appearance of post-traumatic epilepsy. The EEG gives a fairly good picture of the course of the damaged brain towards improvement or cure, or towards epileptic manifestations. In patients with a normal or improving electrogram, it may be fairly strongly affirmed that they will not develop clinical seizures as a consequence of their trauma.

SUMMARY

An attempt to correlate electroencephalographic findings with the development of post-traumatic epilepsy has been made in a series of patients with cerebral trauma. The EEG provides a good indication of the gravity and course of traumatic brain damage. Serial EEG recordings are necessary for a two-year period after head trauma in order to determine the likelihood of post-traumatic epileptic syndrome. The EEG is of especial value in determining which patients will not develop epilepsy as a consequence of their trauma.

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## SENSITIVITY TO PAIN IN THE AGED*

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THE PERCEPTION of pain has been reported as diminished in aged persons[1, 2] but little quantitative data are available, for no study has been made dealing specifically with this aspect. Chapman and Jones[3] tested 200 normal subjects of various races and ages for cutaneous and visceral pain sensitivity, by a modification of the heat-radiation apparatus of Hardy, Wolff and Goodell. Among their findings they reported that pain sensitivity decreased with age. In an analysis of 450 cases studied for sensitivity to pain, utilizing the Libman and Hollander methods, Sherman[4] noted that the age group under 20 had the greatest degree of hypersensitivity (34.3%). The oldest age group (50-80 years) showed in proportion the greatest degree of normalcy, with a comparatively small degree of hypersensitivity (9.4%).

Pain is unique in that many methods of stimulation can evoke it. Various studies on pain sensitivity have been made, employing chemical, electrical, mechanical and thermal stimuli.[5-15] Before 1940, these methods to evaluate cutaneous pain sensitivity were limited principally by technical difficulties of establishing a stimulus which could be controlled and measured, and which allowed a clearly defined end-point of perception.

The cutaneous heat-radiation apparatus developed by Hardy, Wolff and Goodell in 1940[13] overcame these difficulties. This method (involving the exposure of an area of skin to radiant heat) has been shown to answer the requirements stated above for the measurement of pain-producing stimuli, since sensory impulses arising at the end organ in the skin have been shown to be proportional to the thermal gradient and the latter to be proportional to a stimulus of radiant heat. Therefore, the intensity of radiation is proportional to the amount of pain-producing disturbance at the end organ. By this method the pain threshold can be ascertained in milligram calories per second per square centimetre. The pain threshold is established by obtaining a verbal report from the stimulated subject.

Kutscher and Kutscher,[16] in a critical review of the literature on the evaluation of the Hardy-Wolff-Goodell pain threshold apparatus and technique from 1940 to 1957, came to the following conclusion: "With certain broad reservations as to variations in the technique employed, training of subjects, and methods of statistical evaluation, the Hardy-Wolff-Goodell radiant heat-pain threshold apparatus seems well deserving of its established pre-eminent position in the study of the physiology of pain and the pain threshold."

### STUDY AND METHOD

The present study constitutes an attempt to measure and compare pain sensitivity in 200 normal subjects, from the two poles of life, the young and the aged. The young comprised 90 men and women ranging in age from 20 to 30, representing full physiological maturity. The aged consisted of 110 men and women varying in age from 65 to 97. The entire group was constituted of the three ethnic bodies of the Montreal community, namely,

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Anglo-Saxon, French, and Jewish. All the subjects were tested for pain sensitivity by the Hardy-Wolff-Goodell dolorimeter.* To determine an individual's pain sensitivity, we measured two manifestations of the pain experience: (1) the pain-perception threshold, which is a subjective end-point, and (2) the pain-reaction threshold, or the first objective evidence of withdrawal from the pain stimulus.[3, 17]

As previously reported by Hardy, Wolff and Goodell,[13, 18, 19] the stimuli for cutaneous pain consisted of varying intensities of light which were focused on the middle of the subject's forehead by the Hardy-Wolff-Goodell dolorimeter.

The stimulus projector used in the dolorimeter makes use of radiant energy provided by a special 100-watt projection lamp. Energy from this source is focused by means of a mirror and two glass condensing lenses to a point approximately four inches forward of the nosepiece of the projector. The opening in the nosepiece of the projector is 13/16 inch in diameter, and is located at a point sufficiently far inside the focal point of the filament that the energy is essentially uniform over this area.

The voltage applied to the lamp is controlled by two variable transformers. The first of these, in combination with an accurate voltmeter, serves as a voltage regulator to maintain calibration regardless of line voltage fluctuations. The second variable transformer has a dial which is calibrated in millicalories per square centimetre per second, in the plane of the nosepiece of the projector.

Stimulus can be initiated either through a pushbutton on the handle of the projector which comes in contact with the subject's forehead, or by a similarly acting pushbutton on the panel of the control box. Depending on the setting of a selector switch on the panel of the control box, the stimulus which is initiated by depressing the button can be terminated either by means of a built-in electronic timer, which is set for three seconds for each exposure, or by the release of the same pushbutton in cases where a constant stimulus is applied as a function of time. In the latter case, an auxiliary timer is used which indicates the time during which the stimulus was applied.

Calibration of the instrument is carried out by means of an 8-junction copper constantan thermopile which fits the nosepiece of the projector and measures the energy in the same plane in which the skin of the subject would be located. Through the use of the thermopile and an auxiliary millivolt potentiometer, the calibrated scale of the instrument can be adjusted to maintain an accuracy of better than 5 mcal./sec./sq. cm.

In order to prevent the reflection of wave lengths from the forehead, to minimize the penetration of these wave lengths into the skin, and to convert radiant into molecular energy, in which form the heat is conducted through the epidermis to the pain endings,[3] the skin was blackened by india ink before placing the subject's forehead against the aperture of the projector. The cutaneous pain-perception threshold was held to be the smallest amount of heat stimulus from this apparatus sufficient to cause a sharp jabbing sensation. The pain-reaction threshold was determined as the smallest stimulus necessary to cause the subject to wince, that is, a beginning contraction of the eye muscles at the outer canthus.

The conditions under which these two end-points were measured were standardized in the following manner. All tests were made by the same observer. Each subject was tested on two different occasions, at the same time of the day, and in the same relation to meals. Fatigue and nervous tension, in so far as possible, were eliminated; no drugs or stimulants, other than tea or coffee, were taken.

It was explained to the subject that the procedure was not a test of his ability to endure pain, but rather of his capacity to perceive the first trace of pain. The subject's co-operation in concentrating closely on the sensation at the exact end of the exposure was requested. It was pointed out that at first he would experience a sense of warmth, which later would change its character. The subject was then given a first exposure, usually starting at a stimulus of 150 mcal./sec./sq. cm., which resulted only in a mild sensation of warmth. With a 2-minute interval between exposures, the second stimulus, at the level of 200 mcal./sec./sq. cm., was presented on an adjacent spot on the forehead, and the subject again reported his sensation. If no pricking pain was reported, the intensity was increased by steps of 20 mcal./sec./sq. cm., until the subject reported a sharp, jabbing sensation, i.e. the pain-perception threshold. The test was continued, increasing the intensity of the stimuli in the steps mentioned previously, until the patient winced with a contraction of the eye muscles at the outer canthus, i.e. the pain-reaction threshold. The subject was not informed at any time that a reaction point was being sought.

Each test consisted of from 10 to 14 exposures of light, with a 2-minute interval between each exposure, making the total time for each test between 25 and 40 minutes. In order to avoid the error of suggestion, the description of the subject's varying sensations was elicited by three neutral questions, asked after each exposure:

1. What did you feel?
2. How would you describe what you felt?
3. Was this one as intense, less intense, or more intense than the previous one?

At the end of each test, observations were noted as to any detectable modifying factors such as fatigue, nervous tension, or apprehension. The subject was finally asked these questions: Were you nervous or restless during the tests? Are you tired? How much sleep did you have last night?

*This instrument is manufactured by the Williamson Development Company, West Concord, Massachusetts, U.S.A., in accordance with specifications laid down by the originators.

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TABLE I.—MEAN PAIN-PERCEPTION THRESHOLDS FOR YOUNG (20 TO 30 YEARS) AND AGED (65 TO 97 YEARS) MEN AND WOMEN TAKEN FROM THREE ETHNIC GROUPS

| | *Men* | | *Women* | | *Average (men and women)* | |
|---|---|---|---|---|---|---|
| *Race* | *Young* | *Old* | *Young* | *Old* | *Young* | *Old* |
| French | *273.66 ± 7.12† | 329.34 ± 5.94 | 252.66 ± 8.97 | 318.00 ± 8.34 | 263.16 ± 5.83 | 323.66 ± 5.13 |
| Anglo-Saxon | 305.00 ± 6.31 | 334.00 ± 6.79 | 271.00 ± 10.88 | 305.34 ± 6.72 | 288.00 ± 6.60 | 319.66 ± 5.09 |
| Jewish | 261.34 ± 4.71 | 317.34 ± 5.79 | 242.34 ± 6.00 | 329.34 ± 4.68 | 251.88 ± 3.98 | 323.34 ± 3.76 |

*Mean average threshold in millicalories per second per square centimetre.
†Standard deviation of the corresponding mean.

When was your last meal? Have you had any stimulants?

## RESULTS

The results are presented in Tables I, II and III.

When the age factor was considered, a striking and constant difference was noted between young and old. The decrease in pain sensitivity with age was shown in the increased average values of the pain thresholds. This was true for both perception and reaction and for all groups. The differences between the young and old subjects were significant* at a probability level considerably less than 0.001%† for the French and Jewish subjects. The age difference for the Anglo-Saxon group was significant but at probability levels of 0.05% and 0.5% for perception and reaction respectively.

While the average male was found to have higher threshold values, the differences observed between men and women in the six groups were not significant except in the case of the aged Anglo-Saxons for both pain-perception and reaction, and for the young Anglo-Saxons in the case of perception.

Comparisons between the various ethnic groups indicate that the average response for the French and Jewish subjects are of the same magnitude, the differences not being statistically significant. However, the average response of the Anglo-Saxon group is significantly higher than that of the combined response for the French and Jewish subjects. The probability levels for perception and reaction are 0.5% and 5% respectively (Table III). The differences appear to emanate from the fact that in the case of perception (Table I), the average response of the young Anglo-Saxons seems to be considerably higher than that of the combined average for the other two race groups of the same age. In the case of reaction (Table II), this difference is due principally to the fact that the average response for the young Anglo-Saxon women is higher than that of the combined average for the young women of the French and Jewish groups. A definite conclusion cannot be drawn from these findings. Further studies are indicated in this respect.

## CONCLUSIONS

Schumacher *et al.*[20] reported that the cutaneous pain-perception variation in a group of 150 normal subjects was plus-minus 15%. Chapman and Jones[3] noted minus 40 to plus 50% variation from a mean and pointed out that this discrepancy may be due to the difference in the technique used to elicit a description of the pain-perception end-point.

Our findings also indicate the fact that individual differences occur in the threshold of sensory perception. As did Chapman and Jones, we found a relatively smaller deviation within which a given individual's threshold varied, compared with those of the entire group. These investigators attributed

TABLE II.—MEAN PAIN-REACTION THRESHOLDS FOR YOUNG (20 TO 30 YEARS) AND AGED (65 TO 97 YEARS) MEN AND WOMEN TAKEN FROM THREE ETHNIC GROUPS

| | *Men* | | *Women* | | *Average (men and women)* | |
|---|---|---|---|---|---|---|
| *Race* | *Young* | *Old* | *Young* | *Old* | *Young* | *Old* |
| French | *328.00 ± 9.47† | 394.00 ± 10.37 | 296.66 ± 10.12 | 364.34 ± 9.98 | 312.34 ± 7.16 | 379.16 ± 7.39 |
| Anglo-Saxon | 347.66 ± 8.87 | 390.50 ± 8.98 | 323.34 ± 15.48 | 352.00 ± 8.06 | 335.50 ± 7.46 | 371.25 ± 6.48 |
| Jewish | 309.00 ± 6.99 | 381.16 ± 7.03 | 283.00 ± 7.25 | 351.50 ± 6.60 | 296.00 ± 5.27 | 366.58 ± 5.16 |

*Mean average threshold in millicalories per second per square centimetre.
†Standard deviation of the corresponding mean.

TABLE III.—COMPARISON OF CUTANEOUS PAIN-PERCEPTION AND PAIN-REACTION COMBINED AVERAGE THRESHOLDS FOR YOUNG (20 TO 30 YEARS) AND AGED (65 TO 97 YEARS) MEN AND WOMEN TAKEN FROM THREE ETHNIC GROUPS

| | *Perception* | *Reaction* |
|---|---|---|
| *Race* | *Combined average for young and aged* | *Combined average for young and aged* |
| French | *293.41 ± 4.76† | 345.75 ± 5.97 |
| Anglo-Saxon | 303.88 ± 4.40 | 353.38 ± 5.19 |
| Jewish | 287.58 ± 3.87 | 331.29 ± 4.90 |

*Mean average threshold in millicalories per second per square centimetre.
†Standard deviation of the corresponding mean.

*The authors are indebted to Dr. Jacques St. Pierre, Director, Centre of Statistics, Department of Mathematics, University of Montreal, for the statistical analysis of the data.

†When a factor is considered as statistically significant at the p% level, it means that the probability is less than p% that chance alone can account for a value of the order of magnitude observed for the factor.

the differences probably to age and race. Our study indicates that the age factor is responsible for the aforementioned differences in our subjects.

Wolff and Wolff[19] have stated that the ability to perceive pain depends upon the intactness of relatively simple and primitive nerve connections. Reaction to pain, on the other hand, is modified by the highest cognitive functions and depends in part upon what the sensation means to the individual in the light of his past life experience. The pain sensation is often associated with a reaction of anguish or displeasure and, indeed, these strong feeling states may predominate in the pain experience, becoming to the one who suffers the most relevant aspect of pain. Therefore, it becomes clear that while there is a distinction between sensory perception and the feeling state, both formulate fundamental aspects of the pain experience. Chapman and his colleagues,[17] using radiant heat as a stimulus, found that neurotic patients displayed a lower threshold for reaction than normal subjects.

Other investigators, notably Libman,[9] and later Hollander[10] whose investigations were directed towards estimation of the threshold for pain perception, actually tested reactivity. Libman exerted pressure with his thumb upon the styloid process of human subjects and found that prize fighters and American Indians, as groups, failed to react to some noxious stimuli of intensity great enough to induce a reaction of discomfort in the average city dweller.

Hollander's instrument was a rough metal grater incorporated in a sphygmomanometer cuff. He inflated the cuff and noted the pressure at which the patient winced. He also learned that relatively stoical people have a high threshold for reaction to pain. Drugs such as alcohol and morphine which induce in the subject a feeling of freedom from anxiety may raise enormously the threshold for reaction to pain, in addition to their influence on pain perception. Sherman,[4] using the Libman and Hollander methods, reported that patients with organic disease have a higher threshold than those with functional complaints; coal miners and Micmac Indians have a much higher threshold for reaction to pain than other individuals.

It was noted in our findings that the average spread between pain perception and pain reaction was 18%. The changes in pain reaction according to age were parallel to those in pain perception.

SUMMARY

Two hundred normal subjects from the two poles of life, young (20-30 years) and aged (65-97), were tested for cutaneous pain sensitivity by the Hardy-Wolff-Goodell dolorimeter. This group was comprised of three ethnic bodies, namely, Anglo-Saxon, French, and Jewish.

Two end-points were measured for cutaneous pain: a beginning jab sensation for the pain-perception threshold; and the first evidence of wincing, as manifested at the outer canthus of the eye, for the pain-reaction threshold.

Pain sensitivity decreased with age, as manifested by increased average values of the pain threshold in the older group. This finding was constant in the three racial groups studied.

The men showed higher readings than the women, but the differences were not significant except in the case of the older Anglo-Saxon male for both pain perception and reaction, and for the young Anglo-Saxon male for pain perception.

Comparison between the three ethnic bodies indicated that the average responses for the French and Jewish subjects were of the same magnitude. The average response of the Anglo-Saxon group was significantly higher than that of the combined response of the French and Jewish subjects. No definite conclusion can be drawn from these findings. Further studies would be warranted in this respect.

The findings showed relatively smaller deviation within which a given individual's pain perception and reaction threshold values varied, compared with those of the entire group. Our study indicates that the age factor is responsible for these differences.

While there is a distinction between sensory perception and reaction, both formulate fundamental aspects of the pain experience.

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## INTERNATIONAL CONFERENCE ON CELL RESEARCH

Some 90 cell researchers from a large number of countries met in Stockholm in September for a conference arranged by two UNESCO-affiliated organizations, the International Union of Biochemistry and the International Union of Biological Sciences. The meeting was held at the Wenner-Gren Institute, with the Swedish financier Dr. Axel Wenner-Gren as Patron of Honour. About 50 scientific lectures were held during the conference, the main theme of which was "biological structure and function". While of a purely basic research character, the lectures also had a bearing on topical medical questions and dealt with chemical, physical and medico-biological investigations into the build-up of albumins under normal and pathological conditions.—The Swedish-International Press Bureau, Stockholm.