FEELING-TONE IN INDUSTRY

(*A Report to the Industrial Fatigue Research Board.*)

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I. THE 'FEELINGS OF FATIGUE'

AT an early stage in the investigation of 'fatigue' it became clear that the 'feelings of fatigue' were not reliable criteria of the 'capacity to work.' Rivers states this conclusion in the following words: "In the performance of mental work especially, decided sensations of fatigue may be experienced when the objective record shows that increasing and not decreasing amounts of work are being done; and there may be complete absence of any sensations of fatigue when the objective record shows that the work is falling off in quantity, or in quality, or in both¹." And Thorndike writes: "Kraepelin has emphasised this fact [that the feelings of fatigue are not measures of mental ability] but chiefly in connexion with the claim that we can be mentally fatigued without feeling so. What I wish to emphasise is that we can *feel* mentally fatigued *without being so*²."

In dealing with the data the general character of which has been expressed in the above quotations, the factors actually correlated have been *output* and 'feelings of fatigue.' The output, however, has always been *experimentally obtained*, and under conditions of *maximal effort* on the part of the subject; and in such experimental conditions it has usually been regarded as the best attainable measure of 'fatigue.' But 'fatigue' investigations have been chiefly concerned with the attempt to find a *test* of 'fatigue.' Consequently—since (1) output was accepted

¹ *The Influence of Alcohol and other Drugs on Fatigue*, 2.

² *Psychol. Rev.*, 1900, VII, 481.

as a measure of 'fatigue' and (2) output and 'feelings of fatigue' could not be correlated by any straightforward formula—'feelings of fatigue' were altogether abandoned as a possible 'fatigue' *test*. And, largely because of the preoccupation of 'fatigue' investigations with the question of a 'fatigue' *test*, the 'feelings of fatigue' have come to be almost entirely disregarded, not only in 'fatigue' *test* investigations, but also in the investigation of the characteristics of normal working activity; and their exclusion from these investigations has appeared the more final in view of the failure of physiological psychology up to the present to arrive at a plausible conception of the physiological concomitants of 'feeling.'

So far as the question of a 'fatigue' *test* is concerned, this position doubtless is final, because of general considerations affecting the question as well as the special relation of the 'feelings of fatigue' to output. But from the point of view of understanding what happens in much of the normal work of the world, these feelings seem far from negligible. They might indeed be regarded as negligible if their correlation with output were *nil*, and many statements could be quoted which appear to be based upon this assumption. But though what might be called the paradoxes of activity feelings are striking, it would be false to say that 'feelings of fatigue' bear *no* relation to activity or to output. If the 'feelings of fatigue' were to be used as a *test* of 'fatigue,' the coefficient of correlation between the two factors ('fatigue' and 'feelings of fatigue') would need to be approximately +1; but to say that these feelings cannot be used as a 'fatigue' *test* is not to imply that the correlation between the two factors is approximately .00. And, in fact, if 'fatigue' be measured indirectly by reference to output, this correlation would certainly be considerable¹, as common experience shows, and as is obvious from the

¹ Cf. T. Arai, *Mental Fatigue*, 114: "we conclude that the feeling of fatigue is somewhat, though far from perfectly, correlated with the state of mental inefficiency." It was found, for instance, that in memorising German equivalents of English words the average time taken per word when the subject (the writer herself) felt 'good' was 15.7'' (A.D.=4.1''), when she felt 'medium' it was 16.9'' (A.D.=3.5''), and when she felt 'tired' 18.8'' (A.D.=5.37''). In mental multiplication of a 3-place by a 3-place number the time taken per example when the subject felt 'good' was 138.8'' (A.D.=30.6''), when she felt 'medium' 142.9'' (A.D.=20.6''), and when she felt 'tired' 151.3'' (A.D.=28.8''). Of nine adult subjects who did two hours of mental multiplication, five felt 'medium' at the end of the period and four felt 'tired.' Both before and after this two hours of work nonsense syllables were memorised. For the five who felt 'medium' after work "the average ratio which the average number of nonsense syllables remembered *after* is to that *before*" is 101.2 (A.D.=3.1), while for the four who felt 'tired' it is only 80.6 (A.D.=14.9). In this case correlating change of feeling for the worse with decreased efficiency at the end of the work period gave a coefficient of +.99. Finally, for twelve adult subjects, decrease of efficiency in mental

data given below. This being so, there are possibly many characteristics of normal human 'work' that find their explanation in human *feelings*. For instance, any fall in normal industrial output curves may be very largely due, in a sense to be explained below, to the painful feeling-tone of 'fatigue' feelings. The data now to be presented bear upon this point.

II. EXPERIMENTAL DATA.

The question concerned in obtaining the data given here was whether the 'fatigue' feelings of a group of workers vary in any characteristic way throughout a day's work. That they would do so might seem to be obvious, but it is by no means obvious just what variations they would show. Attempts were therefore made to obtain records of their 'feelings' from two groups of workers at regular intervals during each of several days. The 'feelings' concerned were what would be regarded generally as 'feelings of fatigue.' No attempt was made to analyse them minutely. The subjects were asked merely to state whether or not they were experiencing certain degrees of 'fatigue' feelings at certain periods throughout the day.

A. Data obtained from a group of twenty women medical students.

In the carrying out of an experiment dealing with the relation of certain mental tests to mental 'fatigue¹,' a group of twenty women medical students² was given three tests (lasting altogether about four minutes) once an hour; the first test period on any day being at 10 a.m. and the last at 5 p.m. Thus, there were 8 test periods in a day, any two separated by approximately an hour; and in the intervals between the test periods (and also for an hour before the first) the subjects carried on their regular academic work—attendance at lectures, demonstrations,

multiplication (as a result of two hours work) was correlated with fatigue feelings and yielded a coefficient of + .37 (*ibid.* 72-79).

G. E. Phillips, also (*Mental Fatigue*, 65-66) presents data bearing upon this point. He classified fatigue feelings as 'Not tired at all,' 'Slightly tired,' 'Fairly tired,' 'Tired,' and 'Very tired,' and correlated these feelings with depreciation in multiplication and cancellation tests during ninety minutes of continuous work with these tests. The correlation coefficient between feeling tired and depreciation in multiplication in these conditions was .42 (p.e. = .086), though between feeling tired and cancellation it was not significant. The subjects were 35 boys between the ages of 11½ and 13½. These subjects however were working at maximal effort and were doing their best to disregard fatigue feelings—which indeed was also true of Arai's subjects.

¹ See *This Journal*, 1920, x, 327-344.

² These students were taking the medical courses at the London Royal Free Hospital School of Medicine for Women.

etc. The experiment lasted for 5 days. The work in this case was exclusively 'mental,' and the question here to be considered was whether the 'fatigue' feelings varied in any characteristic way during a day of such work. The subjects were therefore required, before starting the tests at each test period, to record in writing on the cover of the test leaflets their feelings of relative 'fitness.' The printed instructions were:

Underline the word or words best corresponding to your feelings.

Fit.

Fairly Fit.

A Little Tired.

Very Tired.

The subjects (who were very trustworthy) were of course instructed to make their records as exact as they could, and it is fairly certain that they did. It was part of the plan of the experiment that none of the subjects was to discuss it or anything connected with it with anyone while it lasted. As regards the 'feelings of fatigue,' therefore, no subject knew what any other subject had recorded while the experiment was in progress.

In order to be able to compare these feelings at different times of the day, numerical values were arbitrarily assigned to each of the four degrees of felt fitness recorded. 'Fit' was given the value 4, 'Fairly Fit' the value 3, 'A little Tired' the value 2, and 'Very Tired' the value 1. The 'fatigue' feelings of the whole 20 subjects at any test period could thus be expressed numerically.

The question of course arises how far the ratio of the numbers 4, 3, 2 and 1 expresses the relations between the four degrees of 'fatigue' feelings; but to answer this question one would require a 'hedonic calculus'—indeed, a 'hedonic calculus' for each subject. Still, there is no doubt that 'Fit' indicates an experience more pleasantly-toned than that indicated by 'Fairly Fit,' and similarly that the experience indicated by 'Fairly Fit' is more pleasantly toned than that indicated by 'A little Tired,' and so on. But whether the hedonic difference between the experiences indicated by 'Fit' and 'Fairly Fit' is identical with that between the experiences indicated, for instance, by 'Fairly Fit' and 'A little Tired,' is a question to which no given answer could be accepted as absolutely accurate. It is therefore assumed that the values here assigned to the four degrees of 'fatigue' feelings are sufficiently indicative of their differences to give a valid idea of diurnal changes in these feelings.

In Table I and Fig. 1 the results are given for the last four days of the experiment, the first day being omitted as an adjustment period.

The *average* feeling is employed for comparative purposes. Thus, the number given as the 'Mean' at any period in Table I is obtained by the following formula: (No. of subjects recording themselves 'Fit' $\times$ 4 + No. recording themselves 'Fairly Fit' $\times$ 3 + No. recording themselves 'A little Tired' $\times$ 2 + No. recording themselves 'Very Tired' $\times$ 1) $\div$ the total number of subjects (20). For instance, on Wednesday of the experiments (see Table I) at 10 a.m., 8 of the 20 subjects recorded

TABLE I.

Numerical expression of diurnal changes in the feelings of weariness of 20 women medical students engaged in academic work.

		HOUR OF DAY							
		10 a.m.	11 a.m.	12 (noon)	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.
Tuesday	{ Mean	3.22	3.21	3.10	3.00	3.10	2.90	2.42	2.42
	{ M.V.	.69	.66	.66	.63	.66	.66	1.01	.59
Wednesday	{ Mean	3.10	3.15	2.95	2.75	3.10	2.90	2.75	2.40
	{ M.V.	.72	.76	.73	.52	.63	.63	.60	.56
Thursday	{ Mean	3.28	3.40	3.44	3.12	3.12	2.60	2.20	2.40
	{ M.V.	.56	.54	.44	.40	.33	.66	.44	.87
Friday	{ Mean	3.44	3.33	2.83	2.60	3.00	2.80	2.44	2.44
	{ M.V.	.68	.67	.46	.63	.44	.64	.88	.88

Fig. 1. The broken lines are the curves for each of the four days; the solid line is the average of the four daily curves.

themselves as 'Fit,' 6 as 'Fairly Fit' and 6 as 'A little Tired.' Hence, we have

$$\{(8 \times 4) + (6 \times 3) + (6 \times 2)\} \div 20,$$

which gives 3.1 as the numerical expression of the *mean* 'fatigue' feeling at that period. It will be observed that the larger this number, or the

higher the curve in Fig. 1, the more pleasantly toned are the activity feelings of the group.

Lunch was taken between 1 p.m. and 2 p.m., and tea, occupying about twenty minutes, soon after the 4 p.m. test period.

B. Data obtained from a group of fifteen young women typists.

The data now to be described were obtained in a typewriting office from a group of fifteen young women typists. The working conditions in the office were good: physical features, such as lighting and ventilation, were satisfactory, and the personal relations between the management and the employees were excellent. Hours of work were $7\frac{1}{4}$ per day, except on Thursdays when they were 4. The morning spell was from 9 a.m. until 1 p.m. without any regular break, though an interval for refreshment was allowed about half-way through the spell if it were desired. After lunch work was resumed at 2.30 p.m. and ceased at 6 p.m., there being a break of fifteen minutes for tea at 4.30 p.m. Wages were on a weekly time basis.

The work in the office consisted mostly of typing from MSS. but involved as well certain clerical duties other than typing.

During three days in one week (Tuesday, Wednesday and Saturday) this group of fifteen typists recorded at intervals their feelings of relative weariness. Blanks for recording these feelings were distributed to them at the times when the records were desired: the character of the blanks is shown below. It was intended that these should be filled out 10 times during the day; but it seemed desirable that the distribution and collection of them should be made by one of the office employees rather than by a stranger, and this resulted in their not being distributed at all of the times originally determined upon. On two of the days they were distributed 8 times only.

The Record Blank.

FEELINGS OR FITNESS OR TIREDNESS

Underline the word or words *which best describe your feelings* at this period.

1. DEGREES OF TIREDNESS.

Fit (not tired).

A Little Tired (generally, or in some special part).

Tired (generally, or in some special part).

Very Tired (generally, or in some special part).

Note also, by *underlining*, whether you have any *aches, pains, or feelings of tiredness* in any of the following parts of the body: Eyes, Back of neck, Head, Shoulders, Arms or wrists, Sides or back, Legs.

2. OTHER FEELINGS.

- Feeling of *clumsiness* (awkwardness).
- Feeling of *boredom* (small or great).
- Feeling of *excitement*.
- Feeling of *tension* (strain).
- Feeling of *hunger*.

Note any other feelings you may have.....

Name.....Hour.....

General character of last hour's work

The subjects, who were naturally not trained in self-observation, were very carefully instructed to record as exactly as possible just how they *felt* at the various times, and to add to the blank if it did not provide a sufficient range of feelings. In some instances additions were made; e.g. 'pressure on head' was written in several times by one typist. The fact that a number of alternatives was presented in the blank would operate against suggestion. It was made clear to the subjects that the records would be treated confidentially, and it was requested that each subject should preserve absolute secrecy concerning her records until all the data were collected. On the whole, therefore, these records seem as reliable as any that could be obtained from subjects not specially trained in introspection.

For the purpose of comparing the feelings at different times of the day, the data were treated in the same way as the data obtained from the group of medical students; the only difference being that an attempt was here made to make finer distinctions between various weariness feelings. This difference is indicated by the numerical values here assigned to the different feelings recorded, which were as follows: 'Fit' = 4; 'A little Tired, in some special part' = 3; 'A little Tired, generally' = 2.5; 'Tired, in some special part' = 2; 'Tired, generally' = 1.5; 'Very tired, in some special part' = 1; 'Very Tired, generally' = 0. For comparative purposes, *average* feelings were used as before, the method of obtaining them being identical with that explained in connexion with the former group. The results are shown in Table II and Fig. 2, which are to be read in the same way as Table I and Fig. 1.

The records made in the second part (2) of the blank were relatively few and unimportant; the results given below are therefore concerned altogether with the feelings recorded in the first part (1) of the blank.

The detailed records of 'aches, pains, or feelings of tiredness' (see blank) in special parts of the body give concrete feeling to these generalised results. The parts of the body mentioned most frequently are the

eyes, the head, the neck and the shoulders. The individual records tend to become extensive as a spell of work proceeds, and towards its end assume a form showing clearly the predominance in the experience of

TABLE II.

Numerical expression of diurnal changes in the feelings of weariness of 15 young women typists.

		Hour of Day (Tuesday)									
		9.15 a.m.	10.15 a.m.	11.10 a.m.	12.10 p.m.	1 p.m.	2.35 p.m.	3.35 p.m.	4.30 p.m.	5.15 p.m.	6 p.m.
Mean		4.00	3.73	3.58	3.00	2.93	3.85	3.44	2.90	2.72	2.61
M.V.		.00	.39	.60	.54	.40	.27	.60	.50	1.00	.70

		Hour of Day (Wednesday)							
		10.30 a.m.	11.15 a.m.	12 (noon)	12.50 p.m.	2.40 p.m.	3.45 p.m.	4.50 p.m.	5.50 p.m.
Mean		3.37	3.25	2.77	2.27	3.65	2.94	2.82	2.30
M.V.		.78	.57	.62	.53	.56	.50	.74	.84

		Hour of Day (Saturday)							
		9.15 a.m.	10.30 a.m.	11.30 a.m.	12 (noon)	12.50 p.m.	2.30 p.m.	3.30 p.m.	6 p.m.
Mean		3.72	3.50	3.40	3.05	2.88	3.67	3.05	2.58
M.V.		.42	.64	.70	.55	.79	.50	.61	1.07

Fig. 2. Each curve represents one day.

the workers of unpleasant feeling-tone. The following is the record of one typist towards the end of a morning's work: 'Tired generally; in

head, eyes, neck, wrists; hungry¹, bored, feeling of strain.' The records make it clear that as work proceeds the area of the body in which unpleasantly toned sensations are localised becomes wider and wider.

III. DISCUSSION.

The main tendency of the data obtained from both medical students and typists is perfectly definite², and might be expressed by saying that during continuous work feeling-tone, in so far as it is dependent upon 'feelings of fatigue,' tends to become more and more unpleasant. This conclusion would probably be accepted as obvious; and it is not implied that the results given above were necessary to establish it. These results have been presented in order to give definite expression to common experience concerning the relation of continuous activity to feeling-tone, and thus to make possible a comparison of diurnal variations in feeling-tone during work with diurnal fluctuations in industrial output.

Such a comparison shows at once that the normal industrial output curve and the curve for feeling-tone during work are in certain respects strikingly similar. At the same time they are in other respects different. Thus, whatever the class of work, output tends to fall off in quantity towards the end of a spell, and to rise again after the mid-day interval. In these respects the output and feeling-tone curves are so nearly the same that one might reasonably suppose *either* that these variations in output are directly due to the variations in feeling-tone *or* that both sets of variations are due to variations in some third factor—a physiological factor. On the other hand, with most classes of work output *tends to improve* over the first part of the morning spell; and while there is some evidence of a similar improvement in feeling-tone in the results obtained from the medical students, there is no evidence at all of such improvement in the results obtained from the typists.

Now the normal response to the feelings of weariness is to slacken effort or to cease work altogether. This response occurs independently of any deliberate intention of effecting a decrease in the unpleasantness of the feeling by means of it, although normally its occurrence produces this result immediately³. The smith who swings his hammer until every

¹ In the last two recording periods of the morning, hunger is frequently mentioned.

² The curves given here are of the same character as those of Thorndike (*J. of Applied Psychol.* I. 3, 266-267) for the variations in 'satisfyingness' felt during 2 and 4 hours work at grading compositions. Thorndike had 29 adult subjects.

³ Cf. Ward's *Principles of Psychology*, ch. II, § 5. On p. 55 it is said that if a "painful presentation is a movement, it is suspended."

movement of his arm causes an 'ache' relieves himself at once of this unpleasant sensation by simply ceasing to hammer. Such facts as this explain the universal *belief* that relaxation of effort lessens the feeling of weariness; and if this belief be taken in conjunction with the fact that the normal *involuntary* response to the feelings of weariness is to slacken effort or to cease work altogether, we may be certain that where such feelings occur work will be slowed down, and will be slowed down the more the greater the intensity of these feelings. There can be no doubt what the normal response would be to 'Tired generally; in head, eyes, neck, wrists; hungry, bored, feeling of strain.' Have we not here the explanation of decreased output towards the end of a spell of work?

It may be argued that such an explanation is at any rate not complete because the feelings of weariness with their unpleasant feeling-tone will themselves be determined by physiological conditions, and that a complete explanation would need to determine the precise nature of these conditions. This is certainly not denied. But what it seems reasonable to deny is that the physiological conditions concerned, whatever they might be, would have anything to do with output except as affecting feeling-tone; for it is this which seems to stand in a direct dynamic relation to the will of the worker¹. Without entering further

¹ Cf. Thorndike, *Educational Psychology*, III. 124-125: "The behaviour which results in certain products such as sums done...is subject to the laws of all behaviour, and to no others. If a continuance of the productive responses at the same speed and in such form as to give equal quality, is satisfying to the individual concerned, he will continue them. If such continuance brings discomfort, he will tend to stop them altogether, or to intermit them, or to make them in such altered form and speed as lets them bring relative satisfaction. Stopping the work outright does not of course occur in the great majority of experimental investigations of fatigue, but is very common in ordinary mental work." And Joteyko writes (*The Science of Labour*, 20-21): "The psychic factor which regulates the expenditure of energy of the human motor...is the sensation of fatigue...Pain and fatigue are the physical and psychical conditions which we are endeavouring to avoid throughout our lives."

In Thorndike's valuable discussion of 'fatigue' what is emphasised are the normal responses to the 'satisfyingness' or 'unsatisfyingness' of continuing at work. These opposite 'feelings' are of course very complex and arise from a variety of conditions. Thus, for instance, the 'unsatisfyingness' of work may be due primarily to the fact that continuance at work involves the temporary repression of various social impulses, or simply to the fact that it is producing sensory aches and pains. In the present paper the 'satisfyingness' of continuing at work is considered only in so far as it is dependent upon 'fatigue' feelings.

It may be noted that where continuing at work involves the inhibition of strong impulses the total work of the organism is not at all measured by what is ordinarily called the product or output of work. The internal work involved in such inhibition of impulses gives no obvious indication of its occurrence, though its effects may be serious.

into a discussion of what is or is not a complete 'explanation' here, it may be said that the character of the feeling-tone towards the end of a spell of work *should* affect output in precisely the way it is found to be affected; and it may be concluded that any explanation that neglects feeling-tone is incomplete.

If this view is correct, it is necessary to try to explain why the curves for the 'fatigue' feelings and for industrial output are not in agreement throughout; why, that is, if these feelings explain or help to explain certain features of output curves, they do not explain all features. In particular, why should output improve during the early part of the day, since, assuming the data given above to be reliable and typical, the 'feelings' of fatigue apparently become more intense almost from the very beginning of work?—It would seem that the explanation of this fact should be in terms of the operation of incentives and warming up.

The incentives to much modern industrial work are certainly not exclusively the feelings of pleasure derived from the mere performance of it. Indeed, such work is frequently so confined and specialised that its performance can yield nothing very satisfying in itself; nothing comparable, for instance, to the pleasurable *cœnaesthesia* resulting from the moderate or even vigorous exercise of the whole body. When these conditions obtain, work is carried on because of incentives (including habits) extraneous to the work itself. In so far as the tendencies excited by these incentives are being realised through the continuance of the work, the feeling-tone of the worker will be to some degree pleasurable, and thus will contribute to the further continuance of the work. As the 'feelings of fatigue' become more definite, the worker will oscillate between the two responses that are characteristic of pleasurable and painful feeling-tone respectively: if he attends to the pleasurable feeling-tone aroused by the knowledge that he is accomplishing his ends, he will tend to continue his work without relaxation of effort, whereas if he attends to the 'feelings of fatigue' with their painful feeling-tone he will tend to relax his effort. Extraneous incentives will operate more or less effectively so long as the mere performance of the work itself does not become obviously painful. Consequently, although feeling-tone, in so far as it is dependent upon 'fatigue' feelings, may become more and more unpleasant from the very beginning of a spell of work, effort may not be relaxed until its painfulness reaches a certain degree of intensity. Of course, these feelings may be altogether disregarded by the worker, as they often have been under experimental conditions; but normally they are not. The degree of intensity which they must attain

before they give rise to a slackening of effort is doubtless different for different persons and for the same person at different times, but it will generally be directly related to the strength of incentives.

The pleasurable feeling-tone arising from the sense of realising tendencies excited by incentives extraneous to the work will not, however, explain the early actual improvement in output (during a day's work); all it does is to provide a reason for maintaining for some time the working situation and would thus only seem to guarantee that output would not actually deteriorate from the very beginning of a spell of work. To explain the actual improvement in output in this early stage, recourse must probably be had to the physiological factors (and perhaps psychological¹ factors also) forming the basis of warming up, the 'facilitation' due to which would more than compensate for any 'inhibition' due to 'fatigue' feelings of mild intensity. Granting such factors, the cause of the divergence between the output and 'fatigue' feelings curves in the early part of a spell of work seems clear enough.

While there can be no doubt what will be the effects of the feelings of weariness (including local aches due to the maintenance of one posture or one set of movements over long periods) upon immediate effort and output, at least when these feelings have attained a certain intensity, their more remote effects upon the preservation of health are quite unknown. They may be a preventive of over-work, or, as Thorndike² suggests, they may be a useless by-product of activity to which hygiene need pay no attention—a "mere accident" of activity which "habitual disregard may abolish," or suppress. The field for research here is certainly an interesting one, especially in view of the widespread belief that the seeking and avoiding reactions characteristic of pleasure and pain are of profound biological significance.

IV. SUMMARY.

The object of this paper has been to suggest the importance of considering certain of the subjective phenomena of 'fatigue' when dealing with the characteristics of normal work. Curves representing diurnal variations in the 'feelings of fatigue' caused by work were given, and these show certain striking resemblances to common industrial output

¹ Cf. Thorndike, *Educational Psychology*, III. 76: "The notion of Warming-Up...has included the diminishing annoyance of a process due to the progressive inattention to competing desires, interest in achievement, and the like."

² *Psychol. Rev.* 1900, VII. 482.

curves. It is strongly suggested that the deterioration of output towards the end of a spell of work is a direct response to the painful feeling-tone of these 'feelings of fatigue.' These feelings may thus play a far greater part in normal work than current 'fatigue' investigation, engrossed with physiological problems, recognises. And it is suggested that 'feelings' generally—and not merely 'fatigue' feelings—should be accorded more notice in connexion with various sides of industrial life than they at present receive.

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