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THE UNIT OF LABOR

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In the following pages we propose to discuss whether it is possible to reduce different persons' labor-power to common units. An objection may be raised to such an attempt on the ground that the concept of these common units of labor-power has no practical utility, for it is impossible to measure the quality and quantity of a person's labor. Indeed it ought to be frankly admitted that the labor-unit has no practical significance. But it may have a great theoretical utility in that the concept may enable us to clarify our ideas in regard to such fundamental concepts of economics as wages, labor-power, etc. The usefulness of chemistry has been increased by the concept of atoms and atomic weight, although we have as yet been unable to capture atoms under a microscope. The introduction of the use of the C. G. S. units has simplified the problems of physics to some extent, while dietetics has gained by the use of the concept of calories, although the latter concept has little significance except for trained physiological chemists.

At any rate, the introduction of the concept of labor-units in economic discussion is not an innovation. In his *Theory of Political Economy*, Jevons defines "amount of labor" as "a quantity of

two dimensions, the product of intensity and time when the intensity is uniform, or the sum represented by the area of a curve when the intensity is variable." He conceives of labor being applied in successive increments until the utility of the last increment of commodity produced is equal to the pain caused by the application of the last increment of labor[2]. In his *Mathematical Investigations in the Theory of Value and Prices*, Professor Fisher suggests the possibility of taking certain kinds of manual labor as a standard of value[3]. He also points out elsewhere that there are ways in which labor may be evaluated[4].

While, however, only a few suggestions have been made by economists on the possibility of measuring labor-power, psychologists have long been at work to measure the effect of labor on the human system. In this branch of their research they have employed two methods: viz., the measurement of fatigue and the measurement of changes in the temperature of the brain. The first

1. 3rd ed., p. 170.
2. *Ibid*, p. 172 ff.
3. p. 87.
4. *The Nature of Capital and Income*, p. 172.

method, on which Professor Mosso[1] has made great contributions, is used for measuring the fatigue of muscles and also for measuring the fatigue of the brain through the measurement of the fatigue of the muscles[2] or by testing the power of accurate work[3]. This method of ascertaining the effect of labor upon the human system by measuring fatigue is useful for the purpose of comparing the effect of some kinds of labor that are predominatingly muscular with the effect of others of similar nature, or for the purpose of comparing the effect of those that are almost wholly mental with the effects of others of the same character. For the great mass of human activities, however, in which the brain and the muscle both play an important part, this method is not so desirable, for the effect of muscular work would tend to vitiate the test on the effect of mental work. Moreover, the fatigue of muscles and the fatigue of the brain as revealed through the fatigue of muscles cannot be compared on the same basis, for the wrok of the brain has a higher marginal utility, generally speaking, than the work of muscles. Nor can the fatigue of the brain as expressed in the degree of capacity of accurate mental work serve always as an index of the effect of labor, because such standard tests of accuracy as dicta-

1. See *La Fatica;* its English translation, under the title of *Fatigue*, by Margaret Drummoud and W. B. Drummond.
2. See *Fatica*, p. 280.
3. See A. Binet and V. Henri, *La Fatigue intellectuelle*, Pt. II.

tion and calculation cannot be applied to all persons and the results of these tests, even when successful, will have to be expressed in some common units. Such common units are supplied by the second method, i. e., that of measuring changes in the temperature of the brain, which has the additional advantage of getting at the result of labor directly.

It is a well-known fact that all "mental" and "physical" exertions involve chemical changes in the organs or muscles affected by the exertions and a production of heat in them[1]. It is also known that the work of the brain increases its temperature more than the temperature of the other parts of the body[2], and sometimes even tends to lower the latter[3]. On the other hand, muscular work *per se* has little effect on the temperature of the brain[4]. But it should be of course remembered that there is no activity of any organ or muscle of the body which does not, either directly

1. Angelo Mosso, "Phenomenes psychiques et la temperature du cerveau," Philosophical Transactions of Royal Society, 1892, p. 2991; A. Binet and V. Henri, *La Fatigue intellectuelle*, p. 144.
2. See *Ibid.*, Part III, Chap. 30.
3. Huxley, *Lessons in Elementary Physiology*, 1904, p. 92.
4. See J. S. Lombard, *Experements on Effects of Voluntary Muscular Contractions on the Temperature of the Head*, p. 44; also cf. R. W. Amidon, *The Effect of Willed Muscular Movements of the Temperature of the Head: New Study of Cerebral Cortical Localization.*

or indirectly, affect the brain and give rise to changes in the latter's temperature[1].

We are also told that so-called intellectual activities affect the temperature of the brain more than those activities in which the intellectual element is not preponderating[2] and that the degree in which the temperature of the brain is raised is proportional to the difficulty and intensity as well as the duration of work. In this connection we may summarize Dr. J. S. Lombard's experiments on a certain subject as follows[3]:

RISES IN THE TEMPERATURE OF THE HEAD AT THE END OF 60 MINUTES AS THE RESULTS OF VARIOUS TESTS.

Work performed	Rises in temperature (Centigrade) in the three regions of the head		
	Anterior	Middle	Posterior
1. Mathematical calculations of considerable difficulty performed rather slowly.	.025	.023	.020
2. Arithmetical computations performed as rapidly as possible.	.034	.030	.024
3. Making notes of subjects requiring considerable reflection.	.022	.018	.0174
4. Writing ideas which were difficult of expression.	.036	.031	.055

1. Cf. *La Fatigue intellectuelle*, p. 144.
2. See Angelo Moss, *Fatigue*, p. 67, also *La Fatigue intellectueile*, pp. 141-4.
3. J. S. Lombard, *Experimental Researches on the Regional Temperature of the Head*, pp. 125-131.

In the above table we notice that the results of the four tests on the three regions of the head are singularly similar. If we take the figures for the anterior region as the base and compute the corresponding figures for the other regions in percentages, we obtain the following result :

Test	Anterior	Middle	Posterior
1st	100	92	80
2nd	100	88	71
3rd	100	82	79
4th	100	86	71

In every case the figure for the middle region is smaller than that for the anterior and the figure for the posterior region is in turn smaller than that for the middle. If the figures for the fourth test, which are larger than any other test, are taken as 100 and the figures for the other tests are computated as their percentages, the following result is obtained :

Test	Anterior	Middle	Posterior.
4th	100	100	100
2nd	94	97	94
1st	69	74	78
3rd	61	58	68

It will be seen in the above table that the results of the various tests for each region, when arranged in a desending or ascending series, fall exactly in the same order. Thus we may conclude that the tests of Dr. Lombard were fairly accurate and trustworthy. We also notice the fact that there is a strikingly close correspondence between the order of the various increases in cerebral temperature and the order of the intensities of mental application involved in the several tests. The fourth test which caused a rise in the temperature of the head by 0.036° C in one hour was that of writing down "ideas which were difficult of expression." The second test which raised the temperature by 0.034° C was that of rapid arithmetical computation. In the first test, which involved a rise of 0.025° C, the subject was required to make calculations of considerable difficulty slowly. The third test, which had the least effect on the temperature of the head and raised it only by 0.022° C involved making notes of subjects requiring considerable reflection. It is interesting to notice that this is what we should naturally expect from our daily experience. The mere process of leisurely thinking and putting down concepts as they form in the mind, involves less fatigue than calculations. It is also a common observation that rapid computation, involved in the second test, causes greater fatigue than slow computation, as in the first test. On the other hand, it is not at all surprising that the writing down of "ideas which were difficult of expression," which involves the

exercise of imaginative, associative and creative faculties, should cause a greater rise in the cerebral temperature than the comparatively simple mental process of computation.

Dr. Lombard also gives the results of his experiments testing the effect of an activity of emotional nature upon the temperature of the brain. The test used was that of reading poetry aloud, not mechanically but in an appreciative mood. These results may be summarized as follows[1]:

RISE IN THE TEMPERATURE OF THE HEAD AFTER 30 MINUTES OF READING POETRY

Anterior	Middle	Posterior
.04 C	.0392 C	.035 C

For the sake of comparison between the results of the intellectual and emotional tests, we may take the figure of the fourth test for the anterior region, which is the largest for the intellectual tests, and the figure of the emotional test for the same region. The figure for the former is, however, for one hour and the latter for thirty minutes. They should first be reduced to a common basis. The author gives the rise of the temperature of the anterior region by the fourth intellectual

1. *Experimental Researches on the Regional Temperature of the Head*, pp. 176-7.

test as 0.0246° C at the end of 25 minutes and 0.028° C at the end of 35 minutes. If we take the mean of these two figures, assuming that the rise of the temperature was uniform between the 25th and 35th minutes, the rise of the temperature of the anterior region by the fourth test at the end of 30 minutes will be 0.0263° C. Comparing this figure with 0.04° C, which is the rise of the temperature of the anterior region by the emotional test at the end of 30 minutes, we find that the rise of temperature in the latter case is more than 52% greater than in the former case. This is also in accordance with our observation that emotional activities cause greater fatigue than the intellectual.

It should of course be frankly admitted that these experiments are too few in number and were made for too short periods to form any conclusion upon. They at least prove, however, that the greater the intensity of mental exertions the greater the fatigue and the increase in the temperature of the brain. On the other hand, we know that all those exertions which are commonly called physical labor are, fundamentally speaking, psychic and may be expressed in terms of mental exertions.[1] If, however, all mental exertions, including what are popularly called mental and also

1. Angelo Mosso, *Fatigue*, p. 243.

physical labor, give rise to increases in the cerebral temperature in proportion to their respective intensities, we have here a certain common basis upon which we may compare all exertions of men. Remembering also that, generally speaking, the greater the mental exertions of an employee the larger the wages he receives, we may regard the wages of different persons as payments for their mental exertions in proportion to their intensity. For the purpose of comparison of different wages, therefore, a certain degree of the intensity of mental exertions may be taken as the unit of such exertions, or, what amounts to the same thing, as the unit of labor. As such unit of labor we may take a certain amount of exertion which is sufficient to raise the temperature of the anterior region of the head by a certain fraction of one degree Centigrade or to produce in the head as much heat as one calorie or its fraction represents in a given period of time.

It should of course be noted that there are a number of circumstances which tend to weaken the validity of this concept of unit of labor. In the first place, as has already been pointed out, the experiments on which the concept is more or less based are too few in number to draw any definite conclusion from. Another weekness is that these few experiments were performed on a single subject and, therfore, their results may by no means be taken as final. Individual differences in the reaction to various stimuli also tend to make the results less valuable for any broad generalization.

There are still two other important objections. In the first place, it is more or less dangerous to rely entirely on the heat of the brain for the determination of the degree of fatigue. It might be asked whether in some individuals the fatigue of muscles does not constitute a better index of the intensity and magnitude of exertions than the fatigue of the brain. The second objection is that, since man's activities have become very much specialized, there is some doubt as to the possibility of reducing all kinds of exertions to one common basis.

While admitting the strength of these objections, however, the above concept of unit of labor has been given, in the first place, on account of the belief that such concept is undoubtedly useful in the study of the problem of wages, and, in the second place, in the hope that the above concept may serve as the starting point for a discussion of the possibility of such unit of labor, or at least give a needed hint for such discussion.
