

# **THE DIURNAL COURSE OF EFFICIENCY**

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The Diurnal Course of Efficiency by Howard D. Marsh

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**HOWARD D. MARSH**

**THE DIURNAL  
COURSE OF  
EFFICIENCY**



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EFFICIENCY

BY

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A.B., 1901, AND A.M., 1902, OHIO WESLEYAN UNIVERSITY.

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# THE DIURNAL COURSE OF EFFICIENCY

## A. INTRODUCTION

RECURRENCE of phenomena is the source of all scientific knowledge. Rhythmic recurrence in nature is well known; for physics, it is perhaps the most general and fundamental characteristic, underlying the theories of the mechanics of motion, sound, heat, light and electricity. The student of astronomy finds the movements of heavenly bodies marked by like repetition. It appears in biology in a less regular way in the growth changes of vegetable and animal bodies and in a more general way in the successive generation of species; while evolution as a whole is rather completely expressed in alternation of integration and disintegration. Social life, in all its historic aspects, gives evidence of epochal development, and some sociologists have gone so far as to make repetition (as imitation, etc.) the warp of the whole social fabric.<sup>1</sup> Nearer the point of the present research are particular seasonal changes in individual life—yearly, quarterly, monthly, weekly, daily—of whose existence we have hints in various anthropological, physiological and pathological data, more or less closely connected with the sexual, religious and emotional life.<sup>2</sup>

This paper deals only with the question whether there are normally recurring variations of ability at different periods of the day. The discussion of this question is not to be found in general works on psychology, however modern, but in sundry monographs and journal articles appearing in the last fifteen years. This means that the more conservative psychologists are not yet ready to accept such recurrence as a fact. But the investigators themselves seem to consider it quite confirmed, despite the disagreements of their results when intercompared.

Part of this assurance may be due to ignorance of what others have found. The good side of this is that experimentation under such conditions has less tendency to bias, to which workers in individual psychology are perhaps more exposed than are those in other parts of the experimental field. We want not only the subjective

<sup>1</sup> For complete theory, see G. Tarde's *Laws of Imitation* and other social writings.

<sup>2</sup> Of course there is no doubt about the monthly rhythm in females. For other suggested ones, see H. Ellis, *The Psych. of Sex*, 2. 1902.



satisfaction, but also the objective recognition, of having obtained results with a definite pointing—which 'show something'. But that this should be exhibited from the negative side seems often as objectionable to the searcher as discovery of no 'general tendency'.

The writer aims to present all the important work hitherto published, having direct bearing on the problem. On account of the scope of the latter, no collection of this material at any one point is attempted, but it is introduced where most pertinent. The greatest lack in all this work lies in two things—inextensiveness of the experimental series and omission of quantitative expression of the reliability of the results.

It is easy to account for the first of these deficiencies when one remembers the nature of the problem, affecting as it does the whole duration of the day. This makes it hard indeed to secure persons to act as subjects. If the tests are short, they must be repeated on a great number of days, in which case the various conditions must be so much the longer controlled; if they are individually more extended and adequate, they demand most of the subjects' time for the days on which they are taken, and in this case accidental disturbances are more costly. Therefore the investigator is inclined to reduce either the number of days, the number of periods per day, the number of trials per period or the number of subjects tested.

This being true, the second lack mentioned is easily explained. The neglect to calculate the averages obtained—a very serious omission when differences are small and results not always harmonious—arises partly from the feeling that the material at hand is too meager to justify the calculus of probabilities. An additional difficulty is that in a series of tests day after day the curve of diurnal variation is complicated with the curve of progressive improvement due to practise. This makes it especially hard to calculate the reliability of the averages for the different hours of the day. And even the mere labor of the tests and computations is a deterrent; for it is clear that if 500 trials are thought necessary to establish a reliable measure of any function, ten times that many and ten times the calculations will be required to establish it for ten periods of the day. Other minor deterrents might be enumerated that operate in certain cases.

One other occasion for criticism of the works referred to is found in the fact that the tests for the different parts of the day have not always been made on the same day. Such procedure implies the belief that the absolute ability one exhibits on one day is the same as he would manifest at the same hour the next day or any subsequent one: it takes no account of accidental influences, practise

effects and other inherent factors of change. To keep clear of these errors, the tests for the different hours of the day should be made on the same days.

My own work is not free from the first of these criticisms, but avoids the remaining two.

In addition to presenting the work of others, the author, by a great variety of extended tests upon himself, has been able to establish definitely the course of diurnal changes for one normal subject. Six male graduate students, one female graduate, and a group of sixteen female undergraduates were likewise employed for both motor and mental tests, and the measurement of the hourly product of 22 female factory operatives contributed additional data. The tabulation of human deaths for time of day; the results of school examinations and recitation marks for different diurnal periods; the best times of day for athletic performance and for intellectual composition; in short, as wide a class of pertinent matter as could be secured has been applied to the solution of the question of diurnal changes of efficiency.

In the experimental portion of the present work, much use has been made of tests variously employed by others. The aim has been to get such variety as the practical limitations of application would allow. It is not thought that together they give a measure of 'general intelligence' or 'general motor power'. These themselves have rather a precarious existence since analytical psychology has taken an experimental turn. Our activities are recognized as much more complex than they seem, and tests of them, on the basis of simplicity, may not be productive of the most valuable knowledge. Especially is this true of adults, to whom my own tests were chiefly confined. Still it is true that legitimate and interesting results have been reached in the past and that accruing experience must make future efforts more fruitful. As the total outcome of his research, the author is not prepared to 'say the last word' about diurnal rhythms, but hopes that something worth while has been attained.

Acknowledgments are due to Professor Cattell for the original proposal of the problem and for other suggestions; to Professors Thorndike, Woodworth and Meylan, of Columbia University, for assistance of various kinds; to those who acted as subjects at much personal inconvenience; to certain officers and employees of the manufacturing firms of Dennison and Sons, J. English and Sons and the Trow Directory Company, of New York City, for courtesies extended during observational work in their respective factories; to Dr. Guilfooy, registrar of the City Health Department; and to other individuals who contributed in different ways.

## B. THE COURSE OF PSYCHOPHYSIOLOGICAL EFFICIENCY

### I. VITAL ACTIVITIES

ANY strict line of demarcation between so-called physical and mental life does not exist in reality and is maintained primarily for convenience in dealing with the complex phenomena of life. For the data to be presented in this section the term psychophysiological seems best, since from the physical side only the functional aspect is dealt with. What will be called 'vital' activities are on the mental side directly concerned with emotion; 'sensory', with cognition; and 'motor,' with volition, as the words are commonly accepted. The idea is not to support a three-faculty psychology nor to stand sponsor for a rigid meaning of the terms employed. But a more systematic presentation of the subject can be given by adherence to the order named.

Considering the length of time that medicine has been studied, or even that physiology has been a separate science, one would expect to find the matter of physiological rhythms fully discussed. However, the text-books here are as barren as those in psychology with respect to the general problem. The first and only systematic collection of results was published by Vierordt in 1888<sup>1</sup>. The actual work was done by various medical men between 1840 and 1880, and much of it must be considered unreliable, particularly where the conditions of experimentation or observation are not stated. Only such figures as seem most trustworthy will be quoted.

#### 1. *Secretion, Urination, Evaporation*

Vierordt's results here have no value in themselves without fuller information as to number of subjects and their habits of life, their age, sex, health, etc., together with the length and method of experimentation. The following are less deficient in these respects.

#### 2. *Circulation, Respiration, Temperature*

1. *Circulation.*—The most commonly accepted view with regard to pulse rate is that the maximum occurs in early morning, followed by a steady decline till after midnight, broken only by the temporary

<sup>1</sup> *Daten und Tabellen.* 1888.