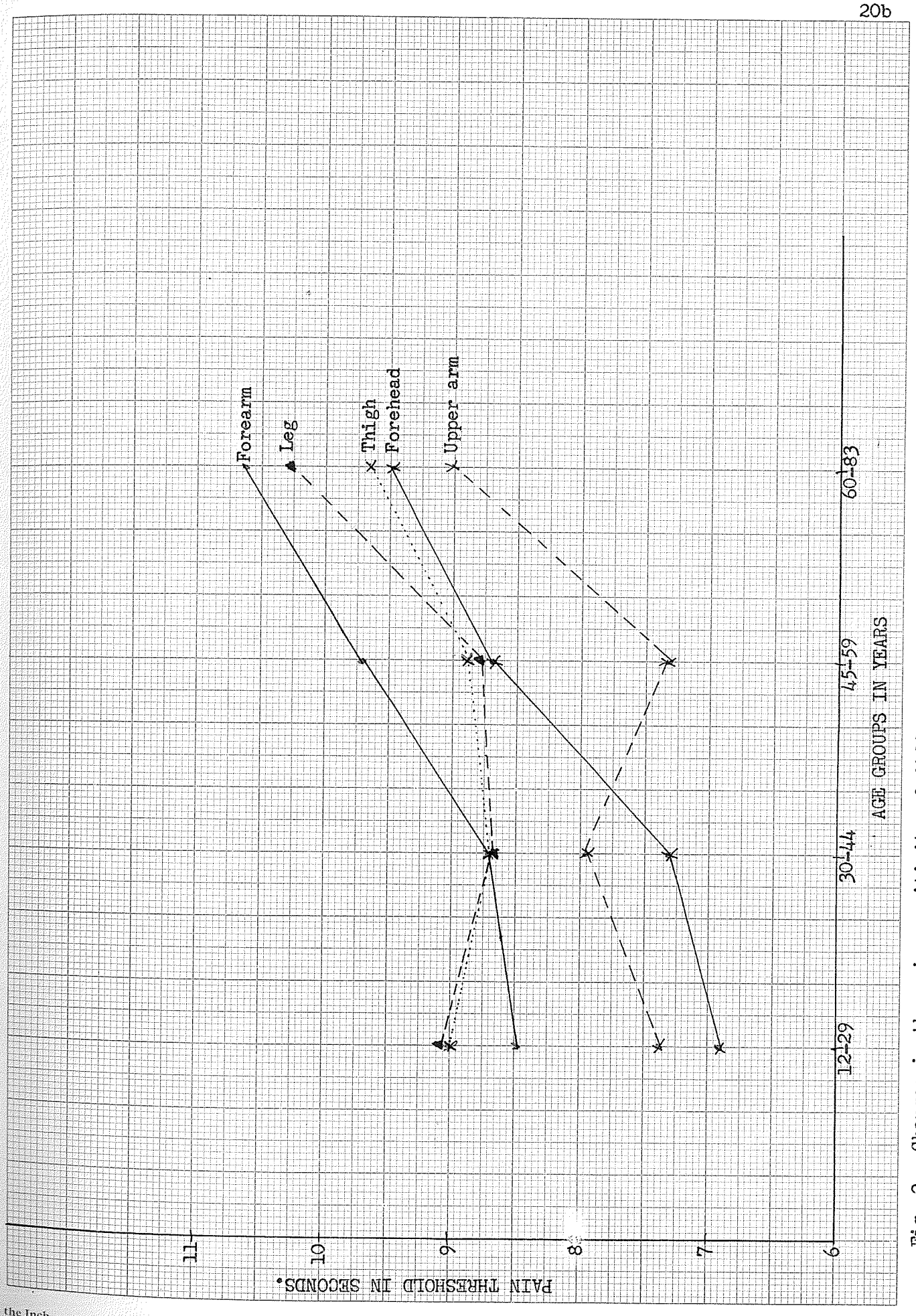

Fig. 2 Changes in the pain sensitivity of different body areas with age.

Figure 1 summarizes the age changes in over-all pain sensitivity (i.e. the mean of the thresholds of the 5 body areas). It can be seen that over-all pain sensitivity remains relatively constant until the fifties, after which it shows a sharp decline. The apparent decline in over-all pain sensitivity from the teens to the late 50's is not statistically significant. The sharp decline after the age of 60, however, is highly significant ($p < .01$).

Figure 2 and Table II summarize the relationship between age and the pain thresholds of the five body areas. It can be seen that the decline in pain sensitivity is not the same for all body areas. The pain sensitivity of the more rostral body areas, i.e. forehead, upper arm, and forearm, shows a much greater decline than the more caudal areas, i.e. the thigh and leg. It can also be seen that the decline in pain sensitivity begins at different ages for different body areas. For the forehead and forearm, sensitivity is significantly worse after the middle 40's ($p < .01$). None of the differences prior to this age are significant. On the other hand, the upper arm, thigh and leg show a significant decrease in sensitivity only after the age of 60 years ($p < .01$). None of the differences prior to this age are significant.

Effect of Socio-Economic Status

The over-all pain sensitivity of the 21-member college group (mean threshold 11.05 sec) was much lower than that of the corresponding 18 members of the section of the main experimental group covering the same age range (mean threshold 7.50 sec). The difference in sensitivity is highly significant (2-tailed t-test, $p < .001$). The standard deviations of the pain threshold of both groups are about equal (college group 2.16 sec, experimental group 2.36).

It is interesting to note that the difference in pain sensitivity between the two socio-economic groups is greater than the greatest difference between any two age groups of the main experimental sample. Age changes in pain sensitivity are therefore easily obscured in cross-sectional studies when different age groups are not comparable with respect to socio-economic status.

II. DISCUSSION OF RESULTS

The results of the present investigation show clearly that over-all pain sensitivity remains constant during adolescence and adulthood but declines noticeably after the late 50's. Although the decline in pain sensitivity during old age is statistically highly significant, it is not

as spectacular as clinical reports such as Critchley's (1931) would suggest. In fact, the over-all threshold of the subjects aged 60-83 (9.82 sec) was found to be lower than that of a special group of college students in their 20's (11.05 sec). The extreme insensitivity to pain during senescence reported by Critchley was probably caused by pathological conditions rather than by the normal aging process.

The finding that pain sensitivity declines in old age is supported by the work of Chapman (1944), but contradicted by the studies of Wilder (1940), Sherman (1943), Hardy, Wolff and Goodell (1943) and Birren, Schapiro and Miller (1950). The results of these last four studies are, however, inconclusive, because their research was unsystematic and their samples were highly heterogeneous. Such factors as socio-economic status and race often have a greater effect on pain sensitivity than age (eg. Chapman 1944, this thesis). Age changes in pain sensitivity are therefore easily obscured in a heterogeneous sample.

The finding that pain sensitivity begins to decline quite late, after the late fifties, is in line with results obtained on other sense modalities. Jalavisto, Orma and Fowast (1951), investigating the pressure sensitivity of the cornea, found that pressure sensitivity decreased slowly at first, but abruptly, after the age of 50. Similarly for

vibratory sensitivity (Neuman and Cobrin 1936) and for taste sensitivity (Cooper, Bilash and Zubek 1959). Misiak (1951), studying the relationship between age and critical flicker frequency, reports that only after the age of 55 is the decline statistically significant. Birren, Bick and Fox (1948) reported no significant changes in dark adaptation thresholds between the ages of 18 and 50, but a progressive decline after this age range. Thus the later age changes in pain sensitivity conform to those occurring in some of the other sense modalities.

The results of this study also suggest that different body areas are not equally sensitive to pain, that pain sensitivity declines at different rates for different body areas and that the decline begins at different ages for different body areas. Since these three observed effects are all within subject's effects, they are genuine, i.e. they cannot be attributed to random variations in subject selection. It is interesting to note that the sensitivity of the two relatively exposed areas, forehead and forearm, not only declined to a greater extent than that of the legs, but also started to decline at an earlier age. Different rates of nerve and receptor degeneration and the effects of exposure on the elasticity and thickness of the skin might possibly account for the differential decline in pain sensitivity.

Because the sensitivity of only five body areas was examined in this study, the data on differential rates of aging must be regarded as exploratory. More systematic research involving the testing of many more body areas is needed before any broad generalizations can be made. It can be pointed out, however, that differential rates of decline are known to exist in other sense modalities. Laidlaw and Hamilton (1937), testing the vibratory sensitivity of 76 points of the body, found that age changes in sensitivity were most pronounced in the caudal half of the body. Similarly, Cooper, Bilash and Zubek (1959) reported that taste sensitivity for sour is less affected by age than that of sweet, bitter and salty.

Although this study indicates that pain sensitivity decreases during old age, it does not give any indications about what factors are primarily responsible for this decline. The data on differential decline for different body areas argue against purely psychological factors, such as attitudinal changes in criteria for pain, because the body area - age group interaction is a within subject effect. On the other hand there are some anatomical changes with which the data of this study could be correlated. Studying the volar skin of the distal segment of the index finger, Ronge (1943) found a decrease with age in the number of Meissner's corpuscles and other receptor end organs. However, since

Ronge's preparations came from only nine subjects, his results must be treated with caution. Cobrin and Gardner (1937) reported a decline with increasing age in the number of myelinated nerve fibres of the peripheral nerves. Their results were confirmed by Cottrell (1940) who reported a reduction in the number of nerve fibres of peripheral nerves beginning around the fourth and fifth decade and becoming more and more pronounced with advancing years. Cottrell also reported the degeneration of myelin sheaths and the accumulation of connective tissue and neuroglia round the nerves. These results would seem to suggest that some of the decreased pain sensitivity in the later years of life may be due to the degenerative changes in the peripheral nerves. Other factors such as circulatory changes, changes in the skin elasticity are probably also involved. Attitudes about pain may change with age and may have contributed to the main effect. Such change, however, could equally likely have depressed the observed decline.

The discovery of significant socio-economic differences in pain sensitivity indicates the importance of controlling socio-economic variables in cross-sectional studies of the skin senses. It also accounts for the fact that some workers (Hardy, Wolff and Goodell, 1943, Birren and Schapiro and Miller, 1950) who did not control this variable, were unable to discover age changes in pain sensitivity. This find-

ing also limits the conclusion about the decline in pain sensitivity after the late 50's to the type of subjects that were employed in this study, namely, skilled and unskilled laborers. Such questions as to whether the decline in pain sensitivity begins at the same age for all socio-economic groups, whether the decline in one social group is as marked as in some other, and whether the differential rate of decline between different body areas is the same for members of different socio-economic classes, can only be solved by future research.

Although the two socio-economic groups were found to differ in pain sensitivity, this study does not give any indications about the factors primarily responsible for this difference. Variations in the type of work done (i.e. manual versus sedentary), producing possible differences in blood circulation and metabolic rate, as well as differences in attitudes to pain are two of many factors which might possibly account for this difference in pain sensitivity. Only systematic research can isolate the responsible factors.

CHAPTER IV

SUMMARY AND CONCLUSIONS

This investigation has been concerned with changes in pain sensitivity with age. Previous research in this area has been confined to unsystematic clinical observations and by-products of experimental research on a different problem. To date no experiment has been carried out which has had as its main objective the investigation of age changes in pain sensitivity.

In this study, 171 white males, ranging in age from 12 to 83 years, all of them from skilled and unskilled labor backgrounds, were used as experimental subjects. Quantitative measurements of the pain threshold, using the Hardy, Wolff and Goodell dolorimeter, were carried out on five body areas, namely, forehead, upper arm, forearm, thigh and leg. In order to appraise the effect of socio-economic status on pain sensitivity, a group of 21 college students and graduates, ranging in age from 17 to 29, was tested in addition to the main experimental group. The pain sensitivity of the college group was compared with that of a section of the main experimental group of the same age range.

It was found that the "over-all" pain sensitivity

remains constant from the teens to the late fifties, but shows a significant decline thereafter. The various body areas were found to differ in the rate of decline and the age at which decline begins. The pain threshold of the college group was found to be much higher than that of the corresponding section of the main experimental group. The limitations of the study were discussed and suggestions were made for further research.

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