medium. The subsequent determination is carried out as described by Atkin, Schultz and Frey.[9]

Micro analyses[9] and analyses by this technique are in good agreement, Table IV. Novocain and adrenalin

TABLE IV

COMPARISON OF MICRO (8) AND SUBMICRO TECHNIQUES OF THIAMIN ANALYSIS. THIAMIN EXPRESSED AS MICROGRAMS PER GRAM TISSUE*

Cat	Date	Condition	Muscle thiamin	
			Micro analysis	Submicro analysis
Old white number 1	5/15	Normal	0.4	
		Heart 1.8, liver 2.3, kidney 2.2, Brain 1.4	0.4	..
			0.4	
Old gray number 2	6/22	Normal	..	0.5
				0.5
Old gray number 2	7/31	3 weeks semi-starvation, moderately deficient diet. Heart 1.0, liver 2.0, kidney 1.7, Brain 1.2	0.3	0.4
				0.4
			0.3	0.3
Young black number 3	6/23	Normal	..	0.7
				0.7
				0.8
Young black number 3	7/13	2 weeks semi-starvation, moderately deficient diet	0.3	0.3
			0.3	0.4
			0.3	0.3
			0.3	0.3
				0.3
				0.3
Young black number 3	7/23	3½ weeks semi-starvation, moderately deficient diet	0.22	0.27
			0.23	0.27
			0.22	0.25
			0.23	0.26
				0.25
				0.26
Young black number 3	7/27	2 days after subcutaneous injection of 2 mg. of thiamin	0.96	1.20
			0.99	1.15
			1.08	1.20
			1.08	1.10
				1.18

* For micro analyses 1 to 2 grams of skeletal muscle were removed surgically under nembutal anesthesia; for submicro analyses 5 to 15 milligrams of muscle were removed with the Silverman needle.

used in skin anesthesia do not interfere with measurements by the yeast fermentation method. When the muscle is abnormal, aliquots of suspension may be used for micro nitrogen or phosphorus determinations[10] and the thiamin concentration expressed in micrograms per milligram of muscle nitrogen or phosphorus.

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VARIABILITY IN THE PAIN THRESHOLD

HARDY, Wolff, Goodell and Schumacher have reported an unusual series of observations on the absolute pain threshold in man. Using radiant heat as a stimulus, they found only slight variability in pain thresholds, either for repeated measurements made upon the same person,[1] or for measurements made upon different subjects.[2] Furthermore, this threshold pain was said to be so uniform in quality that it was easily recognized even by untrained subjects. These authors attribute the commonly observed differences in pain sensitivity to conditions governing "reaction" to pain, rather than to fundamental differences in perceptual sensitivity as such.

In order to test the generality of the conclusion that pain thresholds are uniform, the writer has used electric current in a series of pain threshold measurements made upon 15 college women. An electronic device of the type recently described by Fender[3] supplied the current. This instrument produces condenser discharges which are amplified and delivered through resistance of such high order that variations in the subject's skin resistance have little effect upon the current flowing in the stimulus circuit. An A.C. microammeter measures this current directly. Current strength may be varied continuously by changing the resistances in series with the subject. The electrodes consisted of a silver disc 17 mm in diameter and a rounded silver wire 1 mm in diameter, embedded 8 mm apart in a piece of bakelite.

Threshold determinations were made on four skin areas, two each on the dorsal surface of the left forearm and on the forehead, in the following order: arm, head, head, arm. The "method of minimal changes" was used, with two "ascending" and two "descending" series for each spot. On a second day the experiment was repeated with 14 of the 15 subjects.

The mean of 240 threshold determinations made on the first day—irrespective of subject or of skin area—was 15.96 microamperes. The range of the thresholds was from 2.25 to 65 microamperes, while the standard deviation was 8.78 microamperes. If these variability indices are converted into relative units, the range represents a variation about the mean of approximately −80 to +300 per cent., while the standard deviation is ± 55 per cent. of the mean. The repetition of the experiment yielded slightly higher figures for the mean and standard deviation (18.18 ± 10.14), but the relative variability remained almost unchanged (S.D./Mean = 56 per cent.).

The variability of these pain threshold measurements is markedly greater than that reported by Hardy and his collaborators for thermal stimuli. Their standard deviation represented a variation

[10] Nessler and Kuttner-Lichtenstein techniques modified (see O. Schales, R. V. Ebert and E. A. Stead, Jr., *Proc. Soc. Exp. Biol. and Med.*, 49: 1, 1942; T. D. Fontaine, *Jour. Indust. and Eng. Chem.* (*Anal. ed.*), 14: 77, 1942) and adapted to Coleman spectrophotometer.

[1] J. D. Hardy, H. G. Wolff and H. Goodell, *Jour. Clin. Invest.*, 19: 649, July, 1940.

[2] G. A. Schumacher, H. Goodell, J. D. Hardy and H. G. Wolff, SCIENCE, n. s., 92: 110, August 2, 1940.

[3] F. A. Fender, SCIENCE, n. s., 89: 491, May 26, 1939.

about the mean of ±1 per cent., whereas the corresponding coefficients of variation in our two sets of measurements were greater than 50 per cent. But their frequency distribution was based upon averages of all threshold determinations for each subject, and such values would normally show less variation than a distribution of single threshold measurements. Similar average thresholds have been computed from our data, and means, standard deviations, and coefficients of relative variability have been determined. For the first day's averages, these three measures were as follows, in microampere units: mean, 16.06; standard deviation, 7.86; S.D./Mean, 49 per cent. Corresponding values for the second day were: mean, 18.0; standard deviation, 8.12; S.D./Mean, 45 per cent. These indices of relative variability are somewhat lower than those for the single measurements, but they are still almost fifty times as great as the value reported for thermal stimulation.

These results show definitely that pain thresholds for this form of electrical stimulation are not uniform or constant in different individuals. A further question arises as to the constancy of sensitivity in the same individual. Does the subject with a low threshold for one series of measurements continue to exhibit the same level of sensitivity in subsequent tests in the same area, in different areas, or on different days? In order to test the reliability of these thresholds, rank-difference correlation coefficients have been computed between several series of measurements. First, the averages of all thresholds for one day were correlated with those for the second day, and the coefficient was .55. This represents a moderately high degree of correlation, but it is far too low for accurate prediction of an individual's standing from one day to the next. It should be noted, however, that one half of the subjects had almost identical ranks on the two days, while the other half exhibited the variability which lowered the correlation.

The consistency of the two sets of threshold measurements made upon the same spot was next determined. The correlations were high between the averages of each of these two series, for all four of the spots tested on the first day. The coefficients were .86, .91, .89 and .94, for arm, head, head, arm, respectively. But the correlations between average thresholds for different spots in the same body area were much lower, varying from .32 to .44. Finally, averages of all threshold determinations made for the arm on a given day were correlated with corresponding averages for the forehead. The correlations of two sets of such values, secured on the two days, were exactly the same, the coefficient in each case being .60.

It is clear from these correlations that the electrical pain threshold of an individual may vary considerably from day to day, and from one skin area to another. Certain subjects are relatively stable, while others fluctuate over a wide threshold range. Further study of the conditions of such individual variability is needed.

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THE EFFECT OF SODIUM BICARBONATE ON THE THIAMINE CONTENT OF PEAS[1]

IT is generally believed by nutritionists that cooking with sodium bicarbonate results in the destruction of a large proportion of the thiamine content of foods. In order to obtain definite data on this subject, the experiments recorded in Table 1 were carried out with fresh and frozen peas.

TABLE 1*

Type of peas and method of cooking	No. of tests	Time of cooking	pH of water after cooking	Thiamine in gamma		
				Per 100 gm peas	In total cooking water	Total
		min.				
Frozen-Type I†						
Raw	3					408
Water-cooked	3	6	7.66	326	90	416
Sodium bicarbonate-cooked	3	4	8.77	330	44	374
Frozen-Type II†						
Raw	1					351
Water-cooked	1	6		238	102	340
Sodium bicarbonate-cooked	1	4	8.70	193	25	218
Fresh						
Raw	4					333
Water-cooked	4	17	7.29	257	78	336
Sodium bicarbonate-cooked	4	8	8.84	258	63	321

* In all tests 85 gms of peas were cooked with 180 cc of water. In sodium bicarbonate tests 0.22 gm of sodium bicarbonate was added.
† Type I represents a brand of peas prepared by tunnel freezing; Type II, plate freezing.

The average time necessary to complete the cooking of the peas was determined in separate tests where it was found that sodium bicarbonate greatly reduces the time of cooking. Thiamine was determined by a modification of the fermentation procedure of Schultz, Aiken and Frey.[2] The applicability of the above method of biochemical determination was confirmed by bioassay of dried ground water-cooked and sodium bicarbonate-cooked peas by the method of Kline, Hall and Morgan.[3]

The greater loss in thiamine found in Type II of the frozen peas is probably to be ascribed to the partial mashing of the peas by this method of freezing.

[1] This investigation was aided by a research grant from the Church and Dwight Company, Inc.

[2] A. S. Schultz, L. Aiken and C. N. Frey, *Ind. Eng. Chem., Anal. Ed.*, 14: 35, 1942.

[3] O. L. Kline, W. L. Hall and J. F. Morgan, *Jour. Asn. Off. Agr. Chem.*, 24: 147, 1941.