

The Principles of Psychology

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shows make only the more regrettable.* Such elaborately artificial constructions are, it seems to me, only a burden and a hindrance, not a help, to our science.†

In French, M. Rabier in his chapter on Association,‡ handles the subject more vigorously and acutely than any one. His treatment of it, though short, seems to me for general soundness to rank second only to Hodgson's.

In the last chapter we already invoked association to account for the effects of use in improving discrimination. In later chapters we shall see abundant proof of the immense part which it plays in other processes, and shall then readily admit that few principles of analysis, in any science, have proved more fertile than this one, however vaguely formulated it often may have been. Our own attempt to formulate it more definitely, and to escape the usual confusion between causal agencies and relations merely known, must not blind us to the immense services of those by whom the confusion was unfelt. From this practical point of view it would be a true *ignoratio elenchi* to flatter one's self that one has dealt a heavy blow at the psychology of association, when one has exploded the theory of atomistic ideas, or shown that contiguity and similarity between ideas can only be there after association is done.§ The whole body of the associationist psychology remains standing after you have translated 'ideas' into 'objects,' on the one hand, and 'brain-processes' on the other; and the analysis of faculties and operations is as conclusive in these terms as in those traditionally used.

* See his *Grundtatsachen des Bewusstseins* (1888), chap. vi *et passim*, especially pp. 106 ff., 364.

† The most burdensome and utterly gratuitous of them are perhaps Steinthal's, in his *Einleitung in die Psychologie*, 2te Aufl. (1881). Cf. also G. Glogau: *Steinthal's Psychologische Formeln* (1886).

‡ *Leçons de Philosophie*, I. *Psychologie*, chap. xvi (1884).

§ Mr. F. H. Bradley seems to me to have been guilty of something very like this *ignoratio elenchi* in the, of course, subtle and witty but decidedly long-winded critique of the association of ideas, contained in book II. part II. chap. I. of his *Principles of Logic*.

CHAPTER XV.*

THE PERCEPTION OF TIME.

IN the next two chapters I shall deal with what is sometimes called internal perception, or the perception of *time*, and of events as occupying a date therein, especially when the date is a past one, in which case the perception in question goes by the name of *memory*. To remember a thing as past, it is necessary that the notion of 'past' should be one of our 'ideas.' We shall see in the chapter on Memory that many things come to be thought by us as past, not because of any intrinsic quality of their own, but rather because they are associated with other things which for us signify pastness. But how do these things get *their* pastness? What is the *original* of our experience of pastness, from whence we get the meaning of the term? It is this question which the reader is invited to consider in the present chapter. We shall see that we have a constant feeling *sui generis* of pastness, to which every one of our experiences in turn falls a prey. To think a thing as past is to think it amongst the objects or in the direction of the objects which at the present moment appear affected by this quality. This is the original of our notion of past time, upon which memory and history build their systems. And in this chapter we shall consider this immediate sense of time alone.

If the constitution of consciousness were that of a string of bead-like sensations and images, all separate,

"we never could have any knowledge except that of the present instant. The moment each of our sensations ceased it would be gone for ever; and we should be as if we had never been. . . . We should be wholly

* This chapter is reprinted almost verbatim from the *Journal of Speculative Philosophy*, vol. xx. p. 374.

incapable of acquiring experience. . . . Even if our ideas were associated in trains, but only as they are in imagination, we should still be without the capacity of acquiring knowledge. One idea, upon this supposition, would follow another. But that would be all. Each of our successive states of consciousness, the moment it ceased, would be gone forever. Each of those momentary states would be our whole being."*

We might, nevertheless, under these circumstances, *act* in a rational way, provided the mechanism which produced our trains of images produced them in a rational order. We should make appropriate speeches, though unaware of any word except the one just on our lips; we should decide upon the right policy without ever a glimpse of the total grounds of our choice. Our consciousness would be like a glow-worm spark, illuminating the point it immediately covered, but leaving all beyond in total darkness. Whether a very highly developed practical life be possible under such conditions as these is more than doubtful; it is, however, conceivable.

I make the fanciful hypothesis merely to set off our real nature by the contrast. Our feelings are not thus contracted, and our consciousness never shrinks to the dimensions of a glow-worm spark. *The knowledge of some other part of the stream, past or future, near or remote, is always mixed in with our knowledge of the present thing.*

A simple sensation, as we shall hereafter see, is an abstraction, and all our concrete states of mind are representations of objects with some amount of complexity. Part of the complexity is the echo of the objects just past, and, in a less degree, perhaps, the foretaste of those just to arrive. Objects fade out of consciousness slowly. If the present thought is of A B C D E F G, the next one will be of B C D E F G H, and the one after that of C D E F G H I—the lingerings of the past dropping successively away, and the incomings of the future making up the loss. These lingerings of old objects, these incomings of new, are the germs of memory and expectation, the retrospective and the prospective sense of time. They give that continuity to

* James Mill, *Analysis*, vol. I. p. 319 (J. S. Mill's Edition).

consciousness without which it could not be called a stream.*

* "What I find, when I look at consciousness at all, is, that what I cannot divest myself of, or not have in consciousness, if I have consciousness at all, is a sequence of different feelings. . . . The simultaneous perception of both sub-feelings, whether as parts of a coexistence or of a sequence, is the total feeling—the minimum of consciousness—and this minimum has duration. . . . Time-duration, however, is inseparable from the minimum, notwithstanding that, in an isolated moment, we could not tell which part of it came first, which last. . . . We do not require to know that the sub-feelings come in sequence, first one, then the other; nor to know what coming in sequence means. But we have, in any artificially isolated minimum of consciousness, the *rudiments* of the perception of former and latter in time, in the sub-feeling that grows fainter, and the sub-feeling that grows stronger, and the change between them. . . .

"In the next place, I remark that the rudiments of memory are involved in the minimum of consciousness. The first beginnings of it appear in that minimum, just as the first beginnings of perception do. As each member of the change or difference which goes to compose that minimum is the rudiment of a single perception, so the priority of one member to the other, although both are given to consciousness in one empirical present moment, is the rudiment of memory. The fact that the minimum of consciousness is difference or change in feelings, is the ultimate explanation of memory as well as of single perceptions. A former and a latter are included in the minimum of consciousness; and this is what is meant by saying that all consciousness is in the form of *time*, or that time is the form of feeling, the form of sensibility. Crudely and popularly we divide the course of time into past, present, and future; but, strictly speaking, there is no present; it is composed of past and future divided by an indivisible point or instant. That instant, or time-point, is the strict *present*. What we call, loosely, the present, is an empirical portion of the course of time, containing at least a minimum of consciousness, in which the instant of change is the present time-point. . . . If we take this as the present time-point, it is clear that the minimum of feeling contains two portions—a sub-feeling that goes and a sub-feeling that comes. One is remembered, the other imagined. The limits of both are indefinite at beginning and end of the minimum, and ready to melt into other minima, proceeding from other stimuli.

"Time and consciousness do not come to us ready marked out into minima; we have to do that by reflection, asking ourselves, What is the least empirical moment of consciousness? That least empirical moment is what we usually call the present moment; and even this is too minute for ordinary use; the present moment is often extended practically to a few seconds, or even minutes, beyond which we specify what length of time we mean, as the present hour, or day, or year, or century.

"But this popular way of thinking imposes itself on great numbers even of philosophically-minded people, and they talk about the *present* as if it was a *datum*—as if time came to us marked into present periods like a

THE SENSIBLE PRESENT HAS DURATION.

Let any one try, I will not say to arrest, but to notice or attend to, the *present* moment of time. One of the most baffling experiences occurs. Where is it, this present? It has melted in our grasp, fled ere we could touch it, gone in the instant of becoming. As a poet, quoted by Mr. Hodgson, says,

"Le moment où je parle est déjà loin de moi,"

and it is only as entering into the living and moving organization of a much wider tract of time that the strict present is apprehended at all. It is, in fact, an altogether ideal abstraction, not only never realized in sense, but probably never even conceived of by those unaccustomed to philosophic meditation. Reflection leads us to the conclusion

measuring-tape." (S. H. Hodgson: *Philosophy of Reflection*, vol. i. pp. 248-254.)

"The representation of time agrees with that of space in that a certain amount of it must be presented together—included between its initial and terminal limit. A continuous ideation, flowing from one point to another, would indeed *occupy* time, but not *represent* it, for it would exchange one element of succession for another instead of grasping the whole succession at once. Both points—the beginning and the end—are equally essential to the conception of time, and must be present with equal clearness together." (Herbart: *Psychol. als W.*, § 115.)

"Assume that . . . similar pendulum-strokes follow each other at regular intervals in a consciousness otherwise void. When the first one is over, an image of it remains in the fancy until the second succeeds. This, then, reproduces the first by virtue of the law of association by similarity, but at the same time meets with the aforesaid persisting image. . . . Thus does the simple repetition of the sound provide all the elements of time-perception. The first sound [as it is recalled by association] gives the beginning, the second the end, and the persistent image in the fancy represents the length of the interval. At the moment of the second impression, the entire time-perception exists at once, for then all its elements are presented together, the second sound and the image in the fancy immediately, and the first impression by reproduction. But, in the same act, we are aware of a state in which only the first sound existed, and of another in which only its image existed in the fancy. Such a consciousness as this *is* that of time. . . . *In it no succession of ideas takes place.*" (Wundt: *Physiol. Psych.*, 1st ed. pp. 681-2.) Note here the assumption that the *persistence* and the *reproduction* of an impression are two processes which may go on simultaneously. Also that Wundt's description is merely an *attempt to analyze the 'deliverance' of a time-perception, and no explanation of the manner in which it comes about.*

that it *must* exist, but that it *does* exist can never be a fact of our immediate experience. The only fact of our immediate experience is what Mr. E. R. Clay has well called 'the *specious* present.' His words deserve to be quoted in full:*

"The relation of experience to time has not been profoundly studied. Its objects are given as being of the present, but the part of time referred to by the datum is a very different thing from the conterminous of the past and future which philosophy denotes by the name Present. The present to which the datum refers is really a part of the past—a recent past—delusively given as being a time that intervenes between the past and the future. Let it be named the specious present, and let the past, that is given as being the past, be known as the obvious past. All the notes of a bar of a song seem to the listener to be contained in the present. All the changes of place of a meteor seem to the beholder to be contained in the present. At the instant of the termination of such series, no part of the time measured by them seems to be a past. Time, then, considered relatively to human apprehension, consists of four parts, viz., the obvious past, the specious present, the real present, and the future. Omitting the specious present, it consists of three . . . nonentities—the past, which does not exist, the future, which does not exist, and their conterminous, the present; the faculty from which it proceeds lies to us in the fiction of the specious present."

In short, the practically cognized present is no knife-edge, but a saddle-back, with a certain breadth of its own on which we sit perched, and from which we look in two directions into time. The unit of composition of our perception of time is a *duration*, with a bow and a stern, as it were—a rearward- and a forward-looking end.† It is only

* The Alternative, p. 167.

† Locke, in his dim way, derived the sense of duration from reflection on the succession of our ideas (*Essay*, book II. chap. XIV. § 3; chap. XV. § 12). Reid justly remarks that if ten successive elements are to make duration, "then one must make duration, otherwise duration must be made up of parts that have no duration, which is impossible. . . . I conclude, therefore, that there must be duration in every single interval or element of which the whole duration is made up. Nothing, indeed, is more certain than that every elementary part of duration must have duration, as every elementary part of extension must have extension. Now, it must be observed that in these elements of duration, or single intervals of successive ideas, there is no succession of ideas, yet we must conceive them to have duration; whence we may conclude with certainty that *there is a conception of duration where there is no succession of ideas in the mind.*" (*Intellectual Powers*, essay III. chap. V.) "Qu'on ne cherche point," says Royer Collard in the Fragments added to Jouffroy's Translation of Reid,

as parts of this *duration-block* that the relation of *succession* of one end to the other is perceived. We do not first feel one end and then feel the other after it, and from the perception of the succession infer an interval of time between, but we seem to feel the interval of time as a whole, with its two ends embedded in it. The experience is from the outset a synthetic datum, not a simple one; and to sensible perception its elements are inseparable, although attention looking back may easily decompose the experience, and distinguish its beginning from its end.

When we come to study the perception of Space, we shall find it quite analogous to time in this regard. Date in time corresponds to position in space; and although we now mentally construct large spaces by mentally imagining remoter and remoter positions, just as we now construct great durations by mentally prolonging a series of successive dates, yet the original experience of both space and time is always of something already given as a unit, inside of which attention afterward discriminates parts in relation to each other. Without the parts already given as *in* a time and *in* a space, subsequent discrimination of them could hardly do more than perceive them as *different* from each other; it would have no motive for calling the difference temporal order in this instance and spatial position in that.

And just as in certain experiences we may be conscious of an extensive space full of objects, without locating each of them distinctly therein; so, when many impressions follow in excessively rapid succession in time, although we may be distinctly aware that they occupy some duration, and are not simultaneous, we may be quite at a loss to tell which comes first and which last; or we may even invert their real order in our judgment. In complicated reaction-time experiments, where signals and motions, and clicks of the apparatus come in exceedingly rapid order, one is at first much perplexed in deciding what the order is, yet of the fact of its occupancy of time we are never in doubt.

"la durée dans la succession; on ne l'y trouvera jamais; la durée a précédé la succession; la notion de la durée a précédé la notion de la succession. Elle en est donc tout-à-fait indépendante, dira-t-on? Oui, elle en est tout-à-fait indépendante."

ACCURACY OF OUR ESTIMATE OF SHORT DURATIONS.

We must now proceed to an account of the *facts* of time-perception in detail as preliminary to our speculative conclusion. Many of the facts are matters of patient experimentation, others of common experience.

First of all, we note a marked *difference between the elementary sensations of duration and those of space*. The former have a much narrower range; the time-sense may be called a myopic organ, in comparison with the eye, for example. The eye sees rods, acres, even miles, at a single glance, and these totals it can afterward subdivide into an almost infinite number of distinctly identified parts. The units of duration, on the other hand, which the time-sense is able to take in at a single stroke, are groups of a few seconds, and within these units very few subdivisions—perhaps forty at most, as we shall presently see—can be clearly discerned. The durations we have practically most to deal with—minutes, hours, and days—have to be symbolically conceived, and constructed by mental addition, after the fashion of those extents of hundreds of miles and upward, which in the field of space are beyond the range of most men's practical interests altogether. To 'realize' a quarter of a mile we need only look out of the window and *feel* its length by an act which, though it may in part result from organized associations, yet seems immediately performed. To realize an hour, we must count 'now!—now!—now!—now!' indefinitely. Each 'now' is the feeling of a separate *bit* of time, and the exact sum of the bits never makes a very clear impression on our mind.

How many bits can we clearly apprehend at once? Very few if they are long bits, more if they are extremely short, most if they come to us in compound groups, each including smaller bits of its own.

Hearing is the sense by which the subdivision of durations is most sharply made. Almost all the experimental work on the time-sense has been done by means of strokes of sound. How long a series of sounds, then, can we group in the mind so as not to confound it with a longer or a shorter series?

Our spontaneous tendency is to break up any monotonously given series of sounds into some sort of a rhythm. We involuntarily accentuate every second, or third, or fourth beat, or we break the series in still more intricate ways. Whenever we thus grasp the impressions in rhythmic form, we can identify a longer string of them without confusion.

Each variety of verse, for example, has its 'law'; and the recurrent stresses and sinkings make us feel with peculiar readiness the lack of a syllable or the presence of one too much. Divers verses may again be bound together in the form of a stanza, and we may then say of another stanza, "Its second verse differs by so much from that of the first stanza," when but for the felt stanza-form the two differing verses would have come to us too separately to be compared at all. But these superposed systems of rhythm soon reach their limit. In music, as Wundt* says, "while the measure may easily contain 12 changes of intensity of sound (as in $1\frac{1}{2}$ time), the rhythmical group may embrace 6 measures, and the period consist of 4, exceptionally of 5 [8?] groups."

Wundt and his pupil Dietze have both tried to determine experimentally the *maximal extent of our immediate distinct consciousness for successive impressions*.

Wundt found † that twelve impressions could be distinguished clearly as a united cluster, provided they were caught in a certain rhythm by the mind, and succeeded each other at intervals not smaller than 0.3 and not larger than 0.5 of a second. This makes the total time distinctly apprehended to be equal to from 3.6 to 6 seconds.

Dietze ‡ gives larger figures. The most favorable intervals for clearly catching the strokes were when they came at from 0.3 second to 0.18 second apart. Forty strokes might then be remembered as a whole, and identified without error when repeated, provided the mind grasped them in five sub-groups of eight, or in eight sub-groups of five strokes each. When no grouping of the strokes beyond making *couples* of

* *Physiol. Psych.*, II. 54, 55.

† *Ibid.* II. 213.

‡ *Philosophische Studien*, II. 362.

them by the attention was allowed—and practically it was found impossible not to group them in at least this simplest of all ways—16 was the largest number that could be clearly apprehended as a whole.* This would make 40 times 0.3 second, or 12 seconds, to be the *maximum filled duration* of which we can be both *distinctly and immediately* aware.

The maximum unfilled, or *vacant duration*, seems to lie within the same objective range. Estel and Mehner, also working in Wundt's laboratory, found it to vary from 5 or 6 to 12 seconds, and perhaps more. The differences seemed due to practice rather than to idiosyncrasy.†

These figures may be roughly taken to stand for the most important part of what, with Mr. Clay, we called, a few pages back, the *specious present*. The specious present has, in addition, a vaguely vanishing backward and forward fringe; but its nucleus is probably the dozen seconds or less that have just elapsed.

If these are the maximum, what, then, is the *minimum* amount of duration which we can distinctly feel?

The smallest figure experimentally ascertained was by Exner, who distinctly heard the doubleness of two successive clicks of a Savart's wheel, and of two successive snaps

* Counting was of course not permitted. It would have given a symbolic concept and no intuitive or immediate perception of the totality of the series. With counting we may of course compare together series of any length—series whose beginnings have faded from our mind, and of whose totality we retain no sensible impression at all. To count a series of clicks is an altogether different thing from merely perceiving them as discontinuous. In the latter case we need only be conscious of the bits of empty duration between them; in the former we must perform rapid acts of association between them and as many names of numbers.

† Estel in Wundt's *Philosophische Studien*, II. 50. Mehner, *ibid.* II. 571. In Dietze's experiments even numbers of strokes were better caught than odd ones, by the ear. The *rapidity of their sequence* had a great influence on the result. At more than 4 seconds apart it was impossible to perceive series of them as units in all (cf. Wundt, *Physiol. Psych.*, II. 214). They were simply counted as so many individual strokes. Below 0.31 to 0.11 second, according to the observer, judgment again became confused. It was found that the rate of succession most favorable for grasping long series was when the strokes were sounded at intervals of from 0.3" to 0.18" apart. Series of 4, 6, 8, 16 were more easily identified than series of 10, 12, 14, 18. The latter could hardly be clearly grasped at all. Among odd numbers, 3, 5, 7 were the series easiest caught; next, 9, 15; hardest of all, 11 and 13; and 17 was impossible to apprehend.

of an electric spark, when their interval was made as small as about $\frac{1}{800}$ of a second.*

With the eye, perception is less delicate. Two sparks, made to fall beside each other in rapid succession on the centre of the retina, ceased to be recognized as successive by Exner when their interval fell below 0.044".†

Where, as here, the succeeding impressions are only two in number, we can easiest perceive the interval between them. President Hall, who experimented with a modified Savart's wheel, which gave clicks in varying number and at varying intervals, says: ‡

"In order that their discontinuity may be clearly perceived, four or even three clicks or beats must be farther apart than two need to be. When two are easily distinguished, three or four separated by the same interval . . . are often confidently pronounced to be two or three respectively. It would be well if observations were so directed as to ascertain, at least up to ten or twenty, the increase [of interval] required by each additional click in a series for the sense of discontinuity to remain constant throughout." §

* The exact interval of the sparks was 0.00205". The doubleness of their snap was usually replaced by a single-seeming sound when it fell to 0.00198", the sound becoming *louder* when the sparks seemed simultaneous. The difference between these two intervals is only $\frac{1}{100000}$ of a second; and, as Exner remarks, our ear and brain must be wonderfully efficient organs to get distinct feelings from so slight an objective difference as this. See Pfüger's Archiv, Bd. xi.

† *Ibid.*, p. 407. When the sparks fell so close together that their irradiation-circles overlapped, they appeared like *one spark moving* from the position of the first to that of the second; and they might then follow each other as close as 0.015" without the *direction of the movement* ceasing to be clear. When one spark fell on the centre, the other on the margin, of the retina, the time-interval for successive apprehension had to be raised to 0.076".

‡ Hall and Jastrow: Studies of Rhythm, Mind, xi. 58.

§ Nevertheless, multitudinous impressions may be felt as discontinuous, though separated by excessively minute intervals of time. Grünhagen says (Pfüger's Archiv, vi. 175) that 10,000 electric shocks a second are felt as interrupted, by the tongue (!). Von Wittich (*ibid.* xi. 329), that between 1000 and 2000 strokes a second are felt as discrete by the finger. W. Preyer, on the other hand (Die Grenzen des Empfindungsvermögens, etc., 1868, p. 15), makes contacts appear continuous to the finger when 36.8 of them follow in a second. Similarly, Mach (Wiener Sitzgsh., Lx. 2, 142) gives about 36. Lalanne (Comptes Rendus, LXXXII. p. 1314) found summation of finger-contacts after 22 repetitions in a second. Such discrepant figures are of doubtful worth. On the retina 20 to 30 impressions a second

Where the first impression falls on one sense, and the second on another, the perception of the intervening time tends to be less certain and delicate, and it makes a difference which impression comes first. Thus, Exner found* the smallest perceptible interval to be, in seconds:

From sight to touch.....	0.071
From touch to sight.....	0.053
From sight to hearing.....	0.16
From hearing to sight.....	0.06
From one ear to another.....	0.064

To be conscious of a time interval at all is one thing; to tell whether it be shorter or longer than another interval is a different thing. A number of experimental data are on hand which give us a measure of the delicacy of this latter perception. The problem is that of the *smallest difference between two times* which we can perceive.

The difference is at its minimum when the times themselves are very short. Exner,† reacting as rapidly as possible with his foot, upon a signal seen by the eye (spark), noted all the reactions which seemed to him either slow or fast in the making. He thought thus that deviations of about $\frac{1}{100}$ of a second either way from the average were

at the very utmost can be felt as discrete when they fall on the same spot. The ear, which begins to fuse stimuli together into a musical tone when they follow at the rate of a little over 30 a second, can still feel 132 of them a second as discontinuous when they take the shape of 'beats' (Helmholtz, Tonempfindungen, 8d ed. p. 270).

* Pfüger's Archiv, xi. 428. Also in Herrmann's Hdbh. d. Physiol., 2 Bd., I. Thl. pp. 260-262.

† Pfüger's Archiv, vii. 639. Tigerstedt (Bihang till Kongl. Svenska Vetenskaps-Akad. Handl., Bd. 8, Häfte 2, Stockholm, 1884) revises Exner's figures, and shows that his conclusions are exaggerated. According to Tigerstedt, two observers almost always rightly appreciated 0.05" or 0.06" of reaction-time difference. Half the time they did it rightly when the difference sank to 0.03", though from 0.03" and 0.06" differences were often not noticed at all. Buccola found (Le Legge del Tempo nei Fenomeni del Pensiero, Milano, 1888, p. 871) that, after much practice in making rapid reactions upon a signal, he estimated directly, in figures, his own reaction-time, in 10 experiments, with an error of from 0.010" to 0.018"; in 6, with one of 0.005" to 0.009"; in one, with one of 0.002"; and in 3, with one of 0.008".

correctly noticed by him at the time. The average was here 0.1840". Hall and Jastrow listened to the intervals between the clicks of their apparatus. Between two such equal intervals of 4.27" each, a middle interval was included, which might be made either shorter or longer than the extremes. "After the series had been heard two or even three times, no impression of the relative length of the middle interval would often exist, and only after hearing the fourth and last [repetition of the series] would the judgment incline to the *plus* or *minus* side. Inserting the variable between two invariable and like intervals greatly facilitated judgment, which between two unlike terms is far less accurate." * Three observers in these experiments made no error when the middle interval varied $\frac{1}{10}$ from the extremes. When it varied $\frac{1}{15}$, errors occurred, but were few. This would make the minimum *absolute* difference perceived as large as 0.355."

This minimum absolute difference, of course, increases as the times compared grow long. Attempts have been made to ascertain what *ratio* it bears to the times themselves. According to Fechner's 'Psychophysic Law' it ought always to bear the same ratio. Various observers, however, have found this not to be the case.† On the contrary, very interesting *oscillations* in the accuracy of judgment and in the direction of the error—oscillations dependent upon the absolute amount of the times compared—have been noticed by all who have experimented with the question. Of these a brief account may be given.

In the first place, *in every list of intervals experimented with there will be found what Vierordt calls an 'INDIFFERENCE-POINT';* that is to say, an interval which we judge with maximum accuracy, a time which we tend to estimate as neither longer or shorter than it really is, and away from which,

* Mind, xi. 61 (1886).

† Mach, Wiener Sitzungs., II. 2. 133 (1865); Estel, *loc. cit.* p. 65; Mehner, *loc. cit.* p. 586; Buccola, *op. cit.* p. 378. Fechner labors to prove that his law is only overlaid by other interfering laws in the figures recorded by these experimenters; but his case seems to me to be one of desperate infatuation with a hobby. (See Wundt's Philosophische Studien, III. 1.)

in both directions, errors increase their size.* This time varies from one observer to another, but its average is remarkably constant, as the following table shows.†

The times, noted by the ear, and the average indifference-points (given in seconds) were, for—

Wundt ‡	0.72
Kollert §	0.75
Estel (probably)	0.75
Mehner	0.71
Stevens ¶	0.71
Mach ¶	0.35
Buccola (about)**	0.40

The odd thing about these figures is the recurrence they show in so many men of about three fourths of a second,

* Curious discrepancies exist between the German and the American observers with respect to the *direction* of the error below and above the point of indifference—differences perhaps due to the *fatigue* involved in the American method. The Germans lengthened intervals below it and shortened those above. With seven Americans experimented on by Stevens this was exactly reversed. The German method was to passively listen to the intervals, then judge; the American was to reproduce them actively by movements of the hand. In Mehner's experiments there was found a second indifference-point at about 5 seconds, beyond which times were judged again too long. Glass, whose work on the subject is the latest (Philos. Studien, IV. 423), found (when corrections were allowed for) that all times except 0.8 sec. were estimated too short. He found a series of points of greatest relative accuracy (viz., at 1.5, 2.5, 3.75, 5, 6.25, etc., seconds respectively, and (thought that his observations roughly corroborated Weber's law. As 'maximum' and 'minimum' are printed interchangeably in Glass's article it is hard to follow.

† With Vierordt and his pupils the indifference-point lay as high as from 1.5 sec. to 4.9 sec., according to the observer (cf. Der Zeitsinn, 1868, p. 112). In most of these experiments the time heard was actively reproduced, after a short pause, by movements of the hand, which were recorded. Wundt gives good reasons (Physiol. Psych., II. 289, 290) for rejecting Vierordt's figures as erroneous. Vierordt's book, it should be said, is full of important matter, nevertheless.

‡ Physiol. Psych., II. 286, 290.

§ Philosophische Studien, I. 86.

|| Mind, XI. 400.

¶ *Loc. cit.* p. 144.

** *Op. cit.* p. 378. Mach's and Buccola's figures, it will be observed, are about *one half* of the rest—sub-multiples, therefore. It ought to be observed, however, that Buccola's figure has little value, his observations not being well fitted to show this particular point.

as the interval of time most easy to catch and reproduce. Odder still, both Estel and Mehner found that *multiples* of this time were more accurately reproduced than the time-intervals of intermediary length;* and Glass found a certain periodicity, with the constant increment of 1.25 sec., in his observations. There would seem thus to exist something like a periodic or rhythmic sharpening of our time-sense, of which the period differs somewhat from one observer to the next.

Our sense of time, like other senses, seems subject to the law of contrast. It appeared pretty plainly in Estel's observations that an interval sounded shorter if a long one had immediately preceded it, and longer when the opposite was the case.

Like other senses, too, *our sense of time is sharpened by practice.* Mehner ascribes almost all the discrepancies between other observers and himself to this cause alone.†

Tracts of time filled (with clicks of sound) *seem longer than vacant ones* of the same duration, when the latter does not exceed a second or two.‡ This, which reminds one of what happens with spaces seen by the eye, becomes reversed when longer times are taken. It is, perhaps, in accordance with this law that a *loud* sound, limiting a short interval of time, makes it appear longer, a *slight* sound shorter. In comparing intervals marked out by sounds, we must take care to keep the sounds uniform.§

There is a certain emotional *feeling* accompanying the intervals of time, as is well known in music. *The sense of haste goes with one measure of rapidity, that of delay with another;* and these two feelings harmonize with different mental moods. Vierordt listened to series of strokes performed by a metronome at rates varying from 40 to 200 a

* Estel's figures led him to think that *all* the multiples enjoyed this privilege; with Mehner, on the other hand, only the *odd* multiples showed diminution of the average error; thus, 0.71, 2.15, 3.55, 5, 6.4, 7.8, 9.3, and 10.65 second were respectively registered with the least error. Cf. Phil. Studen, II. pp. 57, 562-565.

† Cf. especially pp. 558-561.

‡ Wundt: *Physiol. Psych.*, II. 287. Hall and Jastrow: *Mind*, XI. 62.

§ Mehner: *loc. cit.* p. 558.

minute, and found that they very naturally fell into seven categories, from 'very slow' to 'very fast.'* Each category of feeling included the intervals following each other within a certain range of speed, and no others. This is a qualitative, not a quantitative judgment—an æsthetic judgment, in fact. The middle category, of speed that was neutral, or, as he calls it, 'adequate,' contained intervals that were grouped about 0.62 second, and Vierordt says that this made what one might almost call an *agreeable* time.†

The feeling of time and accent in music, of rhythm, is quite independent of that of melody. Tunes with marked rhythm can be readily recognized when simply drummed on the table with the finger-tips.

WE HAVE NO SENSE FOR EMPTY TIME.

Although subdividing the time by beats of sensation aids our accurate knowledge of the amount of it that elapses, such subdivision does not seem at the first glance essential to our perception of its flow. Let one sit with closed eyes and, abstracting entirely from the outer world, attend exclusively to the passage of time, like one who wakes, as the poet says, "to hear time flowing in the middle of the night, and all things moving to a day of doom." There seems under such circumstances as these no variety in the material content of our thought, and what we notice appears, if anything, to be the pure series of durations budding, as it were, and growing beneath our indrawn gaze. Is this really so or not? The question is important, for, if the experience be what it roughly seems, we have a sort of special sense for pure time—a sense to which empty duration is an adequate stimulus; while if it be an illusion, it must be that our perception of time's flight, in the experiences quoted, is due to the *filling* of the time, and to our *memory* of a content which it had a moment previous, and which we feel to agree or disagree with its content now.

It takes but a small exertion of introspection to show

* The number of distinguishable *differences* of speed between these limits is, as he takes care to remark, very much larger than 7 (*Der Zeitsinn*, p. 137).

† P. 19, § 18, p. 112.

that the latter alternative is the true one, and that *we can no more intuit a duration than we can intuit an extension, devoid of all sensible content*. Just as with closed eyes we perceive a dark visual field in which a curdling play of obscurest luminosity is always going on; so, be we never so abstracted from distinct outward impressions, we are always inwardly immersed in what Wundt has somewhere called the twilight of our general consciousness. Our heart-beats, our breathing, the pulses of our attention, fragments of words or sentences that pass through our imagination, are what people this dim habitat. Now, all these processes are rhythmical, and are apprehended by us, as they occur, in their totality; the breathing and pulses of attention, as coherent successions, each with its rise and fall; the heart-beats similarly, only relatively far more brief; the words not separately, but in connected groups. In short, empty our minds as we may, some form of *changing process* remains for us to feel, and cannot be expelled. And along with the sense of the process and its rhythm goes the sense of the length of time it lasts. Awareness of *change* is thus the condition on which our perception of time's flow depends; but there exists no reason to suppose that empty time's own changes are sufficient for the awareness of change to be aroused. The change must be of some concrete sort—an outward or inward sensible series, or a process of attention or volition.*

* I leave the text just as it was printed in the Journal of Speculative Philosophy (for 'Oct. 1886') in 1887. Since then Münsterberg in his masterly Beiträge zur experimentellen Psychologie (Heft 2, 1889) seems to have made it clear what the sensible changes are by which we measure the lapse of time. When the time which separates two sensible impressions is less than one third of a second, he thinks it is almost entirely the *amount to which the memory-image of the first impression has faded* when the second one overtakes it, which makes us feel how wide they are apart (p. 29). When the time is longer than this, we rely, he thinks, exclusively upon the feelings of muscular tension and relaxation, which we are constantly receiving although we give to them so little of our direct attention. *These feelings are primarily in the muscles by which we adopt our sense-organs in attending to the signals used*, some of the muscles being in the eye and ear themselves, some of them in the head, neck, etc. We here judge two time-intervals to be equal when between the beginning and end of each we feel exactly similar relaxations and subsequent expectant tensions of these

And here again we have an analogy with space. The earliest form of distinct space-perception is undoubtedly that of a movement over some one of our sensitive surfaces, and this movement is originally given as a simple whole of feeling, and is only decomposed into its elements—successive positions successively occupied by the moving body—when our education in discrimination is much advanced.

muscles to have occurred. In reproducing intervals ourselves we try to make our feelings of this sort just what they were when we passively heard the interval. These feelings by themselves, however, can only be used when the intervals are very short, for the tension anticipatory of the terminal stimulus naturally reaches its maximum very soon. With longer intervals we *take the feeling of our inspirations and expirations into account*. With our expirations all the other muscular tensions in our body undergo a rhythmical decrease; with our inspirations the reverse takes place. When, therefore, we note a time-interval of several seconds with intent to reproduce it, what we seek is to make the earlier and later interval agree in the number and amount of these respiratory changes combined with sense-organ adjustments with which they are filled. Münsterberg has studied carefully in his own case the variations of the respiratory factor. They are many; but he sums up his experience by saying that whether he measured by inspirations that were divided by momentary pauses into six parts, or by inspirations that were continuous; whether with sensory tension during inspiration and relaxation during expiration, or by tension during both inspiration and expiration, separated by a sudden interpolated relaxation; whether with special notice taken of the cephalic tensions, or of those in the trunk and shoulders, in all cases alike and without exception he involuntarily endeavored, whenever he compared two times or tried to make one the same as the other, to get exactly the same respiratory conditions and conditions of tension, *all* the subjective conditions, in short, *exactly* the same during the second interval as they were during the first. Münsterberg corroborated his subjective observations by experiments. The observer of the time had to reproduce as exactly as possible an interval between two sharp sounds given him by an assistant. The only condition imposed upon him was that he should not modify his breathing for the purposes of measurement. It was then found that when the assistant broke in at random with his signals, the judgment of the observer was vastly less accurate than when the assistant carefully watched the observer's breathing and made both the beginning of the time given him and that of the time which he was to give coincide with identical phases thereof.—Finally, Münsterberg with great plausibility tries to explain the discrepancies between the results of Vierordt, Estel, Mehner, Glass, etc., as due to the fact that they *did not all use the same measure*. Some breathe a little faster, some a little slower. Some break their inspirations into two parts, some do not, etc. The coincidence of the objective times measured with definite natural phases of breathing would very easily give periodical maxima of facility in measuring accurately.

But a movement is a change, a process; so we see that in the time-world and the space-world alike the first known things are not elements, but combinations, not separate units, but wholes already formed. The condition of *being* of the wholes may be the elements; but the condition of our *knowing* the elements is our having already felt the wholes as wholes.

In the experience of watching empty time flow—'empty' to be taken hereafter in the relative sense just set forth—we tell it off in pulses. We say 'now! now! now!' or we count 'more! more! more!' as we feel it bud. This composition out of units of duration is called the law of time's *discrete flow*. The discreteness is, however, merely due to the fact that our successive acts of *recognition* or *apperception* of *what* it is are discrete. The sensation is as continuous as any sensation can be. All continuous sensations are *named* in beats. We notice that a certain finite 'more' of them is passing or already past. To adopt Hodgson's image, the sensation is the measuring-tape, the perception the dividing-engine which stamps its length. As we listen to a steady sound, we *take it in* in discrete pulses of recognition, calling it successively 'the same! the same! the same!' The case stands no otherwise with time.

After a small number of beats our impression of the amount we have told off becomes quite vague. Our only way of knowing it accurately is by counting, or noticing the clock, or through some other symbolic conception.* When the times exceed hours or days, the conception is absolutely symbolic. We think of the amount we mean either solely as a *name*, or by running over a few salient *dates* therein, with no pretence of imagining the full durations that lie between them. No one has anything like a *perception* of the greater length of the time between now and the first century than of that between now and the tenth. To an historian,

* "Any one wishing yet further examples of this mental substitution will find one on observing how habitually he thinks of the spaces on the clock-face instead of the periods they stand for; how, on discovering it to be half an hour later than he supposed, he does not represent the half hour in its duration, but scarcely passes beyond the sign of it marked by the finger." (H. Spencer: Psychology, § 336.)

it is true, the longer interval will suggest a host of additional dates and events, and so appear a more *multitudinous* thing. And for the same reason most people will think they directly perceive the length of the past fortnight to exceed that of the past week. But there is properly no comparative time *intuition* in these cases at all. It is but dates and events, *representing* time; their abundance *symbolizing* its length. I am sure that this is so, even where the times compared are no more than an hour or so in length. It is the same with Spaces of many miles, which we always compare with each other by the numbers which measure them.*

* The only objections to this which I can think of are: (1) The accuracy with which some men judge of the hour of day or night without looking at the clock; (2) the faculty some have of waking at a preappointed hour; (3) the accuracy of time-perception reported to exist in certain trance-subjects. It might seem that in these persons some sort of a sub-conscious record was kept of the lapse of time *per se*. But this cannot be admitted until it is proved that there are no physiological processes, the feeling of whose course may serve as a *sign* of how much time has sped, and so lead us to infer the hour. That there are such processes it is hardly possible to doubt. An ingenious friend of mine was long puzzled to know why each day of the week had such a characteristic physiognomy to him. That of Sunday was soon noticed to be due to the cessation of the city's rumbling, and the sound of people's feet shuffling on the sidewalk; of Monday, to come from the clothes drying in the yard and casting a white reflection on the ceiling; of Tuesday, to a cause which I forget; and I think my friend did not get beyond Wednesday. Probably each hour in the day has for most of us some outer or inner sign associated with it as closely as these signs with the days of the week. It must be admitted, after all, however, that the great improvement of the time-perception during sleep and trance is a mystery not as yet cleared up. All my life I have been struck by the accuracy with which I will wake at the same *exact minute* night after night and morning after morning, if only the habit fortuitously begins. The organic registration in me is independent of sleep. After lying in bed a long time awake I suddenly rise without knowing the time, and for days and weeks together will do so at an identical minute by the clock, as if some inward physiological process caused the act by punctually running down.—Idiots are said sometimes to possess the time-measuring faculty in a marked degree. I have an interesting manuscript account of an idiot girl which says: "She was punctual almost to a minute in her demand for food and other regular attentions. Her dinner was generally furnished her at 12.30 p.m., and at that hour she would begin to scream if it were not forthcoming. If on Fast-day or Thanksgiving it were delayed, in accordance with the New England custom, she screamed from her usual dinner-hour until the food was carried to her. On the next day, however, she again made known her wants promptly at 12.30. Any slight attention shown her on one day was

From this we pass naturally to speak of certain familiar variations in our estimation of lengths of time. *In general, a time filled with varied and interesting experiences seems short in passing, but long as we look back. On the other hand, a tract of time empty of experiences seems long in passing, but in retrospect short.* A week of travel and sight-seeing may subtend an angle more like three weeks in the memory; and a month of sickness hardly yields more memories than a day. The length in retrospect depends obviously on the multitudinousness of the memories which the time affords. Many objects, events, changes, many subdivisions, immediately widen the view as we look back. Emptiness, monotony, familiarity, make it shrivel up. In Von Holtei's 'Vagabonds' one Anton is described as revisiting his native village.

"Seven years," he exclaims, "seven years since I ran away! More like seventy it seems, so much has happened. I cannot think of it all without becoming dizzy—at any rate not now. And yet again, when I look at the village, at the church-tower, it seems as if I could hardly have been seven days away."

Prof. Lazarus* (from whom I borrow this quotation), thus explains both of these contrasted illusions by our principle of the awakened memories being multitudinous or few:

"The circle of experiences, widely extended, rich in variety, which he had in view on the day of his leaving the village rises now in his mind as its image lies before him. And with it—in rapid succession and violent motion, not in chronologic order, or from chronologic motives, but suggesting each other by all sorts of connections—arise massive images of all his rich vagabondage and roving life. They roll and wave confusedly together, first perhaps one from the first year, then from the sixth, soon from the second, again from the fifth, the

demanded on the next at the corresponding hour. If an orange were given her at 4 P.M. on Wednesday, at the same hour on Thursday she made known her expectation, and if the fruit were not given her she continued to call for it at intervals for two or three hours. At four on Friday the process would be repeated but would last less long; and so on for two or three days. If one of her sisters visited her accidentally at a certain hour, the sharp piercing scream was sure to summon her at the same hour the next day," etc., etc.—For these obscure matters consult C. Du Prel: *The Philosophy of Mysticism*, chap. III. § 1.

* *Ideale Fragen* (1878). p. 219 (Essay, 'Zeit und Weile').

first, etc., until it seems as if seventy years must have been there, and he reels with the fulness of his vision. . . . Then the inner eye turns away from all this past. The outer one turns to the village, especially to the church-tower. The sight of it calls back the old sight of it, so that the consciousness is filled with that alone, or almost alone. The one vision compares itself with the other, and looks so near, so unchanged, that it seems as if only a week of time could have come between."

The same space of time seems shorter as we grow older—that is, the days, the months, and the years do so; whether the hours do so is doubtful, and the minutes and seconds to all appearance remain about the same.

"Whoever counts many lustra in his memory need only question himself to find that the last of these, the past five years, have sped much more quickly than the preceding periods of equal amount. Let any one remember his last eight or ten school years: it is the space of a century. Compare with them the last eight or ten years of life: it is the space of an hour."

So writes Prof. Paul Janet,* and gives a solution which can hardly be said to diminish the mystery. There is a law, he says, by which the apparent length of an interval at a given epoch of a man's life is proportional to the total length of the life itself. A child of 10 feels a year as $\frac{1}{10}$ of his whole life—a man of 50 as $\frac{1}{50}$, the whole life meanwhile apparently preserving a constant length. This formula roughly expresses the phenomena, it is true, but cannot possibly be an elementary psychic law; and it is certain that, in great part at least, the foreshortening of the years as we grow older is due to the monotony of memory's content, and the consequent simplification of the backward-glancing view. In youth we may have an absolutely new experience, subjective or objective, every hour of the day. Apprehension is vivid, retentiveness strong, and our recollections of that time, like those of a time spent in rapid and interesting travel, are of something intricate, multitudinous, and long-drawn-out. But as each passing year converts some of this experience into automatic routine which we hardly note at all, the days and the weeks smooth themselves out in recollection to contentless units, and the years grow hollow and collapse.

* *Revue Philosophique*, vol. III. p. 496.

So much for the apparent shortening of tracts of time in *retrospect*. They shorten in *passing* whenever we are so fully occupied with their content as not to note the actual time itself. A day full of excitement, with no pause, is said to pass 'ere we know it.' On the contrary, a day full of waiting, of unsatisfied desire for change, will seem a small eternity. *Tædium*, *ennui*, *Langweile*, *boredom*, are words for which, probably, every language known to man has its equivalent. It comes about whenever, from the relative emptiness of content of a tract of time, we grow attentive to the passage of the time itself. Expecting, and being ready for, a new impression to succeed; when it fails to come, we get an empty time instead of it; and such experiences, ceaselessly renewed, make us most formidably aware of the extent of the mere time itself.* Close your eyes and simply wait to hear somebody tell you that a minute has elapsed. The full length of your leisure with it seems incredible. You engulf yourself into its bowels as into those of that interminable first week of an ocean voyage, and find yourself wondering that history can have overcome many such periods in its course. All because you attend so closely to the mere feeling of the time *per se*, and because your attention to that is susceptible of such fine-grained successive subdivision. The *odiousness* of the whole experience comes from its insipidity; for *stimulation* is the indispensable requisite for pleasure in an experience, and the feeling of bare time is the least stimulating experience we can have.† The sensation of *tædium* is a *protest*, says Volkmann, against the entire present.

* "Empty time is most strongly perceived when it comes as a *pause* in music or in speech. Suppose a preacher in the pulpit, a professor at his desk, to stick still in the midst of his discourse; or let a composer (as is sometimes purposely done) make all his instruments stop at once; we await every instant the resumption of the performance, and, in this awaiting, perceive, more than in any other possible way, the empty time. To change the example, let, in a piece of polyphonic music—a figure, for instance, in which a tangle of melodies are under way—suddenly a single voice be heard, which sustains a long note, while all else is hushed. . . . This one note will appear very protracted—why? Because we *expect* to hear accompanying it the notes of the other instruments, but they fail to come." (Herbart: Psychol. als W., § 115.)—Compare also Münsterberg, Beiträge, Heft 2, p. 41.

† A night of pain will seem terribly long; we keep looking forward to

Exactly parallel variations occur in our consciousness of space. A road we walk back over, hoping to find at each step an object we have dropped, seems to us longer than when we walked over it the other way. A space we measure by pacing appears longer than one we traverse with no thought of its length. And in general an amount of space attended to in itself leaves with us more impression of spaciousness than one of which we only note the content.*

I do not say that *everything* in these fluctuations of estimate can be accounted for by the time's content being crowded and interesting, or simple and tame. Both in the shortening of time by old age and in its lengthening by *ennui* some deeper cause *may* be at work. This cause can only be ascertained, if it exist, by finding out *why we perceive time at all*. To this inquiry let us, though without much hope, proceed.

THE FEELING OF PAST TIME IS A PRESENT FEELING.

If asked why we perceive the light of the sun, or the sound of an explosion, we reply, "Because certain outer forces, ether-waves or air-waves, smite upon the brain, awakening therein changes, to which the conscious perceptions, light and sound, respond." But we hasten to add that neither light nor sound *copy* or *mirror* the ether- or air-waves; they represent them only symbolically. The *only* case, says Helmholtz, in which such copying occurs, and in which

a moment which never comes—the moment when it shall cease. But the odiousness of this experience is not named *ennui* or *Langweile*, like the odiousness of time that seems long from its emptiness. The more positive odiousness of the pain, rather, is what tinges our memory of the night. What we feel, as Prof. Lazarus says (*op cit.* p. 202), is the long time of the suffering, not the suffering of the long time *per se*.

* On these variations of time-estimate, cf. Romanes, Consciousness of Time. in Mind, vol. III. p. 297; J. Sully, Illusions, pp. 245-261, 302-305; W. Wundt, Physiol. Psych., II. 287, 288; besides the essays quoted from Lazarus and Janet. In German, the successors of Herbart have treated of this subject: compare Volkmann's Lehrbuch d. Psych., § 89, and for references to other authors his note 3 to this section. Lindner (Lbh. d. empir. Psych.), as a parallel effect, instances Alexander the Great's life (thirty-three years), which seems to us as if it must be long, because it was so eventful. Similarly the English Commonwealth, etc.

"our perceptions can truly correspond with outer reality, is that of the *time-succession* of phenomena. Simultaneity, succession, and the regular return of simultaneity or succession, can obtain as well in sensations as in outer events. Events, like our perceptions of them, take place in time, so that the time-relations of the latter can furnish a true copy of those of the former. The sensation of the thunder follows the sensation of the lightning just as the sonorous convulsing of the air by the electric discharge reaches the observer's place later than that of the luminiferous ether." *

One experiences an almost instinctive impulse, in pursuing such reflections as these, to follow them to a sort of crude speculative conclusion, and to think that he has at last got the mystery of cognition where, to use a vulgar phrase, 'the wool is short.' What more natural, we say, than that the sequences and durations of things *should* become known? The succession of the outer forces stamps itself as a like succession upon the brain. The brain's successive changes are copied exactly by correspondingly successive pulses of the mental stream. The mental stream, feeling itself, must feel the time-relations of its own states. But as these are copies of the outward time-relations, so must it know them too. That is to say, these latter time-relations arouse their own cognition; or, in other words, the mere existence of time in those changes out of the mind which affect the mind is a sufficient cause why time is perceived by the mind.

This philosophy is unfortunately too crude. Even though we *were* to conceive the outer successions as forces stamping their image on the brain, and the brain's successions as forces stamping their image on the mind,† still, between the mind's own changes *being* successive, and *knowing their own succession*, lies as broad a chasm as between the object and subject of any case of cognition in the world. *A succession of feelings, in and of itself, is not a feeling of succession. And since, to our successive feelings, a feeling of their own succession is added, that must be treated as an*

* *Physiol Optik*, p. 445.

† Succession, time *per se*, is no force. Our talk about its devouring tooth, etc., is all elliptical. Its *contents* are what devour. The law of inertia is incompatible with time's being assumed as an efficient cause of anything.

additional fact requiring its own special elucidation, which this talk about outer time-relations stamping copies of themselves within, leaves all untouched.

I have shown, at the outset of the article, that what is past, to be known as past, must be known *with* what is present, and *during* the 'present' spot of time. As the clear understanding of this point has some importance, let me, at the risk of repetition, recur to it again. Volkmann has expressed the matter admirably, as follows:

"One might be tempted to answer the question of the origin of the time-idea by simply pointing to the train of ideas, whose various members, starting from the first, successively attain to full clearness. But against this it must be objected that the successive ideas are not yet the idea of succession, because succession *in* thought is not the thought *of* succession. If idea A follows idea B, consciousness simply exchanges one for another. That B *comes after* A is for our consciousness a non-existent fact; for this *after* is given neither in B nor in A; and no third idea has been supposed. The thinking of the sequence of B upon A is another kind of thinking from that which brought forth A and then brought forth B; and this first kind of thinking is absent so long as merely the thinking of A and the thinking of B are there. In short, when we look at the matter sharply, we come to this antithesis, that if A and B are to be represented *as occurring in succession* they must be *simultaneously represented*; if we are to think of them as one after the other, we must *think* them both at once." *

If we represent the actual time-stream of our thinking by an horizontal line, the thought of the stream or of any segment of its length, past, present, or to come, might be figured in a perpendicular raised upon the horizontal at a certain point. The length of this perpendicular stands for a certain object or content, which in this case is the time thought of, and all of which is thought of together at the actual moment of the stream upon which the perpendicular is raised. Mr. James Ward puts the matter very well in his masterly article 'Psychology' in the ninth edition of the *Encyclopædia Britannica*, page 64. He says:

"We may, if we represent succession as a line, represent simultaneity as a second line at right angles to the first; empty time—or time-length without time-breadth, we may say—is a mere abstraction. Now, it is with the former line that we have to do in treating of time

* *Lehrbuch d. Psych.*, § 87. Compare also H. Lotze, *Metaphysik*, § 154.

as it is, and with the latter in treating of our intuition of time, where, just as in a perspective representation of distance, we are confined to lines in a plane at right angles to the actual line of depth. In a succession of events, say of sense-impressions, A B C D E . . . , the presence of B means the absence of A and C, but the presentation of this succession involves the simultaneous presence in some mode or other of two or more of the presentations A B C D. In reality, past, present, and future are differences in time, but in presentation all that corresponds to these differences is in consciousness simultaneously."

There is thus a sort of *perspective projection* of past objects upon present consciousness, similar to that of wide landscapes upon a camera-screen.

And since we saw a while ago that our maximum distinct intuition of duration hardly covers more than a dozen seconds (while our maximum vague intuition is probably not more than that of a minute or so), we must suppose that *this amount of duration is pictured fairly steadily in each passing instant of consciousness* by virtue of some fairly constant feature in the brain-process to which the consciousness is tied. *This feature of the brain-process, whatever it be, must be the cause of our perceiving the fact of time at all.** The duration thus steadily perceived is hardly more than the 'specious present,' as it was called a few pages back. Its content is in a constant flux, events dawning into its forward end as fast as they fade out of its rearward one, and each of them changing its time-coefficient from 'not yet,' or 'not quite yet,' to 'just gone' or 'gone,' as it passes by. Meanwhile, the specious present, the intuited duration, stands permanent, like the rainbow on the waterfall, with its own quality unchanged by the events that stream through it. Each of these, as it slips out, retains the power of being reproduced; and when reproduced, is reproduced with the duration and neighbors which it originally had. Please observe, however, that the reproduction of an event, *after* it has once completely dropped out of the rearward end of the specious present, is an entirely different psychic fact from its direct perception in the specious present as a thing immediately past. A creature might be entirely devoid of *reproductive* memory, and yet have the time-sense; but the

* The cause of the perceiving, not the object perceived!

latter would be limited, in his case, to the few seconds immediately passing by. Time older than that he would never recall. I assume reproduction in the text, because I am speaking of human beings who notoriously possess it. Thus memory gets strewn with *dated* things—dated in the sense of being before or after each other.* The date of a thing is a mere relation of *before* or *after* the present thing or some past or future thing. Some things we date simply by mentally tossing them into the past or future *direction*. So in space we think of England as simply to the eastward, of Charleston as lying south. But, again, we may date an event exactly, by fitting it between two terms of a past or future series explicitly conceived, just as we may accurately think of England or Charleston being just so many miles away.†

The things and events thus vaguely or exactly dated become thenceforward those signs and symbols of longer time-spaces, of which we previously spoke. According as we think of a multitude of them, or of few, so we imagine the time they represent to be long or short. But *the original paragon and prototype of all conceived times is the specious present, the short duration of which we are immediately and incessantly sensible.*

* "'No more' and 'not yet' are the proper time-feelings, and we are aware of time in no other way than through these feelings," says Volkman (Psychol., § 87). This, which is not strictly true of our feeling of *time per se*, as an elementary bit of duration, is true of our feeling of *date* in its events.

† We construct the miles just as we construct the years. Travelling in the cars makes a succession of different fields of view pass before our eyes. When those that have passed from present sight revive in memory, they maintain their mutual order because their contents overlap. We think them as having been before or behind each other; and, from the multitude of the views we can recall behind the one now presented, we compute the total space we have passed through.

It is often said that the perception of time develops later than that of space, because children have so vague an idea of all dates before yesterday and after to-morrow. But no vaguer than they have of extensions that exceed as greatly their unit of space-intuition. Recently I heard my child of four tell a visitor that he had been 'as much as one week' in the country. As he had been there three months, the visitor expressed surprise; whereupon the child corrected himself by saying he had been there 'twelve years.' But the child made exactly the same kind of mistake when he asked if Boston was not one hundred miles from Cambridge, the distance being three miles.

TO WHAT CEREBRAL PROCESS IS THE SENSE OF TIME DUE?

Now, to what element in the brain-process may this sensibility be due? It cannot, as we have seen, be due to the mere duration itself of the process; it must be due to an element present at every moment of the process, and this element must bear the same inscrutable sort of relation to its correlative feeling which all other elements of neural activity bear to their psychic products, be the latter what they may. Several suggestions have been made as to what the element is in the case of time. Treating of them in a note,* I will try to express briefly the only conclusion which

* Most of these explanations simply give the *signs* which, adhering to impressions, lead us to *date* them within a duration, or, in other words, to assign to them their order. Why it should be a *time-order*, however, is not explained. Herbart's would-be explanation is a simple description of time-perception. He says it comes when, with the last member of a series present to our consciousness, we also think of the first; and then the whole series revives in our thought at once, but with strength diminishing in the *backward* direction (Psychol. als Wiss., § 115; Lehrb. zur Psychol., §§ 171, 172, 175). Similarly Drobisch, who adds that the series must appear as one already *elapsed* (*durehlaufene*), a word which shows even more clearly the question-begging nature of this sort of account (Empirische Psychol., § 59). Th. Waitz is guilty of similar question-begging when he explains our time-consciousness to be engendered by a set of unsuccessful attempts to make our percepts agree with our *expectations* (Lehrb. d. Psychol., § 52). Volkmann's mythological account of past representations striving to drive present ones out of the seat of consciousness, being driven *back* by them, etc., suffers from the same fallacy (Psychol., § 87). But all such accounts agree in implying one fact—viz., that the brain-processes of various events must be active simultaneously, and in varying strength, for a time-perception to be possible. Later authors have made this idea more precise. Thus, Lipps: "Sensations arise, occupy consciousness, fade into images, and vanish. According as two of them, *a* and *b*, go through this process simultaneously, or as one precedes or follows the other, the *phases of their fading* will agree or differ; and the difference will be proportional to the time-difference between their several moments of beginning. Thus there are differences of *quality* in the images, which the mind may *translate* into corresponding differences of their temporal order. There is no other possible middle term between the objective time-relations and those in the mind than these differences of phase." (Grundtatsachen des Seelenlebens, p. 588.) Lipps accordingly calls them 'temporal signs,' and hastens explicitly to add that the soul's translation of their order of strength into a time-order is entirely inexplicable (p. 591). M. Guyau's account (Revue Philosophique, xix. 353) hardly differs from that of his predecessors, except in picturesqueness of style. Every change leaves a series of *trainées lumineuses* in the mind like

seems to emerge from a study of them and of the facts—unripe though that conclusion be.

the passage of shooting stars. Each image is in a more fading phase, according as its original was more remote. This group of images gives duration, the mere time-form, the 'bed' of time. The distinction of past, present, and future within the bed comes from our active nature. The future (as with Waitz) is what I want, but have not yet got, and must wait for. All this is doubtless true, but is no *explanation*.

Mr. Ward gives, in his Encyclopædia Britannica article (Psychology, p. 65, col. 1), a still more refined attempt to specify the 'temporal sign.' The problem being, among a number of other things thought as successive, but simultaneously thought, to determine which is first and which last, he says: "After each distinct representation, *a b c d*, there may intervene the representation of that *movement of attention* of which we are aware in passing from one object to another. In our present reminiscence we have, it must be allowed, little direct proof of this intervention; though there is, I think, indirect evidence of it in the tendency of the flow of ideas to follow the order in which the presentations were at first attended to. With the movement itself when the direction of attention changes, we are familiar enough, though the residua of such movements are not ordinarily conspicuous. These residua, then, are our temporal signs. . . . But temporal signs alone will not furnish all the pictorial exactness of the time-perspective. These give us only a fixed series; but the law of obliviscence, by insuring a progressive variation in intensity as we pass from one member of the series to the other, yields the effect which we call time-distance. By themselves such variations in intensity would leave us liable to confound more vivid representations in the distance with fainter ones nearer the present, but from this mistake the temporal signs save us; where the memory-continuum is imperfect such mistakes continually occur. On the other hand, where these variations are slight and imperceptible, though the memory-continuum preserves the order of events intact, we have still no such distinct appreciation of comparative distance in time as we have nearer to the present, where these perceptive effects are considerable. . . . Locke speaks of our ideas succeeding each other 'at certain distances not much unlike the images in the inside of a lantern turned round by the heat of a candle,' and 'guesses' that 'this appearance of theirs in train varies not very much in a waking man.' Now what is this 'distance' that separates *a* from *b*, *b* from *c*, and so on; and what means have we of knowing that it is tolerably constant in waking life? It is, probably, that, the residuum of which I have called a temporal sign; or, in other words, it is the movement of attention from *a* to *b*." Nevertheless, Mr. Ward does not call our feeling of this movement of attention the *original* of our feeling of time, or its brain-process the brain-process which directly causes us to perceive time. He says, a moment later, that "though the fixation of attention does of course really occupy time, it is probably not in the first instance perceived as time—i.e. as continuous 'protensity,' to use a term of Hamilton's—but as intensity. Thus, if this supposition be true, there is an element in our concrete time-perceptions which has no place in our abstract conception of Time. In Time physically conceived there is no trace of intensity; in time

The phenomena of 'summation of stimuli' in the nervous system prove that each stimulus leaves some latent activity

psychically experienced, duration is primarily an intensive magnitude, and so far literally a perception." Its 'original' is, then, if I understand Mr. Ward, something like a *feeling* which accompanies, as pleasure and pain may accompany, the movements of attention. Its brain-process must, it would seem, be assimilated in general type to the brain-processes of pleasure and pain. Such would seem more or less consciously to be Mr. Ward's own view, for he says: "Everybody knows what it is to be distracted by a rapid succession of varied impressions, and equally what it is to be wearied by the slow and monotonous recurrence of the same impressions. Now these 'feelings' of distraction and tedium owe their characteristic qualities to movements of attention. In the first, attention is kept incessantly on the move; before it is accommodated to *a*, it is disturbed by the suddenness, intensity, and novelty of *b*; in the second, it is kept all but stationary by the repeated presentation of the same impression. Such excess and defect of surprises make one realize a fact which in ordinary life is so obscure as to escape notice. But recent experiments have set this fact in a more striking light, and made clear what Locke had dimly before his mind in talking of a certain distance between the presentations of a waking man. In estimating very short periods of time of a second or less, indicated, say, by the beats of a metronome, it is found that there is a certain period for which the mean of a number of estimates is correct, while shorter periods are on the whole over-, and longer periods under-estimated. I take this to be evidence of the time occupied in accommodating or fixing attention." Alluding to the fact that a series of experiences, *a b c d e*, may seem short in retrospect, which seemed everlasting in passing, he says: "What tells in retrospect is the series *a b c d e*, etc.; what tells in the present is the intervening *t₁ t₂ t₃*, etc., or rather the original accommodation of which these temporal signs are the residuum." And he concludes thus: "We seem to have proof that our perception of duration rests ultimately upon quasi-motor objects of varying intensity, the duration of which we do not directly experience as duration at all."

Wundt also thinks that the interval of about three-fourths of a second, which is estimated with the minimum of error, points to a connection between the time-feeling and the succession of distinctly 'appereived' objects before the mind. The 'association-time' is also equal to about three fourths of a second. This association-time he regards as a sort of internal standard of duration to which we involuntarily assimilate all intervals which we try to reproduce, bringing shorter ones up to it and longer ones down. [In the Stevens result we should have to say *contrast* instead of assimilate, for the longer intervals there seem longer, and the shorter ones shorter still.] "Singularly enough," he adds (*Physiol. Psych.*, II, 286), "this time is about that in which in rapid walking, according to the Webers, our legs perform their swing. It seems thus not unlikely that both psychical constants, that of the average speed of reproduction and that of the surest estimation of time, have formed themselves under the influence of those most habitual movements of the body which we also use when we try to subdivide rhythmically longer tracts of time."

behind it which only gradually passes away. (See above, pp. 82-85.) Psychological proof of the same fact is afforded by those 'after-images' which we perceive when a sensorial stimulus is gone. We may read off peculiarities in an after-image, left by an object on the eye, which we failed to note in the original. We may 'hark back' and take in the meaning of a sound several seconds after it has ceased. Delay for a minute, however, and the echo itself of the clock or the question is mute; present sensations have banished it beyond recall. With the feeling of the present thing there must at all times mingle the fading echo of all those other things which the previous few seconds have supplied. Or, to state it in neural terms, *there is at every moment a cumulation of brain-processes overlapping each other, of which the fainter ones are the dying phases of processes which but shortly previous were active in a maximal degree.* The AMOUNT OF THE OVERLAPPING determines the feeling of the DURATION OCCUPIED. WHAT EVENTS shall appear to occupy the duration depends on just WHAT PROCESSES the overlapping processes are. We know so little of the intimate nature of the brain's activity that even where a sensation monotonously endures, we cannot say that the earlier moments of it do

Finally, Prof. Mach makes a suggestion more specific still. After saying very rightly that we have a real *sensation* of time—how otherwise should we identify two entirely different airs as being played in the same 'time'? how distinguish in memory the first stroke of the clock from the second, unless to each there clove its special time-sensation, which revived with it?—he says "it is probable that this feeling is connected with that organic *consumption* which is necessarily linked with the production of consciousness, and that the time which we feel is probably due to the [mechanical?] *work* of [the process of?] *attention*. When attention is strained, time seems long; during easy occupation, short, etc. . . . The fatigue of the organ of consciousness, as long as we wake, continually increases, and the work of attention augments as continually. Those impressions which are conjoined with a *greater amount* of work of attention appear to us as the *later*." The apparent relative displacement of certain simultaneous events and certain anachronisms of dreams are held by Mach to be easily explicable as effects of a splitting of the attention between two objects, one of which consumes most of it (*Beiträge zur Analyse der Empfindungen*, p. 103 foll.). Mach's theory seems worthy of being better worked out. It is hard to say now whether he, Ward, and Wundt mean at bottom the same thing or not. The theory advanced in my own text, it will be remarked, does not pretend to be an *explanation*, but only an elementary statement of the 'law' which makes us aware of time. The Herbartian mythology purports to *explain*.

not leave fading processes behind which coexist with those of the present moment. *Duration and events together form our intuition of the specious present with its content.** Why such an intuition should result from such a combination of brain-processes I do not pretend to say. All I aim at is to state the most *elemental* form of the psycho-physical conjunction.

I have assumed that the brain-processes are sensational ones. Processes of active attention (see Mr. Ward's account in the long foot-note) will leave similar fading brain-processes behind. If the mental processes are conceptual, a complication is introduced of which I will in a moment speak. Meanwhile, still speaking of sensational processes, a remark of Wundt's will throw additional light on the account I give. As is known, Wundt and others have proved that every act of perception of a sensorial stimulus takes an appreciable time. When two different stimuli—e.g. a sight and a sound—are given at once or nearly at once, we have difficulty in attending to both, and may wrongly judge their interval, or even invert their order. Now, as the result of his experiments on such stimuli, Wundt lays down this law: † that of the three possible determinations we may make of their order—

"namely, simultaneity, continuous transition, and discontinuous transition—only the first and last are realized, *never the second*. Invariably, when we fail to perceive the impressions as simultaneous, we notice a shorter or longer empty time between them, *which seems to correspond to the sinking of one of the ideas and to the rise of the other*. . . . For our attention may share itself equally between the two impressions, which will then compose one total percept [and be simultaneously felt]; or it may be so adapted to one event as to cause

* It would be rash to say definitely just how many seconds long this specious present must needs be, for processes fade 'asymptotically,' and the distinctly intuited present merges into a penumbra of mere dim *recency* before it turns into the past which is simply reproduced and conceived. Many a thing which we do not distinctly date by intercalating it in a place between two other things will, nevertheless, come to us with this feeling of belonging to a *near* past. This sense of recency is a feeling *sui generis*, and may affect things that happened hours ago. It would seem to show that their brain-processes are still in a state modified by the foregoing excitement, still in a 'fading' phase, in spite of the long interval.

† *Physiol. Psych.*, II. 263.

it to be perceived immediately, and then the second event can be perceived only after a certain time of latency, during which the attention reaches its effective maximum for it and diminishes for the first event. In this case the events are perceived as *two*, and in successive order—that is, as separated by a time-interval in which attention is not sufficiently accommodated to either to bring a distinct perception about. . . . While we are hurrying from one to the other, everything between them vanishes in the twilight of general consciousness."*

One might call this the *law of discontinuous succession in time, of percepts to which we cannot easily attend at once*. Each percept then requires a separate brain-process; and when one brain-process is at its maximum, the other would appear perforce to be in either a waning or a waxing phase. If our theory of the time-feeling be true, empty time *must* then subjectively appear to separate the two percepts, no matter how close together they may objectively be; for, according to that theory, the feeling of a time-duration is the immediate effect of such an overlapping of brain-pro-

* I leave my text as it was printed before Münsterberg's essay appeared (see above page 620, note). He denies that we measure any but minimal durations by the amount of fading in the ideational processes, and talks almost exclusively of our feelings of muscular tension in his account, whereas I have made no mention of such things in mine. I cannot, however, see that there is any conflict between what he and I suggest. I am mainly concerned with the consciousness of duration regarded as a specific sort of object, he is concerned with this object's measurement exclusively. Feelings of tension might be the means of the measurement, whilst overlapping processes of any and every kind gave the object to be measured. The accommodative and respiratory movements from which the feelings of tension come form regularly recurring sensations divided by their 'phases' into intervals as definite as those by which a yardstick is divided by the marks upon its length.

Let a^1, a^2, a^3, a^4 , be homologous phases in four successive movements of this kind. If four outer stimuli 1, 2, 3, 4, coincide each with one of these successive phases, then their 'distances apart' are felt as *equal*, otherwise not. But there is no reason whatever to suppose that the mere overlapping of the brain-process of 2 by the fading process of 1, or that of 3 by that of 2, etc., does not give the *characteristic quality of content* which we call 'distance apart' in this experience, and which by aid of the muscular feelings gets judged to be equal. Doubtless the muscular feelings can give us the object 'time' as well as its measure, because their earlier phases leave fading sensations which constantly overlap the vivid sensation of the present phase. But it would be contrary to analogy to suppose that they should be the only experiences which give this object. I do not understand Herr Münsterberg to claim this for them. He takes our *sense* of time for granted, and only discusses its measurement.

cesses of different phase—wherever and from whatever cause it may occur.

To pass, now, to conceptual processes: Suppose I think of the Creation, then of the Christian era, then of the battle of Waterloo, all within a few seconds. These matters have their dates far outside the specious present. The processes by which I think them, however, all overlap. What events, then, does the specious present seem to contain? Simply my successive *acts of thinking* these long-past things, not the long-past things themselves. As the instantly-present thought may be of a long-past thing, so the just-past thought may be of another long-past thing. When a long-past event is reproduced in memory and conceived with its date, the reproduction and conceiving traverse the specious present. The immediate content of the latter is thus all my *direct experiences*, whether subjective or objective. Some of these meanwhile may be *representative* of other experiences indefinitely remote.

The number of these direct experiences which the specious present and immediately-intuited past may embrace measures the extent of our 'primary,' as Exner calls it, or, as Richet calls it, of our 'elementary' memory.* The sensation resultant from the overlapping is that of the duration which the experiences seem to fill. As is the number of any larger set of events to that of these experiences, so we suppose is the length of that duration to this duration. But of the longer duration we have no direct 'realizing sense.' The variations in our appreciation of the same amount of real time may possibly be explained by alterations in the rate of fading in the images, producing changes in the complication of superposed processes, to which changes changed states of consciousness may correspond. But however *long we may conceive* a space of time to be, the objective amount of it which is *directly perceived* at any one moment by us can never exceed the scope of our 'primary memory' at the moment in question.†

* Exner in Hermann's Hdbch. d. Physiol., Bd. II. Thl. II. p. 281. Richet in Revue Philosophique, xxi. 508 (juin, 1886). See the next chapter, pp. 642-646.

† I have spoken of *fading* brain-processes alone, but only for simplicity's sake. *Dawning* processes probably play as important a part in giving the feeling of duration to the specious present.

We have every reason to think that creatures may possibly differ enormously in the amounts of duration which they intuitively feel, and in the fineness of the events that may fill it. Von Bär has indulged* in some interesting computations of the effect of such differences in changing the aspect of Nature. Suppose we were able, within the length of a second, to note 10,000 events distinctly, instead of barely 10, as now; if our life were then destined to hold the same number of impressions, it might be 1000 times as short. We should live less than a month, and personally know nothing of the change of seasons. If born in winter, we should believe in summer as we now believe in the heats of the Carboniferous era. The motions of organic beings would be so slow to our senses as to be inferred, not seen. The sun would stand still in the sky, the moon be almost free from change, and so on. But now reverse the hypothesis and suppose a being to get only one 1000th part of the sensations that we get in a given time, and consequently to live 1000 times as long. Winters and summers will be to him like quarters of an hour. Mushrooms and the swifter-growing plants will shoot into being so rapidly as to appear instantaneous creations; annual shrubs will rise and fall from the earth like restlessly boiling-water springs; the motions of animals will be as invisible as are to us the movements of bullets and cannon-balls; the sun will scour through the sky like a meteor, leaving a fiery trail behind him, etc. That such imaginary cases (barring the superhuman longevity) may be realized somewhere in the animal kingdom, it would be rash to deny.

"A gnat's wings," says Mr Spencer,† "make ten or fifteen thousand strokes a second. Each stroke implies a separate nervous action. Each such nervous action or change in a nervous centre is probably as appreciable by the gnat as is a quick movement of his arm by a man. And if this, or anything like this, is the fact, then the time occupied by a given external change, measured by many movements in the one case, must seem much longer than in the other case, when measured by one movement."

In hashish-intoxication there is a curious increase in the apparent time-perspective. We utter a sentence, and ere

* Reden (St. Petersburg, 1864), vol. I. pp. 255-268.

† Psychology, § 91.

the end is reached the beginning seems already to date from indefinitely long ago. We enter a short street, and it is as if we should never get to the end of it. This alteration might conceivably result from an approach to the condition of Von Bär's and Spencer's short-lived beings. If our discrimination of successions became finer-grained, so that we noted ten stages in a process where previously we only noted one; and if at the same time the processes faded ten times as fast as before; we might have a specious present of the same subjective length as now, giving us the same time-feeling and containing as many distinguishable successive events, but out from the earlier end of it would have drooped nine tenths of the real events it now contains. They would have fallen into the general reservoir of merely dated memories, reproducible at will. The beginning of our sentences would have to be expressly recalled; each word would appear to pass through consciousness at a tenth of its usual speed. The condition would, in short, be exactly analogous to the enlargement of space by a microscope; fewer real things at once in the immediate field of view, but each of them taking up more than its normal room, and making the excluded ones seem unnaturally far away.

Under other conditions, processes seem to fade rapidly without the compensating increase in the subdivisibility of successions. Here the apparent length of the specious present contracts. Consciousness dwindles to a point, and loses all intuitive sense of the whence and whither of its path. Express acts of memory replace rapid bird's-eye views. In my own case, something like this occurs in extreme fatigue. Long illnesses produce it. Occasionally, it appears to accompany aphasia.* It would be vain to seek

* "The patient cannot retain the image of an object more than a moment. His memory is as short for sounds, letters, figures, and printed words. If we cover a written or printed word with a sheet of paper in which a little window has been cut, so that only the first letter is visible through the window, he pronounces this letter. If, then, the sheet is moved so as to cover the first letter and make the second one visible, he pronounces the second, but forgets the first, and cannot pronounce the first and second together." And so forth to the end. "If he closes his eyes and draws his finger exploringly over a well-known object like a knife or key,

to imagine the exact brain-change in any of these cases. But we must admit the possibility that to some extent the variations of time-estimate between youth and age, and excitement and *ennui*, are due to such causes, more immediate than to the one we assigned some time ago.

*But whether our feeling of the time which immediately-past * events have filled be of something long or of something short, it is not what it is because those events are past, but because they have left behind them processes which are present. To those processes, however caused, the mind would still respond by feeling a specious present, with one part of it just vanishing or vanished into the past. As the Creator is supposed to have made Adam with a navel—sign of a birth which never occurred—so He might instantaneously make a man with a brain in which were processes just like the 'fading' ones of an ordinary brain. The first real stimulus after creation would set up a process additional to these. The processes would overlap; and the new-created man would unquestionably have the feeling, at the very primal instant of his life, of having been in existence already some little space of time.*

he cannot combine the separate impressions and recognize the object. But if it is put into his hand so that he can simultaneously touch it with several fingers, he names it without difficulty. This patient has thus lost the capacity for grouping successive . . . impressions . . . into a whole and perceiving them as a whole." (Grashey, in *Archiv für Psychiatrie*, Bd. xvi. pp. 672-673.) It is hard to believe that in such a patient the time intuited was not clipped off like the impressions it held, though perhaps not so much of it.

I have myself often noted a curious exaggeration of time-perspective at the moment of a falling asleep. A person will be moving or doing something in the room, and a certain stage of his act (whatever it may be) will be my last waking perception. Then a subsequent stage will wake me to a new perception. The two stages of the act will not be more than a few seconds apart; and yet it always seems to me as if, between the earlier and the later one, a long interval has passed away. I conjecturally account for the phenomenon thus, calling the two stages of the act *a* and *b* respectively: Were I awake, *a* would leave a fading process in my sensorium which would overlap the process of *b* when the latter came, and both would then appear in the same specious present, *a* belonging to its earlier end. But the sudden advent of the brain-change called sleep extinguishes *a*'s fading process abruptly. When *b* then comes and wakes me, *a* comes back, it is true, but not as belonging to the specious present. It has to be specially *revoked* in memory. This mode of revocation usually characterizes long-past things—whence the illusion.

* Again I omit the future, merely for simplicity's sake.

Let me sum up, now, by saying that we are constantly conscious of a certain duration—the specious present—varying in length from a few seconds to probably not more than a minute, and that this duration (with its content perceived as having one part earlier and the other part later) is the original intuition of time. Longer times are conceived by adding, shorter ones by dividing, portions of this vaguely bounded unit, and are habitually thought by us symbolically. Kant's notion of an *intuition* of objective time as an infinite necessary continuum has nothing to support it. The *cause* of the intuition which we really have cannot be the *duration* of our brain-processes or our mental changes. That duration is rather the *object* of the intuition which, being realized at every moment of such duration, must be due to a permanently present cause. This cause—probably the simultaneous presence of brain-processes of different phase—fluctuates; and hence a certain range of variation in the amount of the intuition, and in its subdivisibility, accrues.

CHAPTER XVI.

MEMORY.

IN the last chapter what concerned us was the direct *intuition* of time. We found it limited to intervals of considerably less than a minute. Beyond its borders extends the immense region of *conceived* time, past and future, into one direction or another of which we mentally project all the events which we think of as real, and form a systematic order of them by giving to each a date. The relation of conceived to intuited time is just like that of the fictitious space pictured on the flat back-scene of a theatre to the actual space of the stage. The objects painted on the latter (trees, columns, houses in a receding street, etc.) carry back the series of similar objects solidly placed upon the latter, and we think we see things in a continuous perspective, when we really see thus only a few of them and imagine that we see the rest. The chapter which lies before us deals with the way in which we paint the remote past, as it were, upon a canvas in our memory, and yet often imagine that we have direct vision of its depths.

The stream of thought flows on; but most of its segments fall into the bottomless abyss of oblivion. Of some, no memory survives the instant of their passage. Of others, it is confined to a few moments, hours, or days. Others, again, leave vestiges which are indestructible, and by means of which they may be recalled as long as life endures. Can we explain these differences?

PRIMARY MEMORY.

The first point to be noticed is that *for a state of mind to survive in memory it must have endured for a certain length of time*. In other words, it must be what I call a substantive state. Prepositional and conjunctival states of mind are not remembered as independent facts—we cannot recall