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AN INQUIRY INTO THE PERCEPTION AND MEMORY OF TIME RELATIONS, AND PARTICULARLY INTO THE DEVELOPMENT OF THE TIME CONCEPT AMONG HIGH SCHOOL CHILDREN.

by

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PREFACE.

Among the fundamental and primary factors in the study of natural phenomena none is more important than that of time, and of these factors - space, time, mass - none has been the subject of so much misunderstanding. Yet a sound grasp of the elements and of the meaning of time is essential to philosophers, psychologists, scientists and laymen alike. As Sir James Jeans, the astronomer, has said, "We are unlikely to reach any definite conclusions on these questions (of determinancy and causation) until we have a better understanding of the true nature of time." (28) After criticising the idea of time as necessarily a steady, onward flow, and suggesting that this idea may be an illusion, he goes on to say that the theory of relativity "regards time merely as a fourth dimension to be added to the three dimensions of space." Even if we grant this assumption of the scientists, time is still a fundamental factor and must be treated as such.

In some respects, it is true, time is one of the most mysterious of our fundamental ideas, for the question inevitably arises sooner or later - does time have any real existence apart from our minds? On occasion we are very conscious of time, on another occasion we almost forget its existence, as Shakespeare was well aware when he wrote, "I'll tell you who Time ambles withal, who Time trots withal, who Time gallops withal, and who he stands still withal." The subjective variation of time is such that, if we were to measure time by our own thoughts of it, it would be a very uncertain measure we would have. But Nature, it would appear, produces her phenomena in a uniform manner at uniform times - the

Newtonian concept - and so gives us at least a more certain measure of the particular phenomenon we call time. There,are, then, as another astronomer, Prof. Eddington has put it, "two questions - first, what is the real nature of time? Second, what is the nature of that qunatity which has under the name of time become a fundamental part of the structure of classical physics?" (20). In more recent times we have a further physical problem, what is the nature of Einstein's proper - time or interval? "That time is the form of an order appertaining to the perception of the world, and not an absolute background against which the phenomena of nature are observed, is the essential ground of the principle of relativity," says Willdon Carr (14), thus suggesting a new point of view altogether in regard to time.

Now, if we were to believe with Lotze (30) that "the psychologist may, if he pleases, make the gradual development of our ideas of time the object of his inquiry, though, beyond some obvious considerations which lead to nothing, there is no hope of his arriving at any important result," then it would be wiser for us to abandon our efforts here and now, and resign ourselves to our lack of understanding. But, even if it proves impossible for us to elucidate the entire mystery and so satisfy Jeans, it is incumbent upon us to make the effort to arrive at results which may shed light on this subject. As the Dean of Carlisle once said, "We may not understand Time, but we shall not understand it better by talking nonsense about it."

There are many avenues of approach to this subject of time, but our inquiry has been limited to what we may call psychological or subjective time, and its relations to objective or common time.

This we have approached through the historical method, for we bear in mind the important results which have been obtained in other psychological and philosophical studies by the use of this method and we are by nature and by training inclined to the historical method. Metaphysical and physical considerations have been put aside as far as practicable; the questions to which we have addressed ourselves have been;what is the real nature of time, how are we sentient beings aware of it, what memory of it do we possess? To achieve this end, the files of the philosophical and psychological journals and the works of the greater psychological writers have been examined to find out the current opinions on these and allied questions. Each of these writers - Kant, Wundt, Meumann, Ward, James, Bergson, Stout, Myers, Benussi, Guyau and Piéron - illustrates a fresh stage in the development of time ideas. We shall, therefore, proceed to give some account of the earlier ideas as expressed by these and other writers, adding the results of some tests made among school children, to determine the adequacy of their concept of time, and to find out the method by which this concept has developed in their awakening minds, before proceeding to make a synthesis of these opinions and conclusions with a view to arriving at a reasonable view of time as perceived and as conceived.

INTRODUCTION.

The problem of time estimation, which is one of the main elements in the psychology of time and on which most of the experimental work has been done, has been reviewed by psychological writers from time to time. Of these reviewers we have selected three, Titchener (45), Dunlap (82, 85, 86, 88), and Weber (178) as giving us a guide to the work done on this and allied subjects.

Writing in 1905, Titchener (45) divides the work done on the estimation of time intervals into four periods. The first is the preliminary period, before the founding of Wundt's laboratory at Leipzig in 1878, during which the work suffered from psychophysics, as was perhaps natural in the days when psychological work was dominated by Fechner, who, in "Elemente der Psychophysik", tried to formulate laws based on precise and methodical researches. Of those who specially interested themselves in the problem of time, the names of Czermak, to whom we owe the term "time sense" for the ability to estimate intervals of time, of Mach, whose experiments were directed to testing the validity of Weber's Law, and of Vierordt, whose book, "Der Zeitsinn nach Versuchen", aimed "to work out the various functions of the time sense as they are exhibited in at least the most important sense departments, in the execution of voluntary movements, and, finally, in the simple ideation of temporal magnitudes," are remembered.

Then follows what Titchener calls the psychophysical period, which comes after the publication of Wundt's laws covering the whole science in "Grundzüge der physiologischen Psychologie", and after the formation of the Laipzig laboratory and the publication

of the work done there in "Philosophische Studien". Titchener selects as representative of this period seven publications from the pens of Kollert, Estel, Mehner, Glass and Fechner. The first four writers were pupils of Wundt and their works show that they were interested in such problems as the accuracy of our reproduction of time intervals, the constant error, the indifference point, and the "periodicity of the time sense". Kollert and Estel tended to the mathematical point of view, while Mehner and Glass were more influenced by the introspections of their subjects. In general method we read that these investigators abandoned the method of right and wrong cases for the method of average error. For apparatus Estel and Mehner had a primitive form of what is now the standard instrument for investigation into the estimation of time intervals. Their works are also of very great interest because they form the bases of the conclusions of William James on these problems. The other writer, Fechner, like Mach of the earlier period, was interested in testing the validity of Weber's Law.

The third period is distinguished as the intermediate period, when there were many papers on work following up that of the earlier periods. These papers Titchener says were for the most part off the straight line of psychophysical enquiry. In addition there was also a rather rank growth of theory. Finally, there is a fourth division called the modern period, though this is no longer an appropriate name for it, whose characteristic writer is Meumann. His work like that of his contemporaries, Schumann, Wrinch and Hüttner, is marked by a combination of psychological analysis with psychophysical method.

By the time Dunlap (82, 85, 86, 88) wrote his reviews under the titles of "Time and Rhythm", the experimental work was considerably reduced in volume. In 1911 Gildmeister (98) stated his conclusion that, for estimating a time interval without making use of mechanical aids, it was useful to play over a melody in march tempo. He himself was able to come within 10% of estimating 120 measures to the minute using a certain melody, and so, to estimate an interval, all he required to do was to note the number of repetitions of the melody, and the point of ending in the final repetition. We must note, however, that 120 measures to the minute bears quite a definite relation to objective time. There were studies also in 1914 associated with Wundt's laboratory by Kant (111) on the estimation of time intervals. For 16 standard intervals ranging from 230 to 3850° Kant found evidence of a periodic variation in the constant error; the shortest standard was underestimated, the standards from 300 to 680 underestimated or overestimated, and the standards beyond 800 overestimated. But, by 1916, Dunlap noted it as significant that experimental work on the perception of time and of rhythm had nearly ceased. Dunlap himself in 1911 (81), had argued for the explicit consideration of rhythmic grouping as a function of the specious present, and in 1912 (83), he gave the results of experiments which had been undertaken with this consideration in view. The threshold of difference for rate of discrete auditory stimulation (50% discrimination in Dunlap's tables and charts was taken as being the same as 75% right judgments by the traditional method) was lower with rhythmic grouping that without; while it was not appreciably higher for series with

irregular intensities and durations of stimuli than for regular series. The difference thresholds for time intervals corresponding to the rates used, were appreciably higher. Experiments using two intensities of auditory stimuli, and other experiments using two modes of stimuli, say auditory and visual, gave results which Dunlap thought spoke for strain-sensations as time-content. It was at this time that Russell (150) developed a relational theory of time on the assumption that the distinctions of past, present and future depend on experience, that is, on the relations of objects to subjects.

Since the work of Dunlap, much material, both theoretical and experimental in character, has been made available for a study of the psychology of time, and so we find the latest reviewer, Weber (178), laying down as his purpose the consideration of the general theoretical background and of the experimental work done since 1916. We should, however, notice that in 1920 some reviewing of the work was done by Swindle (172), which led him to the following general conclusion on the nature of time perception. For him, time perception meant that every response an organism could execute had a specific temporal attribute and that to manifest a conscious response meant the perception of a characteristic and definite time, independently of whether or not this conformed with any of our physical measurements that might indicate the duration of the response.

Weber (178) does not follow chronological order, as had been done by Titchener, but he divides the works according to their character, whether on the nature of time generally, in which he points out the theories which have been of greatest importance in

the development of the psychology of time, or on some special aspect, such as the effect of interpolated matter and of the limiting stimuli, in which he deals with recent experimental work on "filled" and "unfilled" intervals. His article is a very clear summary of recent work in this field, and it is very suggestive as to the work that still remains to be done. Thus, in his concluding section, he says, "The greatest part of the experimental work on time estimation still remains to be done, as many of the most promising aspects have as yet only been touched upon. Some significant work has been done on the part played by organic and kinesthetic factors. This offers, however, only a starting point for a large number of experiments regarding the operation of these factors under different conditions. For example, an experiment to test the ability to estimate long periods of time under conditions which exclude as far as possible the factor of external criteria, i.e. in a dark, sound-proof room, etc., would throw valuable light on this phase of the temporal problem. Experiments of estimation under conditions of varying degrees of kinesthetic strain would also add materially to our understanding of the time sense. Another line of attack on the problem of temporal estimation which might give interesting and significant results is that of an investigation into differences in estimation as they might arise from filling the interval with stimulation from the different sensory fields, stimulation being restricted to one field at a time and comparison being made with estimation under other sensory stimulation. It might be shown, for example, that there are considerable differences in our estimation of time between an interval filled with auditory stimuli and a similar interval filled with visual stimuli.

These examples represent, of course, only a few of the problems, but they are of significance because they fit in with the well-founded emphasis upon direct investigation into the background of our experience of time - to give us a more adequate understanding of these bases of human temporal experience."

Earlier in his paper Weber had noted the need for more data on the development of the time sense in children and in primitive people as the bases of a theory of the genetic development of the concept of time. To some of these problems our attention and work has been directed and so we offer later in this thesis some data obtained by experiment among High School Children. These experiments may be open to the criticism noted by Weber that the technique for approaching this problem, the method of the questionnaire, which is the only available technique for some parts of the work, is lacking in precision and definiteness; nevertheless, we offer our results for what they are worth.

THE NATURE OF TIME.

The work of the standard writers on the nature of time may be divided according to the interests of these writers into philosophical, scientific and psychological. In the first group, that of philosophy, the writers whose views on this subject have been most important, both in themselves and in their influence on other thinkers and writers, are Kant (29) and Bergson (6, 7, 8, 9). In reading over their work and that of other philosophers, the thought has occurred that it is a pity there is no common agreement on this question of the nature of time, since this so fundamental a factor comes into philosophical discussion on so many occasions and under so many guises.

If we consider the doctrine of time which Kant has propounded, we find it laid down for us in some five dictates. Thus, in the first place, he says that time is not an empirical concept deduced from any experience, for neither coexistence nor succession would enter into our perception, if the representation of time were not given a priori. It is only when this a priori representation is given that we can imagine that certain things happen at the same time, that is, simultaneously, or at different times, that is, successively. Other philosophers, however, have definitely treated time as conceptual in character, as does Mackenzie (123). In the second place, Kant lays it down that time is a necessary representation on which all intuitions depend. We cannot take away time from phenomena in general, though we can well take away phenomena out of time. In time alone is reality of phenomena possible; or as Watson (177) puts it, the time process must be real. All phen-

omena may vanish, but time itself, as the general condition of their possibility, cannot be done away with. Kant goes on, in the third place, to say that on this a priori necessity depends also the possibility of apodictic, or absolute, principles of the relations of time, or of axioms of time in general, as, for instance, that time has one dimension only, and that different times are not simultaneous, but successive. Such principles cannot be derived from experience, because experience could not impart to them absolute universality, nor apodictic certainty. In the fourth place, Kant argues that time is not a discursive, or what is called a general concept, but a pure form of sensuous intuition. Finally, he writes that to say that time is infinite means no more than that every definite quantity of time is possible only by limitations of one time, which forms the foundations of all times. The original representation of time must therefore by given as unlimited. But when the parts themselves and every quantity of an object can be represented as determined by limitation only, the whole representation cannot be given by concepts (for in that case the partial representation comes first), but must be founded on immediate intuition.

To these views of Kant, it may be interesting to add some of Schopenhauer's (37) before summarising them. Like Kant, Schopenhauer agrees that there is but one time, and that all different times are parts of it. Though Schopenhauer agrees with Kant on the whole, he makes some interesting additions to the doctrine. Thus, he mentions that time has three divisions; past, present and future, which form as it were two directions with a point of indifference. Later writers, like Marshall (125, 126), have seized

upon much the same idea when they regard the past and future as contradictory opposites, with the present as the norm. For them, time is a general quality of all presentations, of a three-phased nature, one of which is always predominant and excludes the others. We must note, however, that Schopenhauer is like most philosophical writers in that he does not allow duration to the present, the now. Some may, like Wordsworth (183), argue that there are no limits to the present, that time is one eternal now, but the majority of writers would agree with Schopenhauer. Another interesting suggestion made by him concerns the relations of time and space, for he says that time is perceptible a priori only by means of a line image. Though he may not go so far as Welby (179), by whom time is regarded as a derivative from space, Schopenhauer does say that motion is only possible in time and space, and that time is not directly measurable by means of itself, but only by means of motion.

For Kant and Schopenhauer, time is an a priori form inherent to the human mind; it cannot, however, stand alone, for its existence depends on the events within it. The question of the reality of time, which was for long a great source of contention among philosophical writers, is settled by these writers in the affirmative. Schiller (151), opposing the views of McIntyre (122), says that "it is only in the abandonment of the prejudice against the reality of Time that I can descry a future for hope, a future for philosophy and a philosophy for the future."

More recently Bergson (6, 7, 8, 9) has insisted upon a doctrine of time as fundamental to philosophy. Other contemporary philosophical writers are fully in agreement with this view, thus Dewey

(78) says that perception is a temporal process, its temporality being its fundamental characteristic for him.

In accordance with his general philosophical standpoint, Bergson urges that time must be active and vital, based on experience. He lays it down that it is the insufficiency of perception which makes conception necessary, though conception and judgment are based on these very perceptions. Perception, however, is selective from among our experiences. Turning to the fact of change in our experience, he says that, although contradiction is inherent in change, these contradictions are soluble in time. Just as change and movement are absolutely indivisible, so time is indivisible, and it is this indivisible continuity of change which constitutes true duration or time. That time implies succession, that is, a future and a past joined together, is not denied. As for the present, Bergson says an instant is a pure abstraction, it has no real existance, but he does not stop short at this philosophical or mathematical idea. He adds that for common-sense, the present means a certain interval of duration, the field of attention, which it is not possible to fix exactly. The extent of the field of attention determines the past and the present, whose marks he finds in effort and interest. While it is still influential, whether in individual or in national history, a fact remains for Bergson in the present, thus the boundaries of past and present are rather indeterminate. They can be distinguished, nevertheless, for, while they are continuous, they are not simultaneous. Im memory he sees the feature of the past, though he does not require any special time memory. It is not our remembering

of events but rather our forgetting of them, for which he seeks a physiological explanation in the structure of our brain. The keeping of the past in the present is no other than the indivisibility of change. Now, reality is change, change is indivisible, and, in this indivisible change, the past is one with the present. Change, life, movement are, for Bergson, the essence of eternity. Weber (178) sums up the views of Bergson thus; "For him, time must account for the new in experience and must therefore be an active, vital agency which is capable of leaving its mark on events. He assumes a multiplicity of durations, each flowing at a different rate from one individual to another, and at different rates under different conditions. This is in general agreement with the common experience of time, and gives us a basis for regarding the psychological flow of time as a normal and valid adaptation to fit the existing conditions, since it implies that the individual flow of time is just as real as physical time."

From the work of the second group of writers, the scientific, two general theories have emerged, each of which has been dominant in its own day. First, there is the earlier mechanistic view of time, the Newtonian conception, and second, there is the relativistic conception, the Einsteinian view. Though both views are open to criticism and objection as bases for a theory of the nature of experienced time, nevertheless they have the advantage which belongs to most scientific ideas - a greater definiteness of expression and a great usefulness for astronomical, physical and mathematical purposes.

Scientific knowledge in the Middle Ages was dominated by Aristotle, whose vast range of books on various branches of science yielded, as they thought, a mass of authentic information, but in the seventeenth century men like Bacon, Galileo and Descartes advocated a new kind of science. They insisted on the importance of experimental investigation and on the necessity of exact apparatus. These careful methods led Newton to his many discoveries, and particularly to his three great contribution to knowledge, the theory of the differential calculus, the law of gravitation, and the disclosure of the nature of white light. As Pope expressed it;

"Nature and Nature's laws lay hid in Night,
God said, Let Newton be, and all was light,"

or, as another critical writer, Voltaire put it: "It is to him who masters our minds by the force of truth, not to those who enslave men by violence; it is to him who understands the universe, not to those who disfigure it, that we owe our reverence." According to the Newtonian conception of the physical world, Nature knows no uncertainty as regards time, but produces her phenomena in a uniform manner at uniform times, Time has an existence independent of our thoughts and wills. "Time is a simple homogeneous medium through which events flow without being affected." Weber (178). By Newton and his disciples, Time is regarded as a single continuous steady onward flow or series in which the events of nature take place.

In recent times the theory which holds the field in astronomy and physics is the Einsteinian theory of relativity. As a distinguished modern astronomer, Jeans (28), after criticising the Newtonian

concept as probably illusion, says, "The theory of relativity regards time merely as a fourth dimension to be added to the three dimensions of space." In 1905 Einstein postulated his new law of nature thus: "Nature is such that it is impossible to determine absolute motion (and therefore absolute time) by any experiment whatever." Einstein's first results show that time and space are indissolubly linked together to form a continuum of four dimensions, in which it is impossible to separate the space from the time in any absolute manner. As Wildon Carr (14) has put this idea: "That space and time are forms of an order appertaining to the perception of the world, and not an absolute background against which the phenomena of nature are observed, is the essential ground of the principle of relativity. Time is a concept, an idea of a homogeneous duration, which does not itself impinge on experience by sensible impressions or otherwise affirm its physical existence, but which, like space, is a necessary condition of the real existence of the physical world." Now, as Eddington (20) says, there is a quantity in Einsteinian physics, unrecognised in pre-relativity physics, which more directly represents the time known to consciousness. This is called proper-time or interval. But as the time of consciousness is really subjective time, which is not fixed and absolute, but erratic, varying from person to person, it has been abandoned for physical time or Astronomer Royal's time, which is reckoned to be the same for all people, and which can be used as a standard for comparison. This physical time, this division of the day into hours, minutes and seconds is, like space, a kind of useful frame in which we locate the events of the external world. In addition to this indirect knowledge, derived through the events of

the world outside us, we have also a direct subjective experience of time, a feeling of enduring. Eddington admits that it is this subjective feeling of duration which is so peculiarly characteristic of time, and so he says, "We have intimate acquaintance with the nature of time, and so it baffles our comprehension."

This conception of time as the dimension which binds all the others together certainly gives time a very fundamental place in scientific thought, but it does not help us to any clear concept of psychological time, for, in ordinary experience, we are not concerned with the large distances in space which were investigated by Einstein and his followers, but with smaller distances and spaces, in which we can neglect the errors due to disregarding the time taken by the movement of light through space. "We can assume" with Weber (178), "that our time span takes place at a single, localised point in space." With the relations between space and time which are of psychological origin and value, we shall deal later.

When we come to deal with the writers on time, whose work is chiefly psychological in character, the difficulties of discrimination become very great, and so for convenience we have arranged these authors in three groups, not according to their theories, for these are very diverse, but according to their country of origin. Thus we have a German group, represented by such as Wundt, Meumann and Benussi, a French group, represented by Janet and Piéron, and an English and American group, represented by Ward, James, Stout and others.

The work of the German group is of outstanding importance, for it begins with Wundt (50), the father of modern experimental psychology and it is continued by Benussi (5), who in 1913 wrote the first monograph devoted to the psychology of time. Taking first the views of Wundt (50), we find that he disagrees with Kant, for, unlike Kant, he says that it is not true that the course of inner events, pure internal perception, shows only the one dimension of time. Rather he says that our sensations are intensive magnitudes which form temporal series. Elsewhere (50) he postulates that all our ideas are at once spatial and temporal. In the section of his work (50) given over to a consideration of temporal ideas, his main views are expressed in the following terms: "The primary sources of temporal ideas are two kinds of sensations, the inner tactual sensations from movements, and the auditory sensations. But the psychological bases of temporal ideas are general and are not determined by the special structures of particular sense-organs. Time ideas can arise from all possible sensations. The original development of temporal ideas belongs to touch, through the inner sensations which accompany movements." Rhythmical movements, by the principle of "the isochronism of oscillations of like amplitude" are significant for the psychological development of time ideas. The attribute of the auditory sense which most of all adapts it to the more accurate apprehension of the temporal relations in external processes, is the exceedingly short persistence of its sensations after the external stimulation; so that any temporal succession of sounds is reproduced with almost perfect fidelity in the corresponding succession of sensations. In close

connection with this, we have certain psychological properties of temporal auditory ideas. In the first place, often only the extremities of the single intervals that go to make up the total idea, are marked by sensations. In such a case the relations of such intervals to one another are estimated essentially by the apparently empty or heterogeneously filled intervals that lie between the limiting sensations. Again, in both directions of faster and slower rates of sensation, limits are approached where the synthesis of the impressions into a rhythmical time-idea is no longer possible. The upper limit is about one second, and the lower limit about .1 second. It has also been observed that in general a period divided into intervals is estimated as longer than one not so divided.

The different intensities of the subjective elements, the feeling of expectation, and the degree of concentration of the attention, are reflected in the differences between temporal ideas. The phenomenon of subjective accentuation and its influence on the sensation of rhythms, shows clearly that temporal ideas are not derived from objective impressions alone, but also from subjective elements whose character determines the apprehension of the objective impressions. Temporal ideas arise, for Wundt, through the regular combination of subjective sensational and affective elements with objective impressions. But position in time can be possible only when single psychical elements enter into certain characteristic relations with other such elements.

In a temporal series, a. b. c. d., it is always "the impression of the present moment" in relation to which the rest are arranged in time. Now this "impression of the present moment" will be

more clearly and distinctly perceived than other elements, though this most distinct perception is not connected with the physiological organisation of the sense-organ, but is due entirely to the general attributes of the ideating subjects, as expressed in the affective processes. The momentary feeling accompanying the immediately present impression is what helps to its clearest apprehension. This immediately present impression Wundt calls the inner fixation point (fixationspunckt) beyond which impressions are indirectly perceived. These indirectly perceived, past impressions are arranged in a regular gradation of diminishing degrees of clearness from the fixation point. A unitary temporal idea is possible only so long as the degree of clearness for each of its elements has some positive value.

Finally, Wundt says we may regard the feelings of expectation as the qualitative, and the sensations of movements as the intensive, temporal signs (Zeitzeichen) of a temporal idea. The idea itself must then be looked upon as a fusion of the two kinds of temporal signs with each other and with the objective sensations arranged in the temporal form.

As the work of the Zurich professor, Meumann (129, 130) is also of first rank importance, let us consider his contributions to the problem of time. He early comes to the conclusions that, to appreciate a duration, the recollections of known times must be used as comparisons, that judgments on the relative durations of various intervals must be made in order to concentrate attention on the time factor and that the final judgment must take into account the intensity, the quality, the number and the changing impressions

filling the intervals and also the feeling accompanying the impressions. His conclusion that the impressions filling the interval are of prime importance makes Meumann advocate that "every psychic process is a competent basis of time measurement." (Nichols 138) and deny that Münsterberg is right in attributing the sense of time solely to organic sensations. For Meumann it is impossible to separate time from its accompanying processes; we cannot isolate a duration from its limiting factors or from the impressions filling it. He insists that there exists an immediate appreciation of durations; the perception of time-content is an ultimate and irreducible fact. Schumann (153), his contemporary, says there are other factors, waiting and surprise, which determine the adaptation of attention, and this, in turn, determines our appreciation of time. For Meumann, there is an immediate perception of duration.

Benussi (5), the most recent of this group, wrote in 1913 his treatise in order to find the different conditions in which subjective or perceived time corresponds to objective or real time. The former, however, we may point out, is as much real time as the latter. These conditions are, for Benussi, in ordinary everyday life, the degrees of intensity of the attention given to time and its passage, and the greater or lesser singularity (Auffälligkeit) of the impressions limiting the interval of time. Benussi thinks that the period which can be perceived as a whole, the specious present, extends to about 7 or 8 seconds. Benussi's work is devoted to an analysis of our perception of intervals, the effect of the pauses between the intervals to be compared on our estimate, and the effect of the filling or otherwise of the intervals in

which he comes to the conclusion that, in general, empty times appear shorter than filled times of equal duration. He also suggests that consciousness of time can best be considered as a condition of memory. And finally, to summarise his views, we find that he draws our notice to three factors in the perception of time; first, the division of perceived time into three groups of intervals, short, long and indifferent; second, the disposition of the attention during the process of perceiving time; and third, the disposition of the singularity or peculiarity of the elements, the filling, the extent and the limitation of the interval, which struggle mutually for premier place in our consciousness.

If we turn now to the work of the French psychological writers, it does not appear that they were much attracted to this particular field of study until more recent years when Piéron became the director of L'Année Psychologique. Previously there had been studies by men like Fouillée and Guyau, but we shall delay our examination of their views, particularly those of Guyau, who devoted a whole volume to the origin of time ideas, until we come to the section which is given over to a consideration of the relations of time and space, for it is in that connection that Guyau's chief contributions have been made.

Taking the work of an earlier French writer, we discover that Bourdon (65) makes a very clear-cut distinction between the perception of short durations and of long durations, to which he naturally denies the term perception at all, for he says that the perceptions of long durations, a month, a year, are not really perceptions but conceptions; "nous arrivons á concevoir un an de

la même manière exactement qu'à concevoir une température de 1000°" So far as duration and position in time are concerned Bourdon argues that these are primitive phenomena; they are sensations which are as irreducible as the sensations of colour, of sound, and of number. In thus ascribing a primitiveness to time ideas in our consciousness, in not going beyond these fundamental phenomena to explain our temporal ideas, Bourdon differs radically from writers like Wundt and Münsterberg, who find duration in the perception of rhythmic movements, or in muscular tension, or in the waning of memory images.

In another direction we have the work of Bard (58), whose enquiries are directed to determining the physiological bases of our perception of time. He begins by laying it down that the part played by consciousness is "to read and interpret the mental images", from which it follows that "the notioms of quantity give place to presentations immediate to consciousness as well as to those of quality". On the physiological side he adumbrates a close correspondence between central and peripheral images, without which "the marvellous structural complication of sensorial apparatus would have neither end nor reason." Now, it is our sensorial apparatus which registers the smallest details of exterior phenomena, and so he goes on to say that the perception of duration is made partly by the integration of the central image at intensity and that the superior centres are only to sort out time from the elements of duration contained in the images. "Et il y a un indice local de temps comme un indice local d'espace."

In addition to the pages devoted to time in his work on experimental psychology, Piéron gives over a complete article in

L'année Psychologique (145) to the problem of time. In this article, he analyses the fundamental elements in time into these two; distance or interval, which he regards as essential, and position in a simplified form, which is that of order, the intervals being polarised, so to speak. The impression of distance in a definite order imposing itself on experience is at the foundation of the specific notion of time. The former of these elements he says can be subdivided into simultaneity, succession and rhythm, duration with both an upper and a lower threshold, and finally change. He then proceeds to devote quite a considerable space to an examination of the length of the psychological present, but with this we shall deal later. So far as the perception of temporal magnitudes is concerned, Piéron says that although the "time sense" has been the subject of much experiment, it has equally been a subject of much disagreement, and, in particular, he says that the part played by organic sensations has not been clearly elucidated. He makes the interesting suggestion that, if the unity of time varies from one individual to another, and even in the same individual from time to time, it is probable that the perception of durations and even the value of the differential threshold, varies correlatively. He agrees with the theory which assumes a connection between objective or physical time and subjective or experienced time, for he says that it is a legitimate postulate of scientific psychology, that of integrating psychological time with physical time, of not seeing in the mental unity of duration an absolute measure, but a temporal magnitude which is a function of the speed of certain physico-chemical processes, such as those set in motion

by a change of temperature, With regard to this last point, it is noteworthy that François (95) concludes from his reaearches that it is impossible to separate psychological from physiological factors in the study of time. He seems to have established a close dependence between these factors, at least so far as internal temperature is concerned. This may some day have to be taken into account in theories of time.

Janet (26) divides his work on time into three sections. The first section deals with duration, the second with elementary memory, and the third with the organisation of time. Now, from his work there emerges the general notion that time is built up psychologically by the union of duration with memory. Time, for Janet, is not a form, but a construction of the mind.

The most recent idea from the French writers is that in each human group, the idea of time is constituted by contact with reality and with the developing needs of everyday life, as the group becomes civilised. Thus the human mind arrives eventually at the idea of an infinite and homogeneous time. Such is the idea of Pichon (144) and of Bos (64), who gives expression to it in terms suggesting that time is man himself, since time is in all sensation. Finally, Rageot (148) says that time is born from our personal changes; later time becomes for us the times of others and so we are led from the idea of an individual, personal time to the idea of a universal, world time.

Finally, we have the Anglo-Saxon group of writers, from among whom we have chosen Ward, James and Stout as exponents of the main points of view held by English psychologists. If we first consider

the view of Ward (48) we find that there are three main elements in our knowledge of time to which he devotes his mind; the distinction of past, present and future; the ordering of events in the past; and duration or protensity. Now, Ward relies upon the theory of movements of attention to explain the psychological bases of these elements of time. In dealing with the first two, he combines that theory with the waning or sinking of the primary memory images in intensity and distinctness, the working of obliviscence; in the first he also introduces the waxing of the ordinary images and the attitude or feeling of expectation. One further point worthy of notice in his distinction of past and future is the reference he makes to the conative factor - the active attitude to which the event or memory leads or tends to lead. The temporal signs due to movements of attention and fading brain states are his chief explanations of the phenomena of time, but, even while relying on them, he admits imperfections in his theory. Mistakes in the ordering of events in past time continually occur when the memory train is imperfect; it may happen and does happen that more vivid representations in the past may be confounded with fainter ones nearer the present, which would not be the case if the theory were absolutely sound. His theory is also open to the further objection that in actual everyday life, we do not work back from the present or from events immediately past at maximum intensity to events of still earlier occurrence at lesser degrees of intensity. Our minds are not like cinematograph films, to be unrolled at need. If that were the way in which our minds worked, our memories would be stored with a great many useless

images which we could not avoid recalling. Rather it seems that we do Have the power of selecting from our store of memories not merely the particular portion of the memory-continuum containing the particular memory image we wish to recall, but we can eliminate within that portion all save the particular item we are striving to recall. This power of selection demands some better psychological explanation than that offered by Ward, for, if we depended on the sinking of the memory images we would have to go through the various items until we came to our particular item. In actual practice, we do not pass in review a number of images until we come to the one we desire; we seem to recall it right away.

Spearman (38) also attacks this theory on the grounds that sequence can be detected down to intervals of extremely minute dimensions, which may be perhaps as low as .002 second, a result he quotes from Exner (92); and that shifts of attention, which he defines as the focus of cognitive intensity, have been proved to need as much as .3 second for their accomplishment, the best result in Spearman's laboratory being .2 second. It is interesting to note in passing Spearman's own explanation (38) of our perception of time. He says that the answer lies in regarding the perception of the present as an elementary case of apprehending the characters of experience, and the perception of sequence or definite ordering of events as an elementary case of educing the relations between these characters;; and these are integrated to give us our idea of the present, past and future.

To bring in the temporal signs due to movements of attention as the explanation does not seem adequate, for this theory would

lead also to the sifting of our memory images beginning with the more recent and working backwards; otherwise it would be a contradiction of the other part of Ward's theory. We recall events, it seems to us either because of their outstanding connotations which keep them, irrespective of their place in the memory-continuum, clear and distinct in our memory, or because we follow some chronological ordering; we recall the events in their straightforward order of occurrence, with no thought at all of their memory intensity, until we come to the one we are anxious to recall. Reasoning, for we probably have knowingly or unknowingly invented some bonds, some connotations by which to remember an event, and the ordinary working of recall, seem sufficient to explain our ordering of events in the past. On the other hand, while we agree with Spearman and others that the theory of movements of attention is not adequate to explain the ordering of events, we can allow its usefulness as a factor in helping us to estimate short periods of duration. Attention and the overlapping of memory images are two of the factors admitted by Myers (33) in the estimation of short intervals.

Another writer whose work on the perception and memory of time has been of outstanding importance is James (27). From an analysis of his work it is clearly seen that the principal contribution made by him to the problem of time perception is his insistence on the specious present as the original intuition of time. Though the term was suggested earlier by Clay (15) the idea of the specious present, the fragment of duration "with a rearward - and a forward-looking end," the unit of a few seconds ranging from 3.6 to 6 seconds, which is perceived by us as a whole, and with which every

writer on the subject agrees, has been popularised by James. As he says, that it is probably caused by the simultaneous presence in the mind of brain-processes of different phase, he agrees with Ward in ascribing importance to fading brain states, the overlapping of images, as an explanation of how we can perceive time at all. James adds however, that our perception of time is due to our perception of the events within the interval; we are aware of the events and of their changes, and it is this awareness of change which gives us our perception of time as having duration or protensity. Longer durations than those of the specious present are symbolically conceived and constructed by mental addition. This gives James an easy means of distinguishing perception from conception in time, and the present from the past or the future. The latter are concepts, the former is a percept.

Another important contribution by James is his explanation of the phenomena which most writers on time have noted and have felt impelled to explain, the facts that filled time appears short in passing, but long in retrospect, and that so-called empty time appears long in passing, but short in retrospect. To account for these, and also for the foreshortening of the years as we grow older, James explains that the content of the interval becomes monotonous in empty time with "a consequent simplification of the backward-glancing view", and so, in passing, we have ample opportunity to pay attention to the duration. In recalling the interval, however, and in thinking over later years, the content stimulates few brain-tracts. When these few brain-tracts are restimulated in memory, fewer images are called up and so the period in retrospect

appears short.

Finally, we must emphasise James's analysis of the phenomenon of memory into primary memory and memory proper or secondary memory, which comprises the following elements: revival of an image of the original event; symbolic conception of the fact imagined as in our own particular past; and the restimulation of the brain tracts stimulated by the original event. James, however, allows a selective function to the mind whereby it can select from the memory-continuum those particular memory images and their associates it desires to recall and whereby it can discard the others. This is a restriction upon the pure theory of fading brain processes by which we would be absolutely dependent on the clearness of the images recalled for our memory of time and for our ordering of events; we are not at the mercy of our memories, as Fouillée and to some extent Ward, would suggest. James recognises the independence of our minds and so he makes more reasonable this view that our knowledge of time is due to fading brain states.

In the introduction to the fourth edition of Stout's Manual of Psychology (40), the reviser, Mace, states that "time is either mental in nature or dependent for its existence upon some mind's awareness of it." He admits, however, that Stout is not committed to this view, and he outlines briefly Stout's view of time as follows: "We directly apprehend only fragments of the material world, and fragments of space and time. Our knowledge of what we do not directly apprehend is reached through 'trains of ideas' and through a process of 'ideal construction'".

The first main point in Stout's work, which remains as it was in the first edition, is that he regards our apprehension of time as a complex product of mental development, suggesting that he looks on time as a concept built up by man in the course of his history. Our perception of time depends on the changes which are constantly taking place within our conscious life, and it is the experience of transience involved which is the basis of our thought of succession in time, of the transition from the past to the future. Our direct apprehension of time is limited to fragments of time, the specious present, which we perceive because of change and transition in the physical world around us and in the mental world within us. We must note that Stout, unlike many others, is not committed to the view, though he leans towards it, that time is subjective. He does not rule out objective time, or Newtonian time, from psychological study because he regards it as an ideal construction, and yet he does not deny that subjective time and objective time do not necessarily or always coincide. Our knowledge of periods longer than the specious present and of temporal relations Stout says is reached through "trains of free ideas," which give us a definite apprehension of a time-series, and through a process of "ideal construction", whose starting point for the development of time order in both the past and the future is the absolute present. Now, as both trains of free ideas and ideal construction are mental processes, we are justified in thinking that Stout leans towards the common view among psychologists that time is subjective in character.

Another of his contributions to the subject of time is the part he allows to conation. As we have already noted, he admits that the present is something more than the transition from the past to the future, a mere durationless entity, but that it is the specious present, a very brief duration containing fragments of the past as well as the actual, immediate present. Now, Stout brings in the success or failure of conation as the factor which determines whether the amount of the recent past included is smaller or greater. Conation he regards, and we believe rightly regards, as one of the direct sources of our perception of time. The happy outcome or the frustration of conation explains for him the apparent rapidity or slowness in the passage of time.

Still another factor on which he lays much emphasis is that of the process of attention with its accompaniments and results. For Stout, the measure of the lapse of time is the cumulative effect of the process of attending. Attention, even in its most primitive form, is essentially prospective in nature and so the idea of the future arises, which certainly agrees with common experience that the early stages of mental development are occupied with the future rather than with the past. The idea of the past, however, is involved in the cumulative effect of attention on its own process. Attention is also a factor of prime importance in the subjective measurement of duration; the psychological measure of a period is the cumulative effect of the process of a period is the cumulative effect of the process of attending. This is specially true of our immediate estimate of duration; it is attention which determines whether the period will appear long or short.

When a period which was full of experiences and which therefore appeared short to our immediate estimate because our attention was agreeably aroused and passed easily from object to object, is recalled it appears relatively long because of the plenitude of experiences. The importance of attention and its processes is therefore very much stressed by Stout as a factor on which our knowledge of time and our awareness of its passing depends.

Finally, we must observe that Stout does not believe in a duration line or block; he believes that time is empty save for events and our perception of these events, and that this time is measured by expectant attention and certainly not by ideal reproduction of a series of events. He suggests that there is a direct power of estimating lapse of time, even for comparatively long periods. In this respect he agrees with Myers (33), who finds some evidence for the existence of the absolute impression.

Though the above writers are, as it were, the standard writers, we cannot close this section without some reference to the work of other writers. These views will naturally be somewhat miscellaneous in character, but we shall endeavour later to point out the main tendencies in the psychological theories of time. First, let us note what Hodgson (106) has to say about our perception of a time sequence. He suggests that for perception of a time sequence to be possible at all, the presentations of the prior stages of the sequence must persist in later stages, with a difference only in vividness and in the position. McGilvary (121) sums up his admirable discussion on time thus: "time is a common time experienced by all or different times severally experienced and yet fundamentally

similar. Time is experienced as a continuous succession of events, some of which may be experienced as simultaneous." Swindle's (172) idea of the nature of time is given by him in the following terms. "Time perception means that every response an organism can execute has a specific temporal attribute and that, to manifest a conscious response means the perception of a characteristic and definite time, independently of whether or not this conforms with any of our physical measurements that may indicate the duration of the response." Collins and Drever (16) distinguish the problem of time perception from the wider one of time estimation on the ground that the former, the so-called "time-sense", is purely perceptual, being the apprehension of the present moment with its associations and its context, while the latter may require the introduction of higher mental processes as an explanation. Time perception, they say, is due to the attribute of protensity or duration inherent in all sensations and to the experience of change or transition.

In dealing with the problem of duration, Washburn (176) puts forward the idea that it is really a four-fold problem. It may concern the methods of measuring the objective duration of a conscious process, or it may concern our simple consciousness of present duration. Again, it may concern the conditions which make a duration appear long or short to the subjective estimate, or it may concern the subjective factors on which our estimate of present duration depends. Setting aside the third aspect of the problem, he says that we find two opposite tendencies showing themselves. "On the one hand, the simple consciousness of a present duration is identified with the objective duration of a mental process,

measurable by physical duration, and on the other hand, this simple consciousness is identified with subjective estimates, or measurements of it." He adds further that there has often been a tendency to say that the measurement of duration is aided by the fact that the objective duration of a mental process is measurable in the same terms as the duration of a physical process, but he qualifies this attractive assumption when he denies that objective duration is the same as consciousness of duration. For him, also, we must observe, the psychologically primitive time judgment is one of succession, not of duration. Sturt (41, 169, 170), both in her articles and in her book, generally confirms the idea that time estimation is based on the quantity of thoughts filling the interval. The disagreeable or agreeable character of the events or thoughts does not appreciably modify the perception of the duration. It may be argued that, as her experiments are too few in number, they do not allow of such definite conclusions. There emerges in her book, however, clearly a point of view which is an endeavour to ally objective or common time with subjective or psychological time. For her, time is a concept, that is, it is subjective or individual in character but she allows a place to social or common time, which, as it is based on the Newtonian idea, has the merit of greater constancy. This idea of time as a concept we shall elaborate later.

And now, we shall conclude this discursive expedition among the Anglo-Saxon writers by noting the extremely interesting suggestions of Dibblee (18). After defining time as roughly the application of thought to extension, he goes on to say that subjective or

personal time is measured by the number and rate of our physical pulsations and by the amount of conscious attention given to our own time rate. Nevertheless, the accuracy of the conventional time divisions is psychologically imposed on us until we imagine that astronomical time is real time, whereas all real time is subjective and remains within ourselves. He arrives at this same conclusion also from the differences between the various subject ive times of each individual at different moments of his existence and from the differences between the subjective times of different people, due to the varying cycles of feeling. These discrepancies he says are shelved but not solved by the adoption of common time. Another pretty problem he raises is how we perceive succession in time, or the order of events within the span of our direct perception. The reality of succession we can only grasp by selecting one kind of sensation and concentrating our attention on that particular kind. These necessitate, as a hypothesis, either a time sense or a method of making an automatic succession estimate. This latter is the likelier hypothesis, for, in order to make an automatic estimate of our time rate as the clue to our succession estimate, Dibblee suggests a very interesting physiological explanation in "the peculiar and unexplained relations of the vestibular and auditory senses." He suggests that "the one furnishes the material and the other effectually acts as the instrument of comparison. The vestibular registers the internal movements of our plastic organisation. By the auditory sense we perceive the rhythm of our interior pulsations and vibrations." This physiological time rate is only indirectly manifest to

consciousness, and yet psychological time rate may be a compromise between our individual physiological time and common, measured time. This is probably real time for each of us.

To wind up our survey of these views, we note that most psychological writers make a very useful distinction between objective or physical time and subjective or psychological time. Yet in ordinary circumstances and apart from temporal illusions, there is a sort of relation between them. By writers like Russell (150) and Troland (46) a sort of parallelism is assumed, by which there are representations in subjective time corresponding roughly to events in physical time. This theory, which Weber calls the "subjective-objective dichotomy," is specially useful in experimental work on time perception, for physical time gives us a common standard and a criterion of accuracy. But Weber (178) also notes the danger inherent in this perhaps too easy assumption of parallelism, for he says, "Our knowledge of the objective world is conditioned by perceptual processes, so we are simply pushing our inquiry back another step by our assumption of objective time. The psychological problem involved cannot be explained on the basis of objective time; rather the answer must be sought for in the conditions that operate directly on our conceptions of time. A causal analysis of time perception can be made only through the discovery of those conditions which give rise to variations in our experience of time."

RELATIONS OF SPACE AND TIME

Most writers on temporal ideas, whether philosophical, scientific or psychological, have noted the close relationship between these two fundamental ideas of space and time. As Wundt (50) says, "All our ideas are at once spatial and temporal," Later in his work he adds, "Temporal ideas develop along with spatial ideas. The ability to form temporal ideas shows itself in a child's first months in the movement of its limbs and in the tendency to accompany rhythms." McIntyre (122) quotes Lotze as pointing out that our ordinary notions of time are largely derived from space images, thus we speak of time as a line, extending infinitely in two directions, or again, as a stream flowing from the past to the future, or from the future to the past. Even a writer on the metaphysics of time, Smith (159) says that the first thing to be noticed is the spatial character of time. Events, he goes on, are arranged in spatial order, the past being distant and the future near.

The experiments which have been made to determine the full extent and character of these relationships have most often proved rather inconclusive, thus Manchester's (124) contention is that "time as a factor enters more largely into the surface ideas of men; space is more often a prominent feature of the surface ideas of women." Among the various investigations carried out by the Sterns (39) into the use of words by children, they show that the notion of space is prior to the notion of time and that the idea and designation of the past appear much later than those of the present or the near future as the past is the object only of memory and not of voluntary activity; now the development of the child

proceeds from voluntary to involuntary in character. And Stockton's (165) experiments, when both boys and girls were given the same list of time and space words and asked to make their choice in each pair, lead to the conclusion that a noticeable predominance of time interest is shown by both boys and girls, though there is a slightly greater predominance of time interest among the boys.

Of all the writers who note this characteristic, perhaps the one who gives most attention and emphasis to it is the French writer, Guyau. Guyau (23) generally does not regard time from the Kantian point of view as an a priori form imposed on us, but as the result of a long evolution, of the adaptation of our desires and activity. According to Guyau, we project into our past part of the representations acquired by us in the course of our experience; now this projection is mental. Time exists in the mind, though it is conditioned by the real existence of succession and movement outside ourselves. From our perception of the present, which is limited to our actual experience of the present state together with the actual tendency to another state, and which therefore has a brief duration, we abstract a mass of relations among the phenomena and arrive at a concept of time.

With this general view in mind, we soon discover, however, that the principal thesis maintained by Guyau is that time will be formed in our minds only when our experiences (and he lays stress on the experiential basis of our notion of time) are disposed in a line of one dimension, length. In this connection it is interesting to note the fact that the principle of relativity shows us that there is no way of conceiving time by itself; we can only form a

notion of time by reference to the distance traversed in an instant. Time and space are, for the relativists, intimately and indissolubly linked together, or, as Jeans (28) says, "Space and Time, as separate entities, have already disappeared from the Universe." This thesis of the relation of time and space Guyau proceeds to demonstrate in various ways. For instance, he says that purpose, by which he means our reaction to conscious pleasures and pains, creates our notions of time and space. Succession is purpose followed by a sentiment of satisfaction, when the wants towards which we have been tending have been satisfied. Purpose then, is an effort exercised in space and so succession takes for our minds a spatial form. Again, he says that repetition of the same sensations and of the same muscular efforts forms a series stretching from the present into the future. The past is simply this interior perspective when it is reversed. There is, however, a profound difference between present impressions which are making new tracts in our brains and memories of the past which are previously made images filing past without effort. Some of these memory images, he admits, have greater intensity than others, but even the feebler images are disposed in a certain order which imposes itself on us. The bonds attaching these feebler images to other sensations are the means which produce the perspective of time, the spatial order imposed on us. Memory, then, is the means by which we distinguish one image from another and from present sensations and by which we arrive at an exact order of images: memory enables us to place a present image in time and place. Guyau (23), Taine (43) and Ribot (35) say we determine its position in time, as we

do positions in space, by reference to some fixed point, which is the present for time. Now Ribot suggests that "the number of states of consciousness thus 'determined', gone over retrogressively, and their quantity of duration", (exact consciousness of which is also given by memory) "give the position of any state whatever by reference to the present, its remoteness in time." It is also suggested that to simplify this process we employ "landmarks," that is, outstanding events whose dates are well known and which serve to guide us in the placing of lesser known events. Now these landmarks are localised in space, by which means alone they can be localised in time. From the very first we fix and measure time by space. In this spatial localisation, Guyau sees a very useful analogy, a very convenient mechanism for our thought about time, but Ribot would go further, for he says there is identity; that we think of time only by this spatial configuration. Now while it is true for the majority of people that the representation which they have of time is in this very convenient and easily recalled spatial form, there are people who do not think in such a way. It all depends on the type of imagery they use. Thus a person of purely verbal imagery might find it difficult to understand these arguments of Guyau and Ribot. Nevertheless, most people, it will be agreed, do think of time as a line stretching behind them into the past and fowards into the future, and thus visualise for themselves the continuity of time. Personally, we do not think that it is a mere convention, but a psychological necessity which impels us to arrange our experiences in a time line beginning with events of early occurrence and moving on steadily to events of very recent occurrence.

Mention must be made of Sturt's (41) attitude to Guyau's con-

tention that the ordering of time takes place by reference to space. She admits this as one factor or one possibility, also as a common, if not the commonest, method of time representation, but she does not regard it as a universal or absolute method. For her it is a late development; even though the savage tells off time on a notched stick, she says this spatial method involves reasoning and conscious arrangement, which are late mental developments, and visual imagery. Further, as all people do not employ visual imagery, a spatial arrangement may not actually exist for them at all. The convenience, the utility and frequency of a spatial arrangement, say, of a history chart, no one would deny, but it is denied by Sturt that it is sole method or the only innate method. With this conclusion we agree.

In more recent time there have been two lines of enquiry in this particular field; on one hand, Guilford (101) has studied the use of spatial symbols in our apprehension of time, and on the other hand, writers like Brown (67, 68, 69) have enquired into real and apparent movement in different sensory fields as a clue to the organic relationship between time and space in ordinary perceptual experience. If we take the earlier work of Guilford (101) first, we find that some 90% of his subjects admit using spatial symbols in thinking of time. These spatial representations are of three general types: the time may be a vertical line cut horizontally by a short line representing the present, the portion of the vertical line above this horizontal representing the future, and the portion below representing the past; or it may be a horizontal line stretching from

left to right, the left representing the past and the right the future with a short vertical line to represent the present; or, again, it may be a line moving diagonally from the bottom left hand corner to the upper right hand corner, with the present represented by a short horizontal line between the left hand portion which represents the past and the right hand portion which represents the future. Of these three forms of representation, Guilford says 58% of his subjects use the first, while the third is the least used form of the three. He also finds that many have spatial schemes by which they represent to themselves the idea of historical time. In general, he says, the perception and the representation of time appear to follow the perception and the representation of space; time is thought of as a space traversed.

Following up the investigations and suggestions of Benussi (5) and Scholz (152) into movements in the fields of auditory, visual and tactual senses, De Silva (158) finds that time is the most important factor in determining our perception of movement. Later Guilford (102), in another of his investigations, finds a very close relationship between the muscular adjustments of the eye and our experience of time. In 1931 Brown (67, 68, 69) published the results of his series of experiments in the fields of visual perception, from which the conclusions he draws are that time illusions, or failures in the integration of subjective and objective time, are not so occasional as to deserve the title of illusions and an explanation as such, but are continuous and are conditioned by almost any change in the structure of the entire field of visual

movement. He also points out that our experience of duration in these experiments in visual movement is conditioned by the total field of movement. These experiments, along with those of Helson and King (105), in the field of tactual space, have demonstrated the close dependence of time and space in perception. The feeling of duration gives us a clue to the space traversed, while equally the feeling of the space traversed gives us an indication of the duration.

PART PLAYED BY ORGANIC AND KINAESTHETIC SENSATIONS IN THE ESTIMATION OF TIME.

Another very interesting speculation concerns the relations between our knowledge and estimation of time and our organic and kinaesthetic sensations. With a certain group of writers, those who are interested in physiology especially, this has been a very popular explanation of our ability to estimate time. Perhaps the writer who has most popularised this view, is Münsterberg, who regards our organic sensation as the only sensible explanation, though he does admit that the number of presentations exercises a constant influence upon the estimate of the time interval. He says, however, that subjective conditions affect the estimate greatly, thus in an article by Münsterberg and Wylie (134), we read that "the subjective measure for such time-lengths, eight to twelve seconds, seems to me to lie in sensations peripherally aroused by muscular activity, especially by the strains and relaxations which take place in the various groups of muscles conditioned upon bodily reactions to changing intensities of stimuli. Such

reactions occur in the functions of breathing, in the voluntary movement of the eyes, limbs, etc. We can therefore compare intervals with some certainty, even when the number of outer stimuli filling them is quite varied. On the other hand, we lose that standard of comparison as soon as our attention is fully directed to those outer stimuli and thus withdrawn from our muscular sensations ..... In actual practice, one learns to divide the attention between the presentations of the outer stimuli and the bodily sensations. The more strongly these stimuli absorb the attention, the more must the bodily sensations retreat into the background of consciousness, even with experienced observers, and the shorter must the lapse of time appear. The less interesting the stimuli, the more obtrusive the bodily sensations and the longer the apparent time." This general conclusion Münsterberg says holds good for different kinds of stimuli. In this view he is in agreement with Mach (32), who does not lay as much emphasis upon it, or regard it as the sole explanation. Mach begins, like many others, by suggesting the all-pervasiveness of time; "time-sensation accompanies every other sensation, and can be wholly separated from none." He goes on to say that it is probable that time sensation is connected with "the organic consumption necessarily associated with consciousness." Now, if it is true that time sensation is conditioned by progressive organic consumption, or by the corresponding steady increase of the effort following upon attention, then it is intelligible why physiological time is not reversible, but moves only in one direction. On the other hand, a writer on experimental psychology of the standing of Myers (33) criticises the view of

Münsterberg that our ability to estimate a fairly long 'empty' interval depends on the organic and kinaesthetic sensations arising from various sources and occupying the interval. He admits that it is true that, when they are allowed to use whatever aids they like by which to remember the length of an interval people at first have recourse to voluntary movements of the head or limbs, or to the voluntary regulation of their breathing, and then they attempt to reproduce during the second interval the same sensations with which they filled the first interval, the success of their estimate depending on the exactitude with which the second interval is filled by them. But he adds that these sensory, organic methods are gradually discarded as the subjects become increasingly expert in estimating time, as these aids become eventually an hindrance. Finally no conscious use is made of such devices. Now, Myers leaves his reader with the definite impressions that he does not agree entirely with Münsterberg. It is a great pity that he is not more explicit in his criticisms. His own explanation of our estimation of time is given earlier when he says that the apparent length of an interval is influenced by the number and the nature of the experiences occurring during that interval. He does, however, suggest the need for a careful investigation into this problem when he deals with the indifference point and the claims of observers to have found other indifference intervals at odd multiples of the original indifference point. Münsterberg, he says, attributes these multiples of the shortest indifference interval to multiples of the respiratory rhythm, and even to multiples of the other organic and deeper rhythms. We are entitled to ask why this

phenomena should be confined to the odd multiples, and why it does not extend to the even multiples as well.

Among other writers who have taken up this point of view are Abord and Searle (54), whose examination into the individual differences in the methods used for the reproduction of an interval shows that the principal ones are strain and relaxation, imagined movements, auditory rhythm and the spontaneous occurrence of auditory images of the limiting stimuli. Curtis (76), writing in 1916 on duration and the temporal judgment, reckons that judgments of duration, which are regarded by her as an attribute of sensation, coordinate with quality and intensity, are made by voluntary movements of the body and by strains or general bodily kinaesthesis, though she admits that a part is played by visual imagery, and by a tendency to automatic immediate judgments with no conscious basis save the bare sensation itself. In his chapter on perception, Woodworth (49), after denying that time is a force that can conceivably act as a stimulus to a sense organ, and after suggesting that it must be some change or process that is the stimulus and that serves as an indication of duration, agrees that most likely, "it is some muscular or internal bodily change." At the same time, he goes on to say that "none of the more predise suggestions that have been made square with all the facts. It cannot be the movements of breathing that give us our perception of time, for we can hold our breath, and still distinguish one short interval from another. It cannot be the heart beat, for we can beat time in a rhythm that cuts across the rate of the heart beat. When a singer is accompanying himself on a piano, keeping good time in

spite of the fact that the notes are uneven in length and meanwhile using his feet on the pedals, what has he got left to beat time with? No one has located the stimulus to which accurate time perception responds, though, in a general way, we are pretty certain that change of one sort or another is the datum. With longer intervals, from a minute to several hours, the sign of duration is probably the amount happening in the interval, or such progressive bodily changes as hunger and fatigue. Piéron (34) is also of the same opinion, for he notes that the part played by organic sensations in the perception of temporal magnitudes has not been clearly elucidated, in which connection let us quote his own statement that "it is a legitimate postulate of scientific psychology that the mental unity of duration is a temporal magnitude which is a function of the speed of certain physico-chemical processes, such as those set in motion by a change of temperature." Arising out of these remarks, we have the work of Francois (95), a collaborator of Piéron's in L'année Psychologique, who concludes that it is impossible to separate mental factors from physiological factors in the study of time. This close dependence, at least so far as internal temperature is concerned, appears to be established as an experimental fact by his researches, which will someday have to be given a greater place in the theories of time.

Along a somewhat different line is the work of Hall (104), whose experiments on time sense by guessing at the precise minute shown on an unseen watch, by willing, beforehand, to consult a watch at a precise minute, and by willing, before sleep, to wake at a precise minute, lead him to the conclusions that a time

sense exists, that this time sense works best below the threshold of consciousness, and that the time sense, therefore, is evidence of a sub-conscious self. Hall says there is no lack of evidence that a subconscious measurement of the lapse of time takes place. He quotes the fact that domesticated animals are often strikingly punctual, and that many men can judge the hour correctly without looking at a clock, while others can wake at a predetermined minute. In my own experience I have come across a case of an elderly lady whose ability to guage the time, usually during the night, is as accurate almost as a clock. On no less than one hundred such estimates, her judgment has very rarely been wrong, and, when wrong, the error has never exceeded five minutes. She does not know how she makes her judgment; she simply pauses for a moment and says, "I think it is ten minutes past three." If a clock be then read, it will almost invariably give the same time. Beyond the fact that she is a musician of no mean ability, it is impossible to account for this remarkable accuracy unless by the hypothesis of some internal or subconscious estimate. This ability she has been conscious of all her days. Further, as a rule, post-hypnotic suggestions take effect with startling and cryptic punctuality. Another interesting point made by Hall is that time guaging is much more accurate during sleep and trance than during the waking state. Now, though he does not specifically say so, we are led to infer that behind this subconscious time sense, this absolute impression, organic factors must be at work, otherwise no explanation of its existence can be forthcoming. For the subconscious to function at all, deeper organic sensations must be set in motion.

Like Hall, Brush (72) is interested in the possibility of judging time during a period of sleep, and he comes to the conclusion that it is possible to do so with considerable accuracy. The judgment appeared as awakening under a determination. The average actual time of awakening is far closer to the time set in the experiment than to any time, absolute or relative, that one may have expected for the awakening on the basis of habit. Certain conditions appear as favourable or unfavourable for the operation of the determination, the more important of which are the general physical condition, the amount and the character of sleep, the mental activity subsequent to the setting up of the determination, both before and after going to sleep, the illumination in the room on awakening, and the motivation.

Boring and Boring (63) deal with the accuracy of the estimates of the time of night by subjects just awakened from sleep with a view to finding out the conscious cues to the estimates so far as the subjects can tell these cues. In general, the errors tend to be greatest when the awakening occurs about the third hour of sleep. The most frequent cues, the designation of which all the observers find difficult, are those which depend on the general bodily state, such as feelings of fatigue or restedness, sleepiness, "bladder sensations". Other cues are found in what are called "associative cues," i.e., clearness of consciousness, the facility with which the mind renews the thought of the previous evening, and the memory of previous periods of waking or dreaming. The accuracy of these estimates is found by them to be twice as great as can be expected from random guessing. There are apparently

sufficient conscious internal cues to account for the ability to estimate time without having to resort to such a theory as that of "unconscious cerebration."

Still another more definite exponent of the organic theory appears in the person of Pavlov (142), for whom the sense of time has its primary source in the action of the energy of the pulsatory waves or surges. As he puts it himself, "En resumé, l'écoulement du temps est la perception immédiate et subconsciente des actions de l'energie qui alimente de sang toutes les parties de l'organisme."

Yet another line of approach has suggested the importance of our organic structure in this matter. Guilford (101, 102), Gaehr (96), Packard (140), and Gradle (100) have all noted the phenomenon, which is often noticed or unnoticed by us when watching a cinema film, namely the apparent lack of movement in a moving wheel. It may even appear to us as completely stopped, for we can see in detail the spokes of the wheel. These writers suggest that this phenomenon is an example of our experience of time, on the muscular adjustments of the eye.

Finally, the part played by our organic sensations in the estimates of time is said to depend on our sense of rhythm. There is no doubt that the organic factors in our general bodily state, particularly those connected with the excretory and digestive functions, are connected with rhythm. Now, these physiological rhythms, as we have seen above, play a very important part in our judgment of time. Even our sense of rhythm in music may influence our judgment of intervals, as has been suggested by Anderson and Whitely (55).

This important field still requires some clearing up before an authoritative answer as to the exact place taken by these organic sensations, whether rhythmical in character or not, can be given.

MISCELLANEOUS EXPERIMENTAL WORK.

Ever since the days when Wundt and his fellow-workers popularised the idea of experiment in the realms of mental activities, a great deal of experimental work has been carried on in connection with time. This work has been devoted to such matters as the determination of thresholds, for instance, the shortest perceptible duration, and the largest duration which can be directly perceived as a whole. The indifference point, the influence of a pause, the estimation of long durations, the phenomenon of foreshortening, the influence of the content filling the interval, the ordering of events and the influence of the limiting stimuli have all been the subjects of much investigation. Let us now consider these in turn.

THE SMALLEST PERCEPTIBLE DURATION.

This question of the shortest perceptible interval used to be the subject of a considerable amount of experiment and discussion, for the limit of sensibility in this direction was thought to be a matter of very great interest and concern. Thus James (27), in his admirable chapter on time perception devotes some space to the work that had been done before his time. He says that "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. The problem in the latter is that of the smallest difference between two times which we can perceive. The minimum absolute difference perceived appears to be .355 seconds." He quotes the results obtained by Exner (92), who used different senses: for auditory

stimuli .002, for visual .044, and for different senses, visual to tactual .071, tactual to visual .053, visual to auditory .16, auditory to visual .06, and for one ear to another .064 seconds. Finally, James notes that the minimum absolute difference increases as the intervals compared grow long. Now, though much less work has been done on this subject during the twentieth century, its importance still holds good for an understanding of many fundamental perceptual processes, particularly those associated with the phenomena of flicker and fusion. Geigel (97), working with auditory stimuli in 1910, concludes that an interval of less than 7^{σ} between the strokes or sounds is perceptible. He even finds that, with weaker sounds, still smaller intervals can be detected. But in more recent days the limit has been considerably reduced. Aggazzotti (53) finds that the smallest perceptible interval is less than a thousandth of a second. Dunlap (87), experimenting with flashes of light, reduces Exner's result for the threshold from 12 to 44^{σ} down to 5 to 20^{σ} at the most. It is instructive to note, however, that Spearman, like James, quotes Exner in giving the interval where sequence can still be determined as low as .002 seconds. In this work Dunlap reports that a very great difficulty he encountered is the apparent "twoness" of single light flashes. He suggests possible causes of this effect and, in conclusion, says that "the effects of the brightness of the flashes under varying conditions are so unreliable as to permit of no definite statements." Adaptation is found to be a very important factor. More recently still, Piéron (34) has done some work in this field. According to him, the absolute threshold will have to do with the minimum duration

of a perceptive experience which is such that it ceases to appear as instantaneous and has a temporal extent; or with the minimum duration which must occur between two experiences for them to cease to appear simultaneous and manifest succession; or, finally, with the minimum duration of a pause in order that it may be perceived in a changing process. The threshold of pause is variable, but is about a few hundredths of a second. This is the threshold which has a practical value in the cinema for obviating flicker. The threshold of succession is also variable; for two similar sense impressions, say of a visual character, the average threshold is from 5 to 10 hundredths of a second, for auditory or tactual it is from 1 to 2. When dissimilar sense stimuli mark off the intervals, the average thresholds are 5 to 6 hundredths of a second between visual and tactual, 8 to 10 between visual and auditory, and 3 to 6 between auditory and tactual. Now, although it is possible to take account of the differences due to the varying speeds of sound and light, it is very difficult to consider the losses of time which may take place at the level of the sensory apparatus, losses due to nerve transmission, and to connections at the relay centres. These losses may vary from 2 or 3 hundredths of a second up to or even beyond a second itself. It appears, then, that the shortest perceptible interval is a few hundredths of a second for all practical purposes.

THE SENSORY PRESENT OR THE LARGEST DIRECTLY PERCEPTIBLE DURATION.

The fact that the present, for psychology, has a certain duration was first popularised by William James (27). He quotes from Clay (15) the term "specious present," which has been in common use by most psychologists since that date. Whether we think of it in Clay's terms as "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," or, in the terms of a modern writer, Broad (11), as "the greatest possible duration for a single sensible field, that is, the total event sensed throughout the whole of any process of sensing," the usefulness of the idea cannot be denied. James says that "the units of duration, which all the time-sense is able to take in at a single stroke, are groups of a few seconds," and he quotes from Wundt and Wundt's pupil, Dietze, the result of their experiments to determine the maximal extent of the immediate distinct consciousness for successive impressions as being between 3.6 and 6 seconds (50). Dietze (79) is inclined to give a greater duration, one of 12 seconds, as the maximum filled duration of which we can be both distinctly and directly aware. The maximum unfilled or empty duration seems, from the work of Estel (91) and Mehner (128) to lie within the same objective range. As James puts it, "These figures may be roughly taken to stand for the most important part of 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." We must note,

however, that criticisms have been directed against this point of view. For instance, writing in 1900, Stanley (161), after postulating that pure subjective time is a mode of introspection and self-consciousness, and that the rate of consciousness determines the amount of time perception, goes on to say, "Yet it is plain to simple introspection that any given act of consciousness is per se timeless, is merely the time unit or point. There is then no 'duration-block' as the 'unit' of our perception of time", as is demanded by James. Stanley says he cannot find in his introspections that the psychic moment ever directly perceives itself, but he sees each psychic beat as a timeless, instantaneous act, yet the sum of these acts constitutes, for him, subjective time.

Foucault (94) suggests that our immediate perception of the sensory present, "the original paragon and prototype of all conceived time," may be founded, not merely on the immediately seized or recognised sensorial qualities, but also on such other factors as emotional retentiveness, the sum total of the organic sensations which can be aroused by a given stimulus, and the greater or lesser capacity of the stimulus to impose itself, so to speak, on our attention. Myers (33) also makes use of the idea of the specious present. He first notes the interval of 550$^{\sigma}$ between two sounds as having the character of what he calls "moderate" or "adequate" length, because this interval of 550$^{\sigma}$ is the same length as that required for the development of the complete effect of a sound on consciousness. This "satisfying" interval lies within the specious present since the various changes within the interval can be apprehended as a single whole. Now, he says further that this interval,

which can be perceived as a unitary state of consciousness, can be increased by an increasing effort on the part of our active attention up to about 4 seconds. The qualifying "about" is put there for the very good and sufficient reason that the limits of the specious present are not absolute, but relative; they vary with individuals, with the nature and intensity of the limiting stimuli, and with the state of the individual himself, whether normal, hypnotic or drugged. Benussi (5) gives the specious present as 7 or 8 seconds.

Dunlap (81) gives the results of experiments undertaken to support the view that we should consider rhythmic grouping as a function of the specious present. The threshold of difference for the rate of discrete auditory stimulation is lower with rhythmic grouping than without; while it is not appreciably higher for series with irregular intensities and durations of sound stimuli than for regular series. The difference thresholds for time intervals corresponding to the rates used are appreciably higher. Experiments with two intensities of auditory stimuli, and other with two modes, such as auditory and visual, give results which Dunlap thinks speak for strain sensations as the time content. From introspections made by Quasebarth (147) it appears that the greatest duration which can be perceived as a whole is about 6 seconds for visual stimuli and 5 seconds for auditory stimuli. Beyond this sensory or psychic present, memory must be brought in, for beyond these limits the beginning must be recalled by memory when the end is reached. For Quasebarth, the basis of our perception of duration is our perception of succession - such is his attitude to this

classic problem. Drever and Collins (16), who agree that the specious present is a time interval or duration, state that its length varies with such variable factors as the nature of the sense experience filling the interval, the nature of the stimuli marking off an interval for comparison or reproduction, the relative ease or difficulty with which the attention is maintained, and the bodily condition, whether normal or abnormal. The limit given by them for the specious present, during which we have an immediate impression of duration, is 4 seconds, but even that interval demands close concentration.

In reviewing the problems associated with the psychology of time, Bonaventura (62) gives particular heed to those of simultaneity and the limit of the psychic present. From his studies, and those of others, he concludes that its limit ranges from $3\frac{1}{2}$ to 12 seconds. He goes on further to suggest a use for this knowledge in determining the least fatiguing rhythms for work. Piéron (34), a worker who has done much to maintain the prestige of the French school of experimental psychology, says that there is quite a small limit to our capacity for direct, naive perceptive reactions to durations. This limit he places at 5 to 6 seconds at the maximum.

THE INDIFFERENCE POINT

It was Vierordt (47) who first drew attention to the existence of the indifference point, for there is to be found an interval which is judged with the maximum degree of accuracy and away from which, in both directions, errors increase their size. Below the indifference point, the intervals are over-estimated, and above it

they are underestimated. Much experimenting was done in the nineteenth century to determine the value of this indifference interval and James (27) gives the average indifference point as established by Wundt at .72 second, by Kollert at .75, by Estel at .75, by Mehner at .71, by Stevens at .71, and by Glass at .8. Myers (33) naturally has a section devoted to this phenomenon, which he finds occurs with both the reproductive and the comparative methods of time estimation. According to him, the earliest experimenters found the value of the indifference interval to range between 1500 and 3500 σ, but this result Myers rejects on the grounds that the apparatus was not delicate enough, that the psycho-physical method chosen was not employed with sufficient care, and that the volitional movements used by the subjects in reproducing an interval introduced disturbing features. Under the improved conditions of later experiments, especially in the comparison method, the indifference interval has been shown to lie between 700 and 800 σ, though certain writers claim to have observed other indifference intervals at odd multiples of this primary indifference point. But we are entitled to ask once more, why should these occur at the odd multiples and not at the even multiples as well?

Absolute agreement on this point, as on the value of the specious present, has not been reached, thus, though we find Kastenholz (112) saying that he gets underestimation generally for standard intervals over .7 second while overestimation is unusual, except for times less than .7 second, when it is frequent, we haye other writers who deny this tendency. Guyau (23) has one very interesting suggestion to make, when, after noting that the point where the

interval of estimated time is, on the average, equal to the interval of real time and is reproduced exactly is round about .72 second, he says that this is also the average length of duration necessary for reproduction by memory or representation. The processes of reproduction and of association accomplish themselves most easily at a speed of about ¾ second. From this Wundt concludes that, when we have to represent to ourselves objective times longer or shorter, we try involuntarily to make them equal to this normal speed of representation, or at least approach close to it. Wundt's further remark that this same figure of ¾ second is also the duration which the leg takes of make a pace in a rapid walk suggests to Guyau that it is by the duration of a pace in space that we meaasure time. Hulser's (108) researches into the differential threshold gives him results of 2 seconds, 1.55 seconds and .75 second. Koehler (114) also finds similar thresholds when investigating comparisons and time errors. Swift and McGeogh (171) find that short durations are in general overestimated, and so they agree with the general conclusions about the indifference interval, which appears to be accepted at a value of about .75 second.

In recent years, however, this same certainty does not seem to bind investigators. Piéron (34) says that within the limits of direct perception, there exists an optimal duration for which comparisons are best and this duration he places at about ½ second. At this optimal duration of ½ second, the differential fraction remains fairly constant at about 1/20. In determining the psychic present from introspections, Calabresi (13) notes that .7 second gives a sort of durect intuition of unified duration. The greatest

blow, however, has come from Woodrow (181) who, using the reproduction method for intervals ranging from .2 second up to 30 seconds, finds no evidence for a tendency to overestimate short intervals and underestimate long ones. He finds a great number of variations, even with the same subject, and he suggests that these variations may depend on the different emotional attitude of the subjects. These individual variations are reflected very closely in the results of time experiments, and so they may give us a rough measurement of the subjective variations of any particular subject. This research, as Weber points out, shows the complexity of the judgment of time and throws considerable doubts on the efforts of earlier workers to find constancy. The general weight of evidence, however, tends to confirm the earlier conclusions.

EFFECT OF PAUSE.

Katz's experiments (113) on the effect of pause on the estimation of time intervals yields him an indifference interval of 600$^{\sigma}$ In intervals less than 600$^{\sigma}$ tend to be overestimated, while those greater than 600$^{\sigma}$ are inclined to be underestimated. Those about 600$^{\sigma}$ are easy to note, Katz says, for the attention is easily applied ("Angenehem zu erfassende Zeiten.") On this subject of pause, Myers (33) says that in the reproduction method, the length of the pause between the two intervals affects the judgment. When the subject is unrestricted as to the length of the pause, it is found to be "relatively longest when the given interval is shortest and that, as the interval is increased, the pause absolutely increases up to a certain length of interval, after which it again

declines." Myers suggests that the effect of the pause is really due to the feelings of expectation or surprise aroused by the length or brevity of the pause.

ESTIMATION OF LONG DURATIONS.

So far we have been concerned almost entirely with the estimation of short intervals, that is to say, those which lie within the limits of the specious present, and with its characteristics. Yet it is with longer durations that we have most contact in ordinary life. How, then, do we estimate these longer and more practical intervals?

To begin with, we must note that the durations we have to deal with in everyday life - minutes, hours and days - lie beyond the bounds of our perception and have to be "symbolically conceived and constructed by mental addition." James (27) says that, for these longer durations, our impressions become vague and our only way of knowing them accurately is by counting or by noticing the clock or through some other symbolic conception. This is especially the case when the times exceed hours or days; "our conception of long durations is absolutely symbolic." James suggests that we think of the amount of time in the interval either solely as a name, say an hour, or by running over a few salient dates within the interval, with no attempt to imagine the full durations that lie between them. It is impossible to have any perception of the greater length of time between now and the birth of Christ than of that between now and the Norman Conquest. To an historian, of course, the former interval will suggest a host of additional events and so appear a

more multitudinous thing; in other words, the historian will base his judgment on the amount of the content. There is, however, as James points out, properly no comparative time intuition at all in this case; "it is but dates and events, representing time, their abundance symbolising its length."

As we have seen, Stout's view (40) of our knowledge of durations longer than the mere fragments of time which we can directly apprehend is that this knowledge is reached through "trains of ideas" and through a process of "ideal construction." For Stout, the measure of the lapse of time is the cumulative effect of the process of attending. Our experiences of durations, Stout says, are unique and do not consist in having the parts of our experiences spread out before us in a sort of duration-line or duration block. From the experimental results of other workers Stout arrives at the conclusion that "there undoubtedly seems to be some power of estimating lapse of time, even for comparatively long periods." With practice he says there is a tolerable approach to accuracy. When we estimate a long duration, or when we ideally recall a period of time and estimate it by the number and variety of the events filling the interval, a period agreeably spent is apt to appear relatively longer and a period not agreeably spent, shorter. "In ideal retrospect, periods which appeared interminable while they were passing, shrink as it were; whereas periods that seemed on their actual occurrence to pass rapidly are correspondingly expanded when we review them in the form of a train of ideas."

Myers (33) says an interval greater than the specious present splits up into a number of component parts and only by representation

or conception can it be regarded as a single whole. For the estimation of these longer intervals Myers suggests that at first we make use of organic sensations by voluntary movements of the head or limbs, or of voluntary regulation of the breathing. These aids, however, are abandoned altogether later. Myers further brings forward some evidence for the existence of an absolute impression, a direct judgment based on concentration on the second interval. Our estimation of these longer durations depends, according to Drever and Collins (16) on complex and somewhat obscure conditions, though they do not demand for this ideal representation. For these longer durations, Drever and Collins say "we must assume a cumulative effect of obscure organic changes, which never enter clear consciousness at all." The exact nature of this cumulative effect, due partly to these organic changes and partly to interest and attention has never been determined. Affective factors also play a considerable part in determining our estimation, the agreeableness or otherwise of the events and sensations filling the interval determining our judgment as short or long.

THE PHENOMENON OF FORESHORTENING

(So-called by Ribot)

James (27) notes what nearly every writer on time has noted - the apparent foreshortening of the years as we grow older. He says that "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." He also notes the other very

interesting phenomenon that "the same space of time seems shorter as we grow older." The years are certainly subject to this foreshortening, the days also, but whether the hours are subject to it is doubtful. The minutes and seconds James says remain outside its scope and remain about the same to all appearance. To account for this phenomenon James explains that the content of the interval becomes monotonous both in empty times and also in later years of life, with a "consequent simplification of the backward-glancing view," and so the content stimulates fewer brain tracts. When these brain tracts are restimulated in memory, fewer images are recalled and so the period in retrospect appears short. According to Guyau (23) the apparent length of time appreciated at a distance is due to the number of decided and intense differences noticed in the recalled events. A year full of memorable and diverse happenings appears longer; an empty and monotonous year shorter; now this is analogous to what happens in space. In the same way, the fact that years appear long in youth and short in old age can be explained. The years of youth are full, but in old age there is a monotonous train of events. Guyau quotes the very interesting suggestion made by Janet (Revue Philosophique, 1877) that the apparent length of a certain portion of time, in the life of each man, will be "proportional to the total duration of his life," but, though he agrees that this law expresses a real tendency of the imagination, Guyau thinks that, as proposed by Janet, it is far too mathematical and too simple an explanation of the contraction of the years in the life of an old man. To Guyau, the contraction is due to the fact that, whereas the child has many varied and

distinct representations to put in a year, the adult has only some salient points. Guyau maintains that this is the principal explanation of the apparent shortening of the years.

ORDERING OF EVENTS

James (27) makes our ordering of events depend on our memory. Our memory is strewn with dated events. Now, dating is a mere relation of before or after the present event, or some past or future event. This dating, however, is rather vague and must be replaced by some more exact dating as when we fit an event between two events of a past or future series explicitly conceived. The ability to arrange events in serial order is a factor of great importance for everyday life. It is very largely the need for such arrangements that leads us, as a matter of convenience, to divide time into the three divisions of past, present and future, though the exact boundary lines between these divisions and the means by which we make the divisions have been the sources of much controversy. Sturt (41) suggests that the division arose through a combination of memory and purpose. At first the divisions was vague, but later it became more exact, as culture advanced and as the practical needs of life demanded a more exact arrangement. The psychological means by which this exactness has been brought about, as put by James and Ward (48), are fading brain states or movements of attention. To these explanations there are some objections, and Sturt adds a process of construction or reasoning, whether witting or unwitting, as an explanation. When Ward and Fouillée (22) suggest that it is the clearness of the memory images which gives us our serial order, they do not allow for the fact that our minds do not work backwards; the scroll of history, personal

or national, is not unrolled from the present until, stage by stage, the earlier ages are disclosed. We think rather of some outstanding events round which we group other and less outstanding events, or we think of a simple chronological order. Personally, we do not think that it is a mere convention, but a psychological necessity, which impels us to arrange events in a chronological line of time beginning with events of early occurrence and moving on steadily to events of recent occurrence. The theory of fading brain states, which depends on the clearness of the memory images as its dynamic force, does not explain the vividness of certain past events as compared with others. Ward introduces movements of attention, but it is open to the same objection that it would lead to a reverse order of presentation; further it does not aid us when we are dealing with events of the remote past. These theories, then, are rejected, though the theory of movements of attention may be one factor in the ordering of very recent events. To arrange events in order involves a definite act of memory, which may depend on the conscious creation, probably by reasoning, of some connecting idea. In ordinary life, we may remember the strict chronological order and give no weight to the importance of the events, or we may make our arrangement a matter of inference based on some apprehended dates or other associations, such as a scheme of purpose, cause and effect relation between different events, or space. Dating is the method used for dealing with historical events.

THE EFFECT OF THE LIMITING STIMULI ON TIME ESTIMATION

Even in the days of the earlier experiments, such as those of Meumann, it is noticed that the perception of short intervals of time limited by two impressions varies with the quality and with the intensity of these impressions. Later Alvord and Searle (54) among the individual differences of method used for the reproduction of an interval, note the spontaneous occurrence of auditory images of the limiting stimuli. In considering the effect of varying the limiting stimuli/an interval, Myers (33) says that with intervals of less than 400$^{\sigma}$, the nature of the stimuli, whether auditory, visual or tactual, determines the apparent length of the interval, and he suggests as an explanation that "such variations are doubtless dependent upon the different courses which different sensations pursue, some coming and going quickly, other occupying the attention for a longer period. Doubtless the extent to which the fading memory image of the first stimulus is overlapped by the arrival of the second presentation constitutes an important factor in the estimation of short intervals." Woodrow's (182) work in the investigation of temporal illusions in short temporal stimulus patterns due to different lengths of the bounding auditory stimuli yields these results. A long initial stimulus constantly causes the interval to be judged longer, though a long terminal stimulus gives the same effect, but not to the same marked degree. Kastenholz (112) finds that for very short intervals, those less than 500 or 600$^{\sigma}$, the perception and estimate are based on the rhythm of succession for auditory stimuli, and on the quantity of light for visual stimuli..

Drever and Collins (16) state that the immediate impression of an interval between two stimuli is considerably modified by the nature of the stimuli. "With any particular type of sense stimulus there is always a definite interval which has a peculiarly 'satisfying' character, due to the full development of the series of changes involved in a sensory stimulus," that is, the developing, full and fading sensation, the after sensation and the primary memory image.

THE JUDGMENT OF FILLED AND UNFILLED INTERVALS AND THE EFFECT OF THE INTERPOLATED MATERIAL

On this particular subject of our estimation of intervals and on the influence of the filling on the apparent length of the intervals, a very great amount of work has been done, but, before going on to summarise the work, there is one great general caution we must lay down. We have preferred to write of unfilled intervals rather than empty ones, because of the difficulty of getting such a thing as a really empty interval of time. It is impossible, even when we are trying our utmost, to empty an interval of its experiences, inward or outward. Even when an interval is devoid of the special experiences due to the stimuli marking its beginning and its end, there are motor and organic experiences going on which we cannot stop. An empty interval, then, is really one which is empty of any special sensations or experiences, one which is unfilled.

Meumann (129, 130) writes that our final judgment on the length of an interval must take into account the intensity, the quality, the number and the changing impressions filling the interval and

also the feeling which accompanies these. After criticising Münsterberg's theory of organic sensations, Meumann arrives at the opposite conclusion that it is the impressions which are of prime importance, and so "every psychic process is a competent basis of time measurement." (Nichols 138). He says it is impossible to separate time from its accompanying processes; we cannot isolate a duration from its limiting factors or from the impressions filling it. Meumann further insists that there exists an immediate appreciation or perception of durations: "the perception of time content is an ultimate and irreducible fact." Schumann (153), his contemporary, would introduce other factors, waiting and surprise, which determine the adaptation of attention, which in turn determines our perception of time, that is to say, Schumann believes that our judgment of duration is mediate. It is true that we must concentrate our attention on the time factor in order to arrive at a sound judgment of a duration. Meumann's studies are in the comparison of filled and unfilled intervals, and one conclusion he arrives at is that our perception of short intervals, of less than half a second are of very different nature from that of long or middle intervals, for the manner of filling influences our judgments of the latter. In the case of short intervals, the perception is of the quickness of succession of the limiting stimuli, whereas in long intervals the judgment is of the duration of the interval itself. The appreciation of short intervals varies with the degree of concentration of the attention. Meumann tried a series of comparisons allowing his subjects to use muscular or other organic means of comparison, but, as we have already noted, his results

show no corroboration for Münsterberg's theory. For Meumann, there is an immediate perception of duration.

James (27) draws this conclusion from the work of Wundt that "tracts of time filled with clicks of sound seem longer than vacant onesof the same duration, when the latter does not exceed a second or two." James also suggests in this section of his chapter that there is a certain emotional feeling accompanying intervals of time, a feeling of haste going with one measure of rapidity, that of delay with another. The next main point which he goes on to make is that we have no sense for empty time. Our perception of time is due to the filling and to our memory of its changing content; "we cannot intuit a duration devoid of all sensible content." Awareness of change is thus the condition on which James makes our perception of time depend; the change must be of some concrete kind - an outward or inward sensible series, or a process of attention or volition. In experiencing a duration of empty time, however, there is a feeling of discrete or continuous flow, the discreteness being due to the discreteness of our successive acts of recognition or apperception.

Münsterberg's earlier experiments (134) give the general result that time intervals of from 8 to 12 seconds, marked off and filled with auditory impressions, can, with the most varied content, be compared with sufficient accuracy to show that the presentations do exercise a constant influence on the estimate of the time. It is shown that those durations whose contents highly engrossed the interest of the subject are constantly underestimated. Words appear shorter than noises, verses than the strokes of the

pendulum, chords than simple tones and sentences than strings of nonsense-syllables. Stanley (161) says the amount of time perception is determined by the rate of consciousness itself. A time interval is underestimated when consciousness is proceeding at its normal rate, but it is overestimated when specially filled, say while taking exercise. Thus a period of 150 seconds was estimated as occupying 90 seconds under normal conditions, while a period of 55 seconds exercise was equally estimated as occupying 90 seconds. The variation in the periods is ascribed by Stanley to increased rate of consciousness. Under primitive conditions this subjective time increases with expectant attention and rapidity of consciousness. Thus, in the case of drowning, consciousness is forced to top speed and time perception becomes most acute.

Nelson (137), after remarking that it has been found by Meumann and others that the estimate of small time intervals is influenced by the number of stimuli that fall within the interval, gives the results of his own experiments on the effect of subdivision on the visual estimate of time. From Meumann's results in the comparison of unfilled time with filled time that for short times from .1 second to 4 seconds, when the filled time is given first, the error in estimating is constantly positive, while for longer times the error is negative, Nelson deduces that the error is not due to the filling alone, but to two other factors. It is generally conceded that even when two empty times are compared, there is a similar constant error, positive for short times and negative for longer. That there is a difference other than this constant error, which must be attributed to the filling, Meumann

shows, for, in those cases where the unfilled interval is given first, the sign of the error is also reversed, but the quantity of the error due to the filling alone he does not show, as these two factors are not quantitatively separated. Nelson's own experiments are carried on with longer intervals, from ½ to 10 minutes, and the filling is sensations of light. During the longer periods it is impossible to keep the attention so closely fixed as during the intervals of ½, 1, or at most 2 minutes. It is about this point that the change of sign occurs in the estimates. The general feeling of weariness seems to be the chief criterion in the longer intervals. Another interesting point Nelson makes is that the filled time is psychologically the more empty or barren of the two, for the time is filled with monotonous sensations of light, and empty of vivid or interesting trains of thought. On looking back, there are fewer changes in consciousness to remember and hence the time seems shorter. From his results Nelson agrees with Meumann that in relatively short intervals, as well as in small spaces, the estimate is influenced by the number of impressions that fall within the interval. There is no evidence of a shortening up of the estimate due to the division of the standard interval into halves, As a final result Nelson finds, in intervals of 3 to 60 seconds evidence of a temporal illusion closely corresponding to the space illusion. Both in intervals of time and in visual spaces, when there is more than a single division, the filled stretch is overestimated. As the length of the intervals is increased to minutes, there is not a direct reversal of the effect of the filling, as is found with tactual stimuli; the

illusion either decreases or is entirely lost. The experimental work of Edgel (90) with unfilled intervals leads her to these two main conclusions; that short durations of 1 second and less are overestimated, while longer durations of 2 seconds and more are underestimated, and that the perception of durations presents errors which do not follow Weber's Law.

On this particular topic Stout (40) writes that the amount of the recent past included in our perception varies according to the conditions of introspection. It is smallest probably in experiments on the estimation of very brief intervals; it is longer when conation is obstructed or delayed, shorter when conation proceeds successfully and easily towards the attainment of its object. This affords us, according to Stout, an explanation as to why time seems to pass quickly when we are absorbed in our work or play, or when we are enjoying ourselves. Stout quotes the experimental results of Myers, with whom he is apparently in agreement, that filled intervals appear longer than empty ones. To explain this result Stout says "the most essential factor conditioning this immediate awareness of varying degrees of duration is probably to be found in the process of attention with its accompaniments and results. When and so far as there is continuity of attention, successive experiences are modified by the cumulative effect of retentiveness. This cumulative effect varies in its nature with the amount of time the process has taken." For Stout, the measure of the lapse of time is the cumulative effect of the process of attending. Our experiences of durations are unique and do not consist in having the parts of our experience spread out before us in a sort of duration-

block. We measure so-called empty intervals by the process of expectant attention.

Myers, one of our chief authorities on experimental work, (33), begins by repeating the statement that "the apparent length of an interval is influenced by the number and nature of the experiences occurring during that interval," and proceeds to examine the influence of filling and emptying on our judgment of the length of the interval. He says that by the method of comparison, a filled interval almost invariably appears shorter than an idle or empty interval, no matter the order of the intervals, but when sound stimuli limit the interval, the interval "filled" with sounds appears longer, "the error of estimation increasing up to a certain point with the number of sounds filling the interval. The same holds for visual and still more markedly for tactile stimuli. "His explanation is that there is free development of experiences in the empty interval, but in the filled interval there is interference, "and the attention is directed successively to numerous discrete presentations." That he says holds good for short intervals, but as the intervals increase in length the error of estimation is said to diminish and eventually to be reversed. To get a completely unfilled interval Myers says is impossible. And finally, Myers brings forward some experimental evidence in favour of the existence of the absolute impression, in which we do not make a true comparison, and in the exercise of which we pay attention to the second interval only. In comparing pairs of intervals, with considerable variations in the length of the pause between, "the fact that the number of judgments "second interval shorter"

is found to be practically uniform in spite of the variations in the length of the pause" hints at the existence of this absolute impression. "If the two intervals, standard and variable, be really compared, we should expect the length of the pause between them to have a distinct effect upon the frequency of any particular judgment. Moreover, the judgments 'second interval distinctly shorter' are found to increase in frequency with the length of the pause. This, again, we should not expect if a true process of comparison takes place; it points rather to reliance on the absolutely judgment, which becomes all the more striking in effect, the longer the pause before the occurrence of the time interval to which it refers."

It is interesting to note as a criticism of the view that our knowledge of time is derived from the perpetual changings of our consciousness, the remarks of Spearman (38). He says that this theory of change breaks down for research has not succeeded in discovering any direct dependence between the amount of the changes of consciousness and the seeming or estimated duration. He bases this statement upon the comparative failure of the experiments on filled and unfilled periods of time. There is no doubt considerable conflict among the results, but to base such a sweeping contradiction on this conflict is scarcely justifiable. The balance of opinion, and the results of experiments also, seem to point to some correspondence between the changes of consciousness and estimated duration. Though not conclusive, there appears to be estimation also by the absolute impression, which is probably due to the consciousness changes.

Benussi (5), in his monograph on the psychology of time, sets himself to find out the different conditions in which subjective or perceived time corresponds to objective or clock time. Now, among these conditions he notes the greater or lesser singularity (Auffälligkeit) of the impressions limiting the interval and filling it. From his analysis of our perception of intervals, he finds that unfilled times appear shorter than filled time of the same duration. G.C. Myers (135), in his tests on the incidental perception of time intervals, finds that 1 minute is usually overestimated by about one half. Longer periods of 6¼ minutes are overestimated by about one half by men and by twice by women. He also finds very little difference between the estimations of periods of 1 minute which are incidentally perceived and those that are purposely perceived. Woodrow's experiments (180, 181, 182) on the influence of the order of presentation of the standard and variable intervals suggests to him the existence of the absolute impression. In addition he notes the extreme variations of the errors of temporal judgments which he thinks casts doubts on any such regularity of judgmant in over or underestimation as is supposed to exist by many other writers. In his experiments the methed of reproduction is used. Cary (73), after noting the general tendency to overestimate periods of 15 minutes, which are practically one hundredths of a day, a conclusion which our own experiments do not confirm, also notes the disparity between different estimates of the same period of time due to the different filling, thus a speaker and a hearer have a very different appreciation and therefore estimate of the same time. Spencer (160) first of all

endeavours to eliminate the influence of conventional ideas and conventional units of time, whose use had been noted by Yerkes and Urban (185). This he does by using the method of reproduction rather than that of comparison or estimation, which are in essence the same, and he finds that the intervals he uses in his experiments, 15, 30, 60 and 100 seconds, are generally overestimated. He uses six different interpolations, getting the result as above, but when estimation in conventional terms is allowed, underestimation of all intervals of greater length than 18 seconds is the result. Two other of his results are worth noting: the interpolation of poetry makes the time seem longer than prose or none; the interval is also apparently longer if the subject reads than if the experimenter reads.

Kastenholz (112) makes researches in the comparison of intervals, using auditory stimuli to mark off the periods. The first result he arrives at is that the standard time and the compared time are perceived separately. This is generally true for mean or superior times, that is, those over 700 . During the intervals to be compared the attention is directed essentially on the standard time, and when it ends, there is a feeling of equality or otherwise, thus surprise becomes the criterion of perception. Sometimes the attention is directed to the compared time and then the judgment is based on the perception of the time itself. When, however, as in the case of inferior intervals, the standard time and the compared time are perceived as a whole, the perception is based on the growth of a state of tension and the judgment is based on the strength of the tension, or a feeling of expectation.

For the average or mean standard times, from .7 seconds to 2 seconds, underestimation of the standard time is generally found. Kastenholz explains the constant error by the variation of the attention. His theory is that the primitive datum is change or simple succession, and that duration is perceived only by the quantity of observed successions.

Sturt (41) generally confirms the idea that estimation is based on the quantity of thoughts filling the interval. She does not find that the agreeable or disagreeable nature of the events or thoughts modifies the perception of the duration, but as her experiments are too few in number and made with two subjects only, they do not allow of definite conclusions. In her larger work, Sturt (41) says that duration is a subjective element of late development, the measurement of which is liable to subjective variations and so our ability to estimate durations is never very accurate. From her analysis of the nature of time and from her analysis of the various ways in which duration may be measured, she lays down as the factors involved in any estimate of duration the following: division of attention between the actual experiences and our awareness of these experiences, which gives us the real material for our estimate; the number of events; the pleasantness or unpleasantness of these experiences; the continuity or disconnectedness of these events, that is, their quality; and finally, the comparison of the experienced duration with some ideal scheme. From her consideration of dream material, she arrives at her peculiar contribution, that not only does our estimate of duration depend very largely upon the number of events filling the period, but also

upon a judgment of the nature, the quality, of the mental events, a judgment based partly upon the amount of attention given to them and to the passage of time as such. This demands a fairly good memory for time durations and a certain ability to divide them, which her experiments show we have. Sturt does not, as Weber suggests (178), hold in its cruder form, even for moderately short intervals, the old and widely spread theory that our estimate of time intervals depends on the amount of the mental content. Weber (178), however, makes use of this to note another point, the correlation between the level of behaviour and the tendency to over or underestimate a duration, for he says, "While it is true that the greater complexity of mental processes which we assume to take place at the higher levels of behaviour may be regarded simply as giving a greater number of elements in the mental content, nevertheless there are definite differences between mere amount of mental content and greater complexity. It is possible," he adds, "that this distinction is of significance." Guyau (23), on the other hand, points out that what proves best that we measure time by the number of sensations, and not by the real duration, is the way by which we evaluate approximately the length of a dream. It is solely, says Guyau, by the number of images that we judge passing time in a dream, thus a dream may appear long while in reality it lasts for seconds only. He goes on later to remark that the estimation of duration, being only a phenomenon of interior illusion, a perspective of images, cannot refrain from offering a character of essential relativity. It is relative "to the intensity of the images represented, to the intensity of the differences among these

images, to the number of these images and to the number of their differences, to the rate of succession of the images, to the mutual relations among them, their intensities, their resemblances or differences, their diverse durations, and finally their positions in time, to the time necessary for the perception of these images and of their relations, to the intensity of our attention to these images or to the emotions of pleasure or of pain which accompany them, to the appetites, desires or affections which accompany them, and to the relation of these images with our expectation, with our prevision." Romanes (36) says that, beyond the number of states of consciousness, the additional factor which acts to lengthen or to shorten time is "the relation of the states of consciousness to their own succession." Time appears relatively long when the attention is concentrated on the latter, on the production of a single and unique series of changes. Sully (42) says that the apparent distance of an event not clearly localised in the past series varies in inverse ratio with the nmenonic image. Another cause of error in our perception of duration, according to Guyau, is that we are brought to combine the time enforced by the representation of an event with the real time the event has lasted. Effort, then, rapid and brief, plays a considerable part in our idea of time. When all the events hold together and are similar, the effort of attention necessary to recall the memories adapts itself immediately to each of the successive images, as Wundt remarks, and the smoothly flowing series appears shorter; on the other hand, if the events are not continuous, without bonds, or very diverse and dissimilar, the effort of reproduction demands more time and the

series of events itself appears longer.

Guyau also remarks on the well-known influence of expectation on apparent duration. Our desire tends to show us the future as present and to jump the intermediate steps; consequently we understand time to be shorter than it is or can be. By comparison with ideal time, real time appears to drag in a desperate fashion. On the other hand, happy or filled time fly quickly because, by ideal anticipation we promise ourselves a long happiness, but by comparison with the origin of our desire and of our expectation, the reality appears to us brief. Wundt explains the majority of the errors ralating to duration by the variations of the apperception, that is, of the attention to the representations which is in a more or less great state of tension, brought about by desire or longing. It is by desire that we measure in spite of ourselves the length of time: apparent time varies according to the appetite or desire. In history, certain centuries appear longer; "the period from today to the fall of Constantinople appears longer than from that fall to the First Crusade, though both are almost equal chronologically. This is probably because the first period is better known to us and we mix with it our personal memories." (Sully 42).

Swift and McGeogh (171) use intervals of 30 seconds, 1 minute, 2 minutes, 5 minutes and 10 minutes in their experimental study of the perception of filled and unfilled time, with the following results. Short durations are in general overestimated, but there is no sensible difference in this respect between periods of filled and periods of unfilled time. For the longest period of 10 minutes underestimation is found equally as well when the filling

(copying a text) is interesting as when it is dull. But when listening to a story the long period is overestimated. As we shall see, our results do not confirm this latter statement, underestimation for a period of 15 minutes being found in all cases. Swift and McGeogh further state that overestimated time is that in which we do some work. They conclude also, in opposition to McDougall (118, 119) Yerkes and Urban (185), Gulliksen (103) and our own results, that women appear to estimate time more correctly than men. But of this more anon. Drever and Collins (16) state that filled intervals seem longer than equal unfilled intervals, especially when the stimuli are tactual. This they suggest may be due partly to the impeding of the attention and partly to the fact that the impressions filling the interval tend to interfere with each other's full development. Gulliksen (103), from his experiments using a standard interval of 200 seconds, variously filled by resting, by a metronome beating 184 per minute, by a metronome beating 66 per minute, by working problems in long division, by reading a set of direction in a mirror, by enduring slight pain, by becoming tired through holding the arms extended, and by taking dictation from a text, comes to the conclusion that time appears longer or shorter according to the occupation which fills it. Thus the order of the lengths of the estimations from the longest to the shortest is found by his experiment to be the first of these conditions first, the seventh second, the third third, the fourth fourth, the sixth fifth, the fifth sixth, the eighth seventh and the second last. His results, as we have already suggested, confirm McDougall, and Yerkes and Urban by finding

marked sex differences, women generally estimating the time as longer, though in other respects the coefficient of variability differs little from one sex to the other.

From the fairly extensive researches of Axel (56) with standardised interpolations of four kinds, unfilled, tapping, cancelling figures and analogies and number completions for students and adding for children, the following results emerge: the type of filling has a marked effect on the estimation of short durations, for there is a greater tendency to underestimation the higher the level of behaviour employed. Empty time does not show different results from tapping as regards over-estimation, which Axel says is evidence that there is no marked line of demarcation between the estimation of filled and unfilled times.

DURATION TESTS

In an attempt to summarise the views on time estimation given by the above writers, we must, in the first instance, make a very clear distinction between the results obtained by those who have been working with intervals lying within the specious present and the results of those who have been dealing with intervals lying without the specious present. So far as the first group of results is concerned, two conclusions are agreed upon by almost every experimenter and writer: that, whether the method in use in the experiment be the method of reproduction or the method of comparison, intervals shorter than the indifference interval of about .7 second are overestimated and those longer than this same indifference point are underestimated; and that in the words of Wundt (50) "tracts of filled time seem longer than empty ones of the same

duration, when the latter does not exceed a second or two." With these highly interesting and well corroborated results, we see no reason whatever to disagree.

However definite these results for periods of time within the specious present may be, the results and conclusions for intervals of time, which are greater in extent than the specious present of say 4 seconds, are not so clearly defined or agreed upon, probably because considerably less attention has been devoted to these longer intervals in the psychological laboratories, and yet, for the practical purposes of everyday life, these are the more important intervals. One does not deny the usefulness to psychology of the idea of the specious present and its limited duration as the limit of perception in this field, but the sort of period one is likely to be called upon to estimate in everyday life is only in very rare and extreme instances within the bounds of the specious present; it is, in the proverbial ninety nine cases out of a hundred, certain to be a period of greater duration. Thus, in a recent railway accident inquiry, a witness, who had declared that a period of 3 minutes had elapsed between certain happenings, was asked by the presiding magistrate to give the court his impression of 3 minutes. The actual time given by the witness as equal to 3 minutes was 47 seconds. This result seems at first sight rather unexpected, nevertheless, the enormous difference may be due to the lack of filling in the second case. Witnessing the accident, full of momentous happenings, time would appear very full and therefore long. In the silence of the courtroom, time would appear to drag and so a short period would seem equal to the longer one.

If the results of Stanley (161), Cary (73), Spencer (160), and Swift and McGeogh (171) on the estimation of longer intervals are tabulated, we have the following table:-

Author	Intervals	Method	Results
Stanley	55 seconds and 150 seconds	reproduction	Underestimation, but overestimation when specially filled
Cary	15 minutes	comparison	overestimation
Spencer	15 seconds, 30 seconds, 60 and 100 seconds	reproduction	generally overestimation
Swift and McGeogh	30 seconds, 1 minute, 2 mins. 5 mins, 10 mins.	comparison	(a) short intervals show overestimation with no material difference between filled and unfilled intervals. (b) long interval of 10 minutes shows underestimation, save when filled with stories. (c) women estimate more correctly than men.

With a view to finding out how such longer intervals are estimated by children, four intervals of 30 seconds, 1 minute, 5 minutes and 15 minutes were selected and a number of school children between the ages of 10 and 14 were tested. After a few preliminary questions of a general character on time and clocks, and our conventional measurements, the children were asked to put up their hands when they considered that a period of 1 minute had elapsed from the given starting signal, which consisted of a single clear tap of a pencil on the desk. As was anticipated, hands went up within 15 seconds of the beginning, and only in exceptional cases was there a near approach to accuracy. The experimenter then estimated a period of 1 minute, the pupils checking his endeavour. On one occasion only did the error exceed 5 seconds, a

result to be attributed to practice and not to any special ability. Having thus been shown that a minute of objective time occupies a considerably longer duration of subjective time than is expected the experiment proper was begun. Three series of experiments were carried out. On the first occasion, the intervals were nominally unfilled, and every endeavour was made to keep them as such, for the counting and other devices which would have been adopted by many pupils, especially in the junior classes, as a method of estimation, were forbidden. That is not to say that they were not used, for silent counting could not be detected, and the honesty of the children had to be relied on. Now, a schoolboy's code of honour would not regard with any degree of horror such an easy way of cheating. Hence the unfilled intervals are so called because, as far as it was possible, they were emptied of any active mental activity. In the second series, the intervals were filled with stories told by the experimenter. These were more or less standardised tales from the bypaths of history. The scholars simply noted, as in the first series, their estimates on a slip of paper in front of them and then continued their enjoyment of the stories. In order to encourage genuine answers or estimates, no names were asked for, but merely the age of the pupils in years and months and the sex, denoted by B. or G. A third series was carried through with the senior pupils when the filling consisted of silent reading. As each pupil provided his or her own reading material, we are safe in assuming that the filling was interesting in character and therefore likely to distract attention from the passage of time. As we have already indicated, the ages of the

pupils taking part in these experiments ranged from 10 to 14. Except for the last age group of 14 to 14-11 there was no selection whatever as these comprised representative groups in each case. Owing to circumstances over which the experimenter had no control, it was not possible to test all the pupils in each grade, and so the results, though thoroughly representative, are not so full as they might otherwise have been. These results are set out in detail in the tables in the appendix.

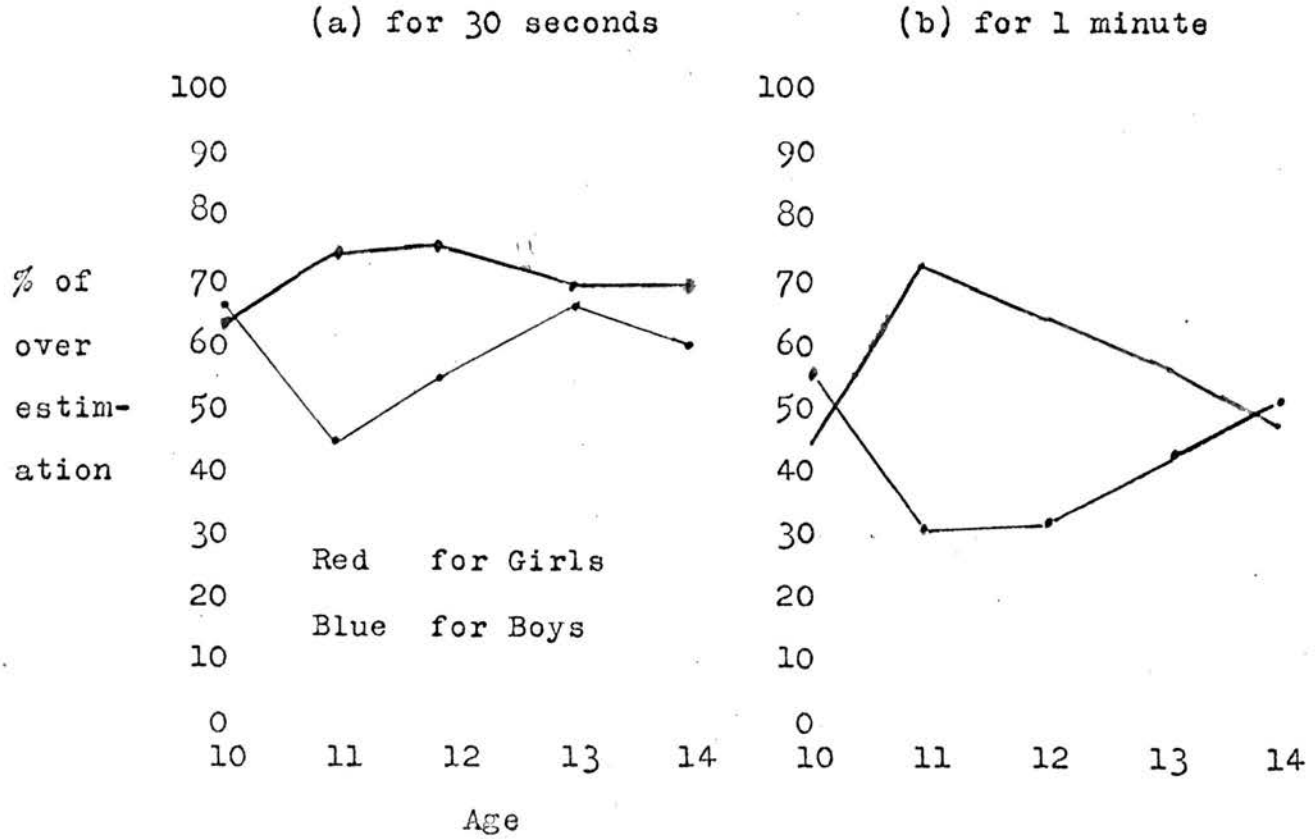
From the results of the first series, the detailed tables of which will be found on pages 155 156, the following summary table has been drawn up.

TABLE FOR UNFILLED INTERVALS.

% of Estimates for 30 seconds.		1 minute			5 minutes			15 minutes					
Age		under	correct	over	under	correct	over	under	correct	over	under	correct	over
10	B	23	10	67	16	29	55	48.5	16	35.5	29	35.5	35.5
	G	28.5	7.5	64	18	38.5	43.5	51.5	18	30.5	59	13	28
11	B	34	20	46	40	26	34	57.5	14	28.5	34.5	20.5	45
	G	21	3	76	9	20	71	53	15	32	50	17.5	32.5
12	B	22.5	24	53.5	46.5	19	34.5	73.5	7.5	19	76.5	16.5	7
	G	12	11	77	12	25	63	62	15	23	49	20	31
13	B	23	13	64	46	11	43	63.5	15	19.5	51	25	24
	G	11.5	20	68.5	37.5	5	57.5	61.5	12	26.5	60	12.5	27.5
14	B	21.5	17.5	61	37	11.5	51.5	60.5	9	30.5	52	17.5	30.5
	G	13.5	17.5	69	38	14	48	44.5	10.5	48	53.5	5	31.5

From the above table the following conclusions can be drawn: that for a period of 30 seconds unfilled time the general tendancy

for all pupils between 10 and 14 is to overestimate the duration; and that at most ages the boys show a superiority over the girls in the matter of accuracy of estimation, for, except at age 10 the % of overestimation is lower for the boys than for the girls by about 20 on the average. If these results are plotted in the form of graphs, a very curious result is produced, for while the graph indicates that the boys show most accuracy, or least inaccuracy, at age 11, the girls show the greatest degree of over-estimation, or most inaccuracy, at that age and at 12. The graphs tend to coalesce after age 13.

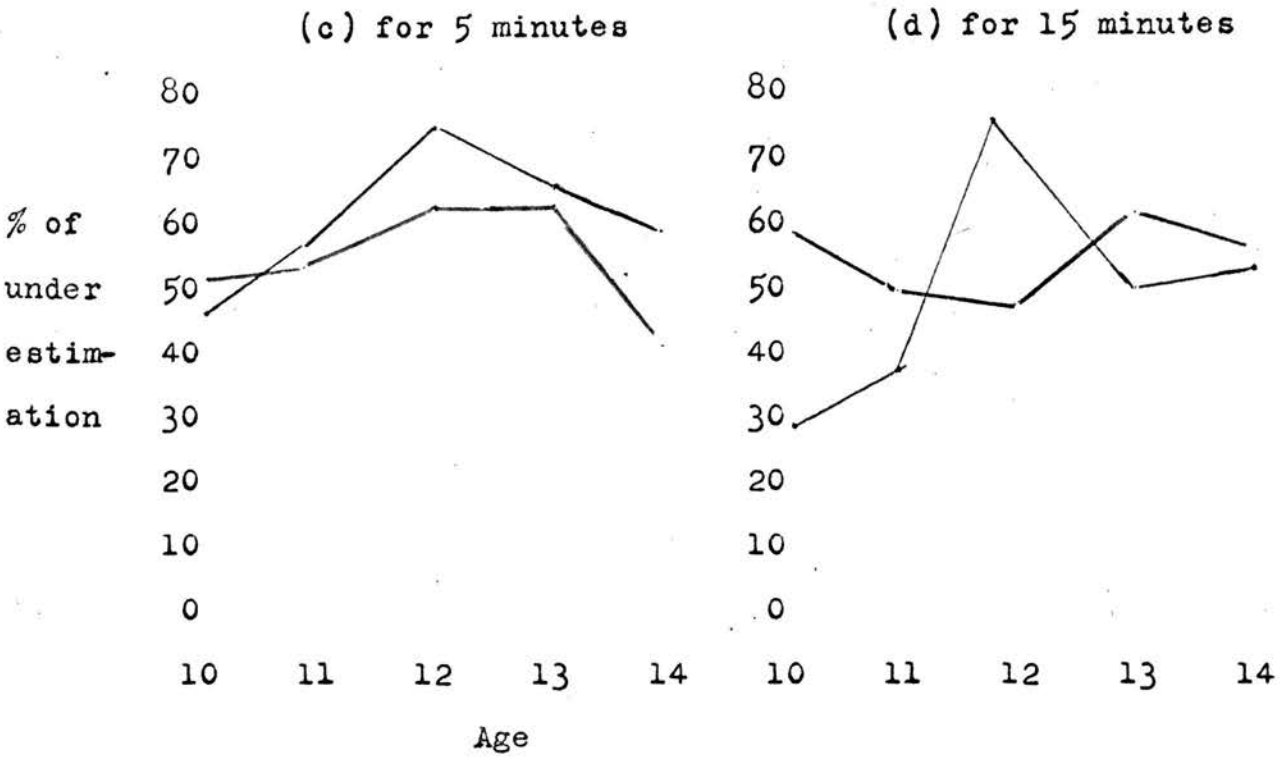


For a period of 1 minute much the same general result is obtained: there is a general tendency to overestimate the interval. There are, however, some exceptions in this case which may indicate

that the interval approaches one where a change of sign is likely to occur. These exceptions are all in the cases of boys; at age 11 there is an approach to equality between under and overestimation with a slight advantage on the side of underestimation; at age 12 underestimation has the advantage by over 10%; and then at age 13 there is comparative equality again. It is quite remarkable that in each of these cases it is the boys who are concerned: it may show that the boys have greater aptitude for estimation than the girls, for at all ages the girls overestimate. The graphs for this interval show that the tendency is for least overestimation or greatest accuracy at ages 11 and 12 for boys, while the graph for the girls' results shows a reverse tendency; greatest overestimation comes at age 11 with a decrease thereafter. The graphs are similar in general character to those for 30 seconds.

If we consider the period of 5 minutes as a long interval then our table shows agreement with the results of Swift and McGeogh that long intervals are in general underestimated, for the balance has definitely swung in favour of underestimation, in every case, except for girls at age 14 where there is a slight advantage with overestimation. This time, however, the greater degree of inaccuracy is displayed by the boys, though the extent is not great. For this period, the graphs for both boys and girls show greater similarity of contour than for either of the shorter periods. The apex of the curve may be reached later by the girls, but the general outline is the same, for both show a gradual rise and fall with the greatest tendency to underestimation at ages 11 and 12 for the boys. In the case of the girls the inaccuracy reaches

its height between 12 and 13 with improvement thereafter.



And finally for the longest unfilled period of 15 minutes the same general tendency is observed. Underestimation is the rule though we must note the cases of the boys at 10 and 11 where there is more overestimation than underestimation. Again, except in the one case of age 12, the girls show a greater degree of underestimation. The graphs show no regular features; they simply confirm the above conclusions.

Our results, then, with periods of unfilled times, suggest the conclusion that, for the shorter intervals of 1 minute and less, the general tendency is for overestimation, while for the longer intervals of 5 minutes and more, the general tendency is for underestimation. A further conclusion may also emerge, that boys tend to show a lesser degree of under or overestimation than girls.

In order to see whether the filling of the interval had any appreciable effect on the estimation, a second and third series

of tests were carried out using interpolated material of a story nature for the junior classes and silent reading for the senior classes. The results are set out below with the detailed results in the appendix I.

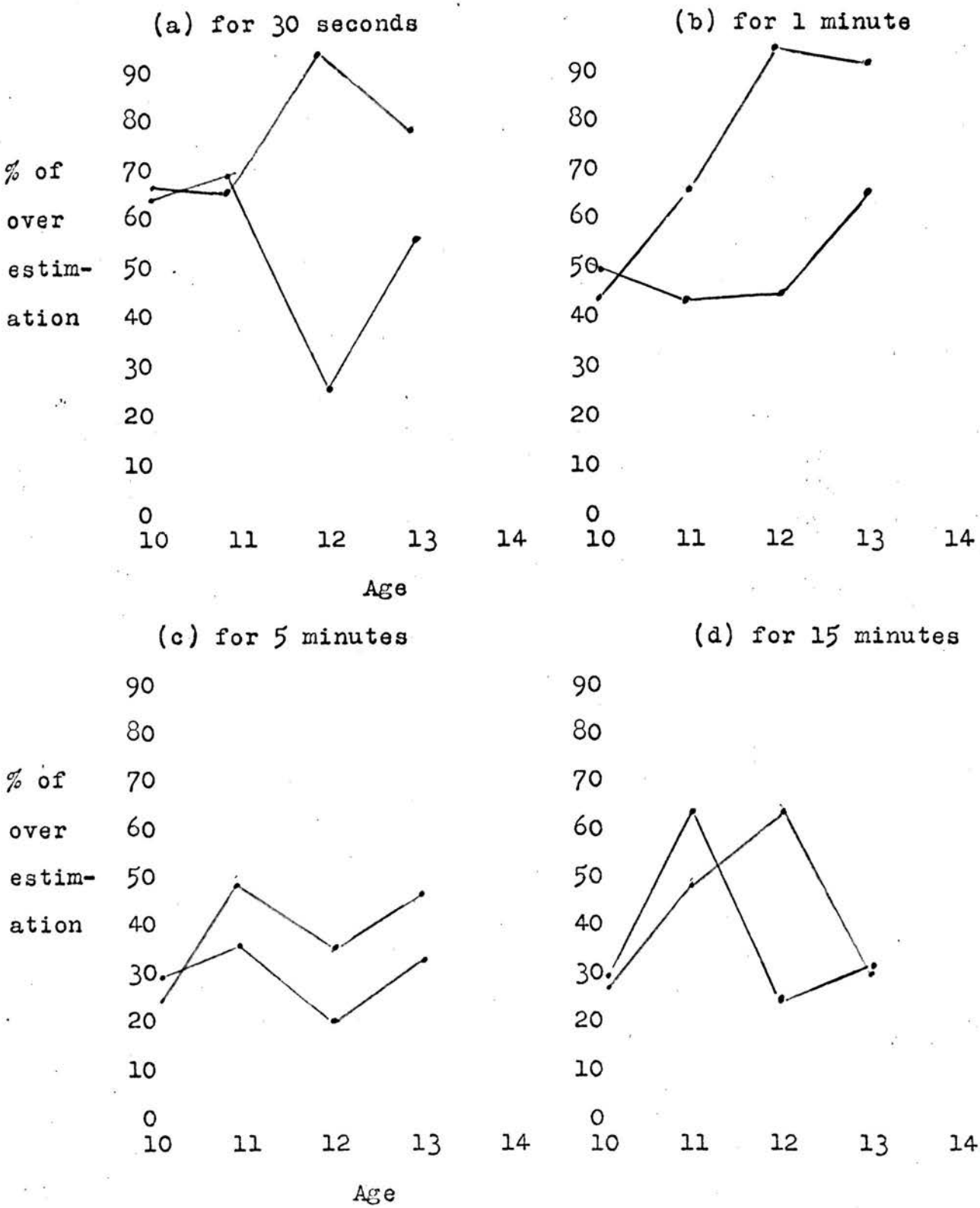
TABLES FOR FILLED INTERVALS.

	% of estimates for 30 secs.			1 minute.			5 minutes.			15 minutes.		
Age	under	correct	over	under	correct	over	under	correct	over	under	correct	over
Nature of Filling - Story Telling												
10 B	30.5	6.5	63	17	33	50	50.5	20	29.5	30.5	40	29.5
G	26.5	8	65.5	18	37	45	53.5	21	25.5	58.5	13	28.5
11 B	17.5	13	69.5	16.5	39.5	44	44	22	34	9	26	65
G	29	6	65	12	23.5	64.5	29.5	23.5	47	29.5	23.5	47
12 B	46	28.5	25.5	37	17	46	71.5	8.5	20	28.5	43	28.5
G	8		92	4	4	92	12	52	36	12	24	64
13 B	26	16	58	20	16	64	48	20	32	32	36	32
G	8	15	77	8	4	88	19	35	46	19	50	31
Nature of Filling - Silent Reading												
13 B	3	16	81	2	2	96	3	24.5	72.5	34	46	20
G	1	40	59	1	27	72	35	9	56	69.5	27	3.5
14 B	15.5	47	37.5	47	31.5	21.5	31.5	15.5	53	78.5	15.5	6
G	19.5	50	30.5	25	25	50	19.5	25	55.5	69.5	5.5	25

As can be seen from the tables, for intervals of 30 seconds and 1 minute of time filled with either stories or silent reading, there is a general tendency for overestimation to take place. There are two slight exceptions to this general rule, for with

stories for boys of 12, the amount of underestimation exceeds the amount of overestimation by some 20% in the case of the interval of 30 seconds, and for silent reading for the boys of 14 by some 25% in the case of the interval of 1 minute. Apart from these, however, overestimation takes place in every case. For the period of 5 minutes filled with stories, the result is very mixed and difficult to determine, underestimation being the general rule with the boys, while the girls of 11, 12 and 13 show quite decided overestimation by fully 20% on the average. When the filling consists of silent reading, overestimation exceeds underestimation with both boys and girls of 13 and 14. For the interval of 15 minutes, a very curious result is found; when the filling consists of stories, the general tendency for practically all the pupils is overestimation or equality of overestimation and underestimation. In the case of the girls of 10 alone does underestimation exceed overestimation. When, however, the filling is silent reading, the result is reversed, for definite and considerable underestimation takes place for pupils of 13 and 14.

If we plot graphs of these results, using the overestimation column, we again find that for the shorter intervals, the boys are best when the girls are worst, at age 12. This divergence disappears with graphs of the longer intervals. On the whole, also, it is clear that the boys are better than the girls at estimation; at least, they do not overestimate so much.



These graphs are for the story filling only, as the results for silent reading are not spread over a sufficiently wide age

grouping, We may claim that the results, both for these filled intervals and for the unfilled intervals as well, may be regarded as thoroughly reliable and representative, as the numbers of pupils tested were 568 for the unfilled intervals, 213 for intervals filled with stories and 248 for intervals filled with silent reading.

Before stating the general conclusions to which our experiments have led us, let us first consider a table comparing the results for the unfilled intervals with those for the filled intervals. In this table the amount by which overestimation exceeds underestimation is given with the necessary plus or minus sign.

Table showing comparison of filled and unfilled intervals, with story telling as the filling.

Table showing comparison of filled and unfilled intervals, with story telling as the filling.

Age	Intervals 30 secs.			1 minute			5 minutes			15 minutes		
	Unfilled	Filled	Diff.	Unfilled	Filled	Diff.	Unfilled	Filled	Diff.	Unfilled	Filled	Diff.
10 B	44	32.5	11.5	39	33	6	-13	-21	8	6.5	- 1	7.5
G	35.5	39	- 3.5	25.5	27	- 1.5	-21.5	-28	6.5	-31	-30	- 1
11 B	12	52	-40	- 6	25.5	-31.5	-29	-10	-19	+10.5	56	45.5
G	55	36	19	62	52.5	9.5	-21	+17.5	-38.5	-17.5	17.5	-35
12 B	31	-20.5	51.5	-12	9	-21	-54.5	-51.5	- 3	-69.5	0	-69.5
G	65	84	-19	51	88	-37	-39	+24	-61	-18	52	-70
13 B	41	32	9	- 3	44	-47	-46	-16	-30	-27	0	-27
G	57	69	-12	20	80	-60	-35	+27	-62	-32.5	12	-44.5
14 B	39.5	22	17.5	14.5	-25.5	40	-30	+21.5	-51.5	-21.5	-72.5	+51.5
G	45.5	11	34.5	10	25	-15	+ 6.5	+36	-29.5	-22	-44.5	+22.5

In the case of age 14 the filling is silent reading. The difference column is obtained by subtracting the results of the filled intervals from those for unfilled intervals, thus a minus sign in the difference column will indicate greater overestimation for the filled intervals and a plus sign will indicate lesser overestimation for the filled intervals. Unfortunately the results are not at all illuminating as to the effect of the filling, except to suggest that on the whole there is more overestimation in the case of filled intervals.

The general conclusions of this study of the effect of filling may be laid down as, that the filling of an interval, especially the nature of the filling, has a definite effect upon the estimation of it, for there is more tendency to overestimation than underestimation; that there are also fewer wild guesses as to the length of the interval; and that there are definite sex differences, the boys tending to estimate better than the girls. No other explanation than sex difference can be brought forward to account for the curious results of the 5 minutes' intervals filled with stories. On the whole, filling tends to promote greater accuracy.

THE GENETIC DEVELOPMENT OF THE CONCEPT OF TIME

Bagley, in his instructive book on the Educative Process (2) says, "An important task of education is to lead the pupil to condense his experiences and attach symbols to the concepts thus formed. The fundamental principle that governs this process has been recognised almost from the beginning - recognised in theory but often sadly neglected in practice. This principle is formulated in the pedagogical maxim: 'Proceed from particulars to generals and from the concrete to the abstract.' Rightly interpreted, this dictum lies at the basis of all national instruction. It means that there is no way to reach concepts that will function efficiently save through a series of experiences with the concrete and particular and passing gradually through the various stages of condensation. There is no 'royal road to learning' and there is no short cut to the concept." All this is very true of the concept of time, for the normal method of its growth is that the individual is subjected to a great number of experiences of a concrete nature and is led consciously to make the analyses, comparisons and abstractions that are necessary to the formation of the time concept. This idea of genetic development lies also at the basis of the theory of recapitulation, which, though it arose first of all as an attempt to explain the play activities of children, has been and can be applied also in wider senses. The early activities and ideas of the race are said by Stanley Hall (24) to be recapitulated, retraced, in the form of play. Now, this tendency to recapitulate must have been preserved by Nature

because of its use in subserving the function of preparation for adult activities. The child's ideas of time follow the same course; at first the crude sense of time due to hunger corresponds to primitive man's knowledge of time, then the more developed ideas of duration correspond to the ideas of the developing savage, and finally, a fully developed apprehension of time corresponds to the cultured man's knowledge of time.

This idea of genetic development has been sometimes explicitly and sometimes implicitly avowed by writers on time. Ward (48), for instance, says that the conditions by which an adult distinguishes past, present and future, in turn will be found "to depend upon all that is implied in the formation of the memory train and upon the recurrence of like series of impressions," without which "our knowledge of time would be impossible," Another writer, who inclines to the genetic viewpoint, though he does not expressly say so, is James (27). There is much in his chapters, however, to make the inference clear, as, for example, when he writes of our referring events and dates to our own particular past. Or again, when he writes that the excellence or otherwise of our memory is dependent partly on the number and partly on the persistence of the brain tracts, the latter being "a physiological property of the brain tissue of the individual, whilst their number is altogether due to the facts of his mental experience." Experience is then, for James, a very important factor in the formation of our ideas on time, but there is the further factor of the use made of the mental experiences, for "the one who thinks over his experiences most, and weaves them into systematic relations with

each other, will be the one with the best memory," native tenacity being equal. James also says that our perception of time is due to our perception of the events within the interval; we are aware of the events and of their changes, and it is this awareness of change which gives us our perception of time as having duration or protensity. "Longer durations than the specious present are symbolically conceived and constructed by mental addition."

Stout (40), in his chapter on temporal perception, regards our apprehension of temporal relations as an extremely complex product of mental development, in which the part played by trains of free ideas is of predominant importance, for these trains of free ideas give us our definite apprehension of a time series. Later, Stout regards the reference to the future made by attention as being as primitive as conative consciousness. This certainly agrees with common experience that the early stages of mental development are occupied with the future rather than with the past. He adds further that the prospective nature of attention/"would seem also to be a primary condition of the possibility of learning to adjust future behaviour to the lessons furnished by past experience." Again, in distinguishing the past and the future, he says that the future is in our own hands and we must be continually adjusting our actions so as to modify this future if we are to survive and to live a tolerable life, but the past is beyond our control; "retrospection can only be of use in supplying data for pre-arranging the future."

Stanley (161), definitely maintaining this point of view, writes that "the genesis of time perception under conditions of

natural selection is in a felt relation of the individual to its environment, and it is a complex of the sense of unrealisation and of position with reference to realization. It is plain that time perception is experience of delayed succession. Time perception is seen to be an adaptive psychosis to exigencies; giving foresight and preparedness and reducing fright to caution. The rise and growth of time perception are then involved in expectant attention which implies memory and the cognition of the break between the real and the ideal. Rageot (148) says time is born from our personal changes at first, but later it becomes for us the common time due to the changes of others, that is to say, we proceed from individual time to general or universal time. Mackenzie also (123) treats time as conceptual in development.

Of the writers who assume genetic development in the course of individual and social experience, one of the most important is Sturt (41, 169, 170). As we shall see later, Sturt distinguishes three stages of development of the time concept. In her earlier work, in collaboration with Oakden (170), she shows that the growth of the child's knowledge of time is slow, beginning before the age of 4 and arriving at nearly adult level at about 13 or 14, though the most important period of growth takes place for all different aspects of time knowledge at about 11. The most difficult, and so latest, factor is what is called temporal organization or the arrangement of events in order. They note also, as one result of their experimental work, that time indications play a less important part in the lives and thought of children than do those of space. This agrees with the findings of Burt. In her larger

work (41) on the psychology of time, Sturt makes it her starting point and also her final conclusion that our knowledge of time is built up during our early years from vague percepts into a workable concept, more or less complete according to the circumstances and the intelligence of the individual. For her, time is a concept based on these vague percepts of earlier years, which passes through the three stages of simple animal, complex animal and educated adult development. These stages are gone through anew by each individual who thus parallels in his progress the development of the idea of time in the race. There is a case for phyolgenetic development made out by Sturt in her chapter on the social organization of time. Now, after a differentiation of past, present and future, Sturt proceeds to the main point in her work, which is to show from studies of children's concepts and from experiments conducted among children that the development of the individual's concept of time follows the stages outlined by her as those in the development of the racial or cultural concept. From the studies of children's words and from her own experiments, her general conclusions are that the child has to acquire laboriously during his early years, up to about the age of 11, a knowledge of the time scheme in general use, and that this labour sufficiently corresponds to the racial development of it as to justify her contention that there is a very close relation between the social and the individual learning of the concept of time. Though there are some differences, such as the ready-made system of abstract time names and the use of numbers available for the civilised child,

these can be accounted for by the higher stage of culture reached. Moreover, these differences are outweighed by the striking similarities. Reverting finally to the nature of time, Sturt regards it as a concept. Time is not denied an experiential basis, which is constituted by what has been well named the specious present, that brief present which is perceived as a unitary whole. This experiential basis comprises our awareness, the succession of our mental states, at a particular moment, the time setting of this awareness or individual time, the concept of universal or Newtonian time, and the perception of change in external objects or common time. For the individual time is the complex of consciousness at any instant, a state of mind possessing no structure but peculiar to the individual and determined by his interaction with external objects. This psychological definition of time marks it off completely from time as understood by the relationists, the fourth dimension of space-time.

Passing now to the work of Guyau (23), we find that he and his friend Fouillée, believe that it is only after a more or less long evolution that the animal projects into the past part of the representations acquired by it and so arrives at the idea of time. Opposing the ideas of Kant, they say that our ideas of time must be slowly and laboriously built up by memories and representations. "In normal beings, the true condition of the idea of time, is in the real existence of succession and of movement outside ourselves, and also in our minds." They go on to say that "at first, the animal has, as a fact, a representation, then a succession of representations, then a representation of representations which he

has had, and that, in a certain imposed order; he has in consequence a representation of the succession of representations; finally this succession takes the form, built up slowly as the brain develops and as experiences accumulate, of time." Later it is said that "the idea of unitary time is the refined product of human reflection. The succession of representations is gradually elevated by the reflection of the experiencing mind on the experience by means of the repetition and condensing organs into the representation of a series, intensive, extensive and protensive." They agree that we have no other perception of time than our actual experience of the present state with the actual tendency to another state. Time is the object partly of perception and partly of conception. Guyau, then, like Stout, is a partisan of experience as the basis of our idea of time. He takes for granted the experience of time together with the physiological and psychological phenomena which make it possible. The immediate perception, the experimental intuition, is implied in the internal experience of change in being, which, according to Guyau, is the essential and primitive element of all ideas, space and movement. In the dynamical representation, "the image of the constant tension and transition which have accompanied each term of the series," gives us the idea of time.

Dealing with what he calls the period of primitive confusion, Guyau almost takes for granted the idea that time is a concept slowly and laboriously built up. That the idea of time is the result of a long evolution he says is difficult to deny and he refers to our language for proof. Further he says that ideas of

ime are slowly imposed on children through the organisation of he confused mass of memories of the past into a perspective of lowing days. Finally, in concluding his study, he says that rom all his arguments we shall conclude that "time is not a con- ition, but a simple effect of consciousness; it does not consti- tute consciousness, it springs from it. It is not a form a priori that we shall impose on phenomena, it is a mass of relations hat experience establishes among them. It is not a ready-made mould into which our sensations and our desires can be poured; it is a bed that they trace for themselves and a course that they spontaneously take in this bed." Time is, for Guyau, no other than a certain regular disposition, an organisation of images. Memory is only the art of calling up and organising these images. There is no time outside of desires and memories, that is, of cer- tain images which, juxtaposing themselves as the objects are juxta- posed which have produced them, give rise all at once to the appear- ance of time and space. Now, beyond consciousness, Guyau asks, is there a reality corresponding to the idea which we create for ourselves of duration? According to Guyau, time is only one of the forms of evolution, it does not produce evolution, it comes from it. Time, in effect, is a consequence of the passage from homogeneous to heterogeneous; it is a differentiation introduced into things. In place of saying that time is the essential factor in change and so in progress, Guyau states that it would be true to say that time has progress for factor and fundamental element; time is the abstract formula of changes in the universe. "Life and consciousness suppose variety and variety creates duration.

Eternity is either nothing or chaos; with the introduction of order into sensations and thoughts begins time."

Other writers, particularly of recent years, have assumed this theory. Thus Burt (12), writing on composition, says that "the changes in the child's intellectual outlook are clearly mirrored in his compositions. Through out school life it is evident, his comprehension of space relations is gradually widening. His horizon becomes enlarged; his world more systematically arranged. And, by somewhat later stages, it would appear, his notion of time pursues a parallel development. There is, too, a constant progress in the degree of generality or abstraction which his mind can envisage; the concrete conception yields to a more general conception and this in turn gives way ultimately to an abstract conception." As Janet (25) says, "time is not a form, but a construction of the mind," or, as Pichon (144) suggests, the idea of time is gradually developed. "In each human group, as the group becomes civilised, the idea of time is constituted by contact with reality, and gradually our mind arrives at the idea of infinite and homogeneous time, the common time experienced by all, or different times severally experienced and yet fundamentally similar. This is the result of time being experienced as a continuous succession of events." Now, the relation between the child's learning and the social construction of the idea of time has been the subject of an extensive investigation by Axel (56). His primary aim is to note the differences in time estimation in children of 9 to 14 and in college students. His material is standardised into four groups, "unfilled" time, time filled with

tapping - motor activity, time filled with cancelling 5's - sensori-motor activy, and time filled with mental activty - adding 7's for children and analogies and number completions for the students. Now, the results of his experiments are summarised by Weber (178) as follows: "for the children,the interpolated material exercised a strong influence on the estimation of small durations. The higher the level of behaviour the greater is the tendency towards equal accuracy between the children of different ages; up to ages 11 or 12 there is a definite tendency for a decrease in extremes of judgment; while from 11 and 12 no further significant decrease in extreme estimates appears; the higher the level the greater is the tendency towards underestimation and the less the tendency to overestimation in the case of a given group; and finally, the type of the interpolated material largely determines the difference in accuracy of estimation between a group of boys of 11 to 14 and a group of college students."

It would certainly be a very profitable line of attack on this problem, as Weber suggests, if we could get some reliable data on the development of the time idea among children and also among primitive people. As yet, there is no great body of data available on which to base definite conclusions. Weber further suggests that this dearth may be due in part to the lack of a precise technique for approaching some phases of the problem, for we are reduced to the use of the questionnaire method, which is lacking in that very precision and definiteness we need. This general weakness of method, however, has not deterred us from making an attempt, in the first place, to add to the body of data available and, in

the second place, to suggest some definite conclusions. After this has been set down, we propose to add a resume of views developed in the course of this study with the object of arriving at a reasonable theory of time as perceived and conceived.

TIME TESTS

Such, then, are the general ideas of time and of its development as a concept in our minds with which we approach our own particular problem, the growth of time ideas in the minds of school children, and especially the growth of the idea of historical time. Already it will be clear that any partiality to the Kantian conception of time as an a priori form merely requiring elucidation has been abandoned and that the idea of time as a concept as suggested by the work of the above writers, as a concept gradually developed as a result of individual and social needs and following a course of development in every child from a very crude and immature concept to a fully-formed and fully-elaborated concept, more or less complete in accordance with the culture and education of the individual concerned, has been adopted in its place.

In order to test out certain sections of this general supposition, two group tests were constructed, copies of which are appended (Appendix $\frac{2}{3}$). The first test, which will be referred to as Test 1, was gradually evolved from a consideration of various mental tests. The Binet-Simon scale and other mental tests were examined and the various items in these tests which had a

bearing on time and our knowledge of it were collected together, and from them, after due consideration, Test 1 was made up. Apart from the heading in which a knowledge of age and date was involved, the test was divided into four sections. Section A was devoted to a number of very simple questions, mostly drawn from the Binet scale, and involving answers to such questions as, name the days of the week or name the months of the year. Section B was given over to five smaller divisions, making use of the usual forms of group test in order to test the children's ability to use ordinary time words, or to use ordinary time ideas. Section C was composed of a number of instructions and problems involving reasoning where the material to be reasoned out dealt exclusively with time ideas and symbols. Section D, the final section, was an absurdity test. Some paragraphs dealing with the Battle of Bannockburn were written, but in these paragraphs many absurdities were introduced. This subject was chosen because of its probable familiarity to the pupils test. As can be seen, in the general construction of this test 1, the lines laid down by Burt in his Mental and Scholastic Tests (12)have been followed, for there he has said that the three most reliable tests are vocabulary, reasoning and absurdity tests and so a dué place has been given to tests of those descriptions.

Test 2 (Appendix 2) was constructed in order to test our children's knowledge of the conventional scheme of time marking as used in dealing with history and also in order to find out the methods by which our pupils think of historical time. To carry out the first of these objects, a number of short tests involving

well-known historical material was set; in some cases not merely were the events, but the dates also were given, as it was not a case of testing historical knowledge, but of the ability to arrange historical data in serial order. In Section B three separate tests were grouped together, the first of which was devised to find out a child's concept of certain periods and his ability to distinguish these periods from one another. The second consisted of five questions, one of which proved useless in practice, directed to find out the method used by children in thinking about historical data. The third subdivision was also an attempt, though couched in a different form, to analyse our children's concepts of different historical periods and to find out to what extent they had clear and definite images of these periods in their minds.

These two group tests are the bases of the results set out hereafter, and from these results certain general conclusions confirming our general ideas have been obtained. These tests were given during the summer term of 1931-32 to classes in Broxburn High School. As many of the pupils had already undergone testing under the Mental Survey promoted by the National Council for Research in Education, and as others had sat a Comprehension Test prepared by the local West Lothian Research Committee, the result was that many pupils and most of the teachers were familiar with the procedure adopted in giving these tests. In addition to the instructions clearly printed at the beginning of the test form, some general instructions were sent to the teachers in charge intimating that there was to be no time limit for the tests. It was not desired that these tests should be turned into an additional

intelligence test, (though some sections would have proved quite reliable in this respect), but that as many results as possible should be obtained. In view of the difficulty of setting all the second test in a simple form, it was left to the discretion of the individual teachers to determine whether or not the second test should be given to their pupils. By permission of the Rector and with the willing co-operation of the staff of Broxburn High School, these tests were given, the first to 898 pupils ranging from 7 years of age to 17 years and over, and the second to 565 pupils ranging from 9 years of age to 17 years and over. As the number of pupils over 15 years of age and under 7 years 11 months in the case of Test 1, and under 9 years 11 months in the case of Test 2 were limited, the reliability of the percentages obtained for these ages must also be considered as limited, an error, no matter how slight, causing a fairly great variation in the percentage. It has been suggested that only the 126, 165 and 156 at ages 11, 12 and 13 are likely to be good samples and even of these the 11 year olds have been suspected. Now, as these were all the pupils of age 8 and upwards in this school, which draws in all the children of the district and many from neighbouring districts as well, with the one exception of the Roman Catholics, and as the district is a modern industrial one, affected to some extent by unemployment, surely these pupils can be looked upon as typical and representative of an area with a typical and representative population, being at neither end of the scales of wealth, social class or intelligence. For these ages, then, we consider that the numbers are sufficient to give a fairly representative result; the pupils below 14 are

an entirely unselected group. For age 14 and over there is certainly some selection. No doubt 60 at 14 is still a fairly large number, but they are, as has been pointed out, the best 60 on the whole out of some 150 or so who might have been expected in school if say, the leaving age had been raised to 15. While we admit the influence of the exodus of many pupils, (good pupils as well as dull ones leaving at 14) on the results for age 14 and over, we are inclined to think that those for ages 8 to 13 are reliable and can be used as the bases of certain conclusions. With these general considerations in mind, let us now proceed to examine the results of these tests.

Taking first of all the heading of the test, three matters of time knowledge are involved; age in years and months, birthday, and the date. Unfortunately some teachers read the instructions as applying only to the sections which followed, and so the results particularly for the date, are better at the earlier ages than would normally have been the case. It was a very simple error which was not anticipated, as any preliminary tests had been made with senior classes, or it might have been avoided. For these three items, the following results are obtained:- in table 1 incorrect designates those who are unable to give their ages correctly in years and months, those who are wrong, and those unanswered; and in table 2 incorrect means those unable to give their birthday correctly or at all.

TABLE 1 - AGE.

Age of pupils.	Correct.	In-correct.	% Correct.	% In-correct.	% Improve-ment.
17	10		100		
16 - 16.11	9	1	90	10	
15 - 15.11	12		100		
14 - 14.11	60		100		7.69
13 - 13.11	142	12	92.31	7.69	- 3.45
12 - 12.11	158	7	95.76	4.24	16.40
11 - 11.11	100	26	79.36	20.64	8.19
10 - 10.11	79	32	71.17	28.83	17.53
9 - 9.11	59	51	53.64	46.36	36.67
8 - 8.11	19	93	16.97	83.03	8.28
7 - 7.11	2	24	7.69	92.31	

The pupil at age 16 who was wrong in giving the months of his age was one whose arithmetical ability was most markedly deficient. In every case of age 11 and above the error is in the months. Below 10.11 it is not uncommon to find children who cannot even give the years correctly. It was not possible to test out pupils of an earlier age and so to prove whether or not this question was an appropriate one/for Scottish pupils at age 5 at which age it appears in the Binet scale, but from the above results we can say that knowledge of and ability to express age in years and months is normally developed by the ages of 9 and 10, for at these ages over 50% are able to answer correctly. The last column shows that the greatest improvement occurs between the ages of 8.11 and 9.11 with considerable improvement in the following year. There is an interesting increase in improvement between ages 11.11 and 12.11; the curious negative result for the following year may be due to the presence of a small group of papers by M.Ds. which occur in that age group.

TABLE 2 - BIRTHDAY.

Age.	Correct.	In-correct.	% Correct.	% Incorrect.	% Improve-ment.
17	10		100		
16	10		100		
15	12		100		
14	60		100		
13	156		100		5.45
12	156	9	94.55	5.45	-2.28
11	122	4	96.83	3.17	1.33
10	106	5	95.5	4.5	.04
9	105	5	95.46	4.54	21.36
8	83	29	74.1	25.9	-6.7
7	21	5	80.77	19.23	

From this table it appears as if the threshold is much lower for this than for age, all ages having scored practically 75% or over. The age showing a real and decided improvement is age 9, as in Table 1. By the age of 13 all are able to give the birthday correctly.

TABLE 3 - DATE.

Age.	Correct.	In-correct.	% Correct.	% Incorrect.	% Improve-ment.
17	10		100		
16	9	1	90	10	
15	12		100		3.33
14	58	2	96.66	3.33	- .78
13	152	4	97.44	2.56	- .14
12	161	4	97.58	2.42	2.34
11	120	6	95.24	4.76	-2.06
10	108	3	97.3	2.7	- .88
9	108	2	98.18	1.82	16.93
8	91	21	81.25	18.75	15.86
7	17	9	65.39	34.61	

The results of the Binet scale show that this is an appropriate test for age 9. Now, although the figures given above in Table 3 seem to contradict this and suggest that for Scottish children it could easily be lowered, the unreliability of these figures because of the teacher's help in the case of the younger children has already

been noted. There emerges, however, the interesting fact that the improvement takes place at ages 8 and 9, confirming the impression obtained from Tables 1 and 2.

Let us pass now to Section A. which consisted of six questions dealing with such simple time words and symbols as would be familiar to all children, the results of which are set out below. The first question, is it morning or afternoon, yields practically no results of importance, the lowest percentage being 90.

TABLE 4 - MORNING or AFTERNOON.

Age.	Correct.	After-noon.	Unan-swered.	% Correct.	% In-correct.	% Improve-ment.
17	10			100		
16	10			100		
15	12			100		5
14	57		3	95	5	-4.36
13	155	1		99.36	.64	3.6
12	158	2	5	95.76	4.24	-1.85
11	123	2	1	97.61	2.39	4.87
10	103	3	5	92.74	7.26	2.74
9	99	3	8	90	10	-4.65
8	106		6	94.65	5.35	2.35
7	24		2	92.3	7.7	

The percentages in column 6 are insignificant; in fact, they are so low as compared with those in the corresponding columns of Tables 1 and 2 that it suggests the misplacement of this question in the scales. Usually it is given as a test at age 6 as compared with the others at age 5. If these results can be relied on, and no reason can be urged against their being accepted, then this test could be given at an earlier age.

In question 2 the pupils were asked to name the days of the week, a test usually given at age 7, a placing more or less confirmed by our results. In this table advantage was taken of the results to find out whether Sunday or Monday was the more popular day with which to begin the week, and the results are set out correspondingly.

TABLE 5 - DAYS of the WEEK.

Age.	Correct			Incorrect.			% Correct.	% Incorrect.	% Improvement.
	Sunday.	Monday.	Any other day,	Sunday.	Monday.	Etc.			
17+	7	3					100		10
16	7	2		1			90	10	-1.67
15	8	3		1			91.67	8.33	-3.33
14	36	22		1	2		95	5	-1.8
13	103	48		3	2		96.8	3.2	2.86
12	91	64		3	5	2	93.94	6.06	2.67
11	54	61		2	6	3	91.27	8.73	2.08
10	44	55		3	6	3	89.19	10.81	9.19
9	38	44	6	5	13	4	80	20	8.57
8	41	38	1	14	13	5	71.43	28.57	13.73
7	4	10		1	9	2	57.7	42.3	

The first point of interest to be noted is the preference among the younger children to begin with Monday. Up to age 11 with the slight exception of age 8 where, however, the figures are nearly equal, the majority begin with Monday. From age 12 upwards, with no exceptions at all, the preference is in favour of beginning with Sunday, as we should naturally expect. Regarding the columns indicating errors the following observations may be made:- the percentage of error when beginning with Sunday was 31.2 of the total error, but when beginning with Monday, it accounted for 51.4%, the remaining 17.4% being due to the last column which, with one exception beginning on Wednesday, owes its numbers to unanswered or very incomplete papers. It should be noted also that by far the largest number of errors is caused by the omission of the day at the end, for example, in the errors when beginning with Sunday, out of the total of 34 no fewer than 31 are due to this reason, nevertheless it seems better to begin with Sunday rather than with Monday. Finally, from the last three columns we are again forced to conclude that this particular item of time information is practically fully developed by age 8, certainly by age 9. It is usually given as a test for age 7, which may be placing it rather low, at least for Scottish children.

Question 3 dealt in a similar way with the months, and the results are as follows:-

TABLE 6 - MONTHS.

Age.	Correct.	Incorrect.	Jumbled.	Unanswered.	Incomplete.	% Correct.	% Incorrect.	% Improvement.
17+	10					100		
16	10					100		
15	12					100		
14	60					100		
13	156					100		7.88
12	152	9	2	1	1	92.12	7.88	4.82
11	110	7	2	2	5	87.3	12.7	7.12
10	89	14	3	5		80.18	19.82	16.54
9	70	18	4	13	5	63.64	36.36	11.39
8	58	28		15	10	52.25	47.75	17.65
7	9	6		7	4	34.6	65.4	

The results here suggest at a first glance that the months are better known, or more easily learnt than the days of the week, but the percentages at the lower ages do not confirm the sound knowledge of later years. It is not until age 10 that a sound grip of the months can be assumed and so to place it at age 9 in an intelligence scale is probably correct. Another point to be noted is the fairly large measure of improvement for the years 8, 9 and 10. A further point is that the months which gave trouble are those about the end of the year, September, October, November, especially October. Whether this was due to the similarity of sound causing a pupil to omit one of them, or to their apparently incorrect names, cannot be said, but the fact of their difficulty cannot be doubted.

The next question concerned itself with the time. Now, as the test was given throughout the school at approximately the same hour and that hour one following the morning interval, the results probably range too high. Again, some classes were in such a position as to see the clock on the local Institute, and so here again we have a factor militating against their reliability. Nevertheless, the results are tabulated below for what they are worth. A certain margin of error was allowed, within half an hour, but all answers (morning, dinner time, summer time, etc.) other than these are noted as incorrect.

TABLE 7 - TIME.

Age.	Correct ½ hour	within 1 hour	In-Correct.	% Correct ½ hour	within 1 hour	In-correct.	% Improve-ment.
17+	10			100			
16	10			100			
15	12			100			8.33
14	55	2	3	91.67	3.33	5	6.4
13	135	6	17	85.27	3.84	10.89	11.94
12	121	15	29	73.33	9.09	17.58	- 6.04
11	100	6	20	79.37	4.76	15.87	21.71
10	64	12	35	57.66	10.81	31.53	19.48
9	42	15	53	38.18	13.64	48.18	-28.1
8	74	5	33	66.08	4.46	29.46	50.69
7	4	9	13	15.39	34.61	50	

Although a margin of half an hour was allowed in the case of the older pupils the margin was actually considerably less; it did not exceed 15 minutes for ages 15 and 16 or 10 minutes for ages 17 and over. Even allowing for the unreliability of the figures, especially for age 8, it seems clear that the ability to tell the time, outwith the adventitious help of the clock, is not fully developed until age 11, which is somewhat higher than the results for the days of the week or the months. The ability to tell the time would appear to be a more difficult accomplishment. Historically the clock was a much later development than the day, the season, or the month. Phylogenetic development may be, then, finding fresh confirmation here.

The clock face itself would appear to be better known. It may be that a spatial representation of the idea of the hours precedes, or is earlier than, the ability to estimate the time without the aid of the clock. At any rate, as Table 8 will show us, the ability to indicate correctly, or partially correctly, a specified hour on a blank clock face, seems to be developed by age 10, a year earlier than we should have anticipated from the preceding table. By partially correct is to be understood the correct placing of the minute hand, but the incorrect placing of the hour hand as directly opposite the figure III and not, as it should be, between the figures III and IV.

TABLE 8 - CLOCK FACE.

Age.	Corr-ect.	Par-tially Correct.	In-Correct.	% Correct.	% Par-tially Correct.	% In-correct.	% Improve-ment.
17+	8	2		80	20		20
16	6	4		60	40		-23.33
15	10	2		83.33	16.67		23.33
14	36	23	1	60	38.33	1.67	10.65
13	77	72	7	49.35	46.15	4.5	7.53
12	69	91	5	41.82	55.15	3.03	3.72
11	48	66	12	38.1	52.38	9.52	12.87
10	28	64	19	25.23	57.66	17.11	11.59
9	15	58	37	13.64	52.73	33.63	9.17
8	5	54	53	4.47	48.21	47.32	4.47
7		11	15	0	42.3	57.7	

The final question in this section asked the pupil whether he would be older or younger when he was 14. The elliptical form of the question may have confounded some of the older pupils, for they answered, "I do not know", or "neither", of "I shall never be 14 again". The fact that the question was not properly understood may account for the low percentages among the senior pupils. The only other point to note is the increase in uncertainty and in incorrectness at the given age of 14 and just over.

TABLE 9 - OLDER or YOUNGER.

Age.	Corr-ect.	In-correct.	Un-certain.	Unan-swered.	% Correct.	% In-correct.	% Improve-ment.
17+	6		2	2	60	40	
16	6	1	1	2	60	40	10
15	6	1	3	2	50	50	- 6.67
14	34	17	4	5	56.67	43.33	-37.56
13	147	3	4	2	94.23	5.77	.9
12	154	4	2	5	93.33	6.67	3.43
11	113	6	2	5	89.9	10.1	1.61
10	98	6	1	6	88.29	11.71	- 3.53
9	101	1		8	91.82	8.18	.03
8	102	2		8	91.79	8.21	3.33
7	23	2		1	88.46	11.54	

As already indicated, Section B of Test 1 is given over to testing children's knowledge of time words. The first test is an opposites test containing some 15 words of which seven pertained to time and eight to other things. In this case the actual score of the pupils was found and compared with the possible score, the percentage of the actual score to the total possible score being worked out. This was done for the time words and for the other words separately so that a comparison of these might also be instituted. As this was the general method followed in dealing with the whole of this section, it shall not be mentioned again, but the results will simply be given in that form. The table showing the results from which the ordinary table has been complied will be given in Appendix 3.

TABLE 10 - OPPOSITES.

Age.	Total Possible score (a)	Actual Score for (b) Time words.	% b to a (c).	% Improvement.	Total possible score (d).	Actual Score for Other Words (e).	% e to d (f).	% Improvement.	% by which f exceeds c.
17 +	70	62	88.57		80	79	98.75	- 1.25	10.18
16	70	62	88.57	-5.47	80	80	100	1.1	11.43
15	84	79	94.04	15.94	96	95	98.9	6.88	4.86
14	420	328	78.1	.35	480	442	92.08	- 4.96	13.98
13	1092	843	77.75	4.15	1248	1211	97.04	2.24	19.29
12	1155	850	73.6	5.92	1320	1251	94.8	4.62	21.2
11	882	597	67.68	7.58	1008	909	90.18	4.48	22.5
10	777	467	60.1	9.2	888	761	85.7	13.77	25.6
9	770	392	50.9	18.13	880	633	71.93	26.62	21.03
8	784	257	32.77	27.28	896	406	45.31	39.06	12.54
7	182	10	5.49		208	13	6.25		.76

From this table we note that this opposites test yields results suggesting the secure formation of time ideas at age 11. Before that age 60% or less can answer correctly. For other ideas the age is two years lower, 9, which suggests that there is a lag in the learning of time ideas, that there is greater difficulty inherent in them. This would be sufficient to cast doubts upon the Kantian theory of the development of time ideas. The percentages attained confirm this also, for the percentage scores for other words exceed the percentage scores for time words by an average of 14.85%. In one case only, age 7, where the numbers tested are not very considerable, is there anything approaching equality attained. Another point of interest is the column indicating the percentage improvement; there is a decided improvement at ages 8 and 9 followed by an equally decided slowing up until age 15 is reached when there is again an increase. As this follows what may be expected from a learning curve, it would seem as if time

ideas were less a matter of intuition than a matter of learning forced upon us by our individual and social needs. On the other hand, this apparent increase in improvement at age 15 may not be a real improvement at all, for it may be due to the change in the composition of the age group. The source of the improvement may be found in the fact that at 14 a great many pupils, especially weaker pupils, have left the school and so the 60 sitting the test are selected pupils. The composition of this group may have been changed first by the clever early qualifiers coming in from our contributory schools in the neighbouring district and then by the advent of the dull late qualifiers. The plateaux of our results may be plateaux of quiescence in selection rather than plateaux in child development. If this latter suggestion, rather than our former suggestion, is correct, then the result we have noted of an increased improvement about age 15 is due simply to the operation of selection and not to any development of time knowledge in children at all. The following notes were made during the scoring: the most difficult time words were "now" for those over 13 and "noon" for those under 13. To "now" in approximately half the cases the answer given was "after" or "future". The easiest words were "early, sunrise, day". The most difficult other word was "here", but the others proved easy.

The next test was an analogies one which gives results as follows:-

TABLE 11 - ANALOGIES.

Age.	Total possible Score (a)	Actual Score (b)	% b to a.	% Improvement
17 +	90	66	73.33	-14.45
16	90	79	87.78	7.23
15	108	87	80.55	13.65
14	540	361	66.9	9.56
13	1404	805	57.34	10.44
12	1485	835	56.9	9.01
11	1134	543	47.89	10.85
10	999	370	37.04	17.95
9	990	189	19.09	11.65
8	1008	75	7.44	1.89
7	234	13	5.55	

In many cases of low scores it appears that the cause is lack of intelligence in reading the instructions rather than lack of knowledge, for in many papars the first six or the last four were left completely alone, thus prejudicing the score considerably. It is also apparent that where the fourth item was left blank, and no alternative answers given, the score is greater on the whole; in the case of score 6, for instance, more than half, 5 out of 8 to be precise, made a score of 3 for the blank analogies. Further, in the correct or nearly correct papers the secondary pupils predominated over advanced division pupils which shows that ability and intelligence are the principal factors in this test; the exact figures were 12 secondary pupils to 5 advanced division pupils. The juniors of 7 did the written answers only. Beyond noting the poor percentages recorded below age 12, there is really little of importance. Again, however, there is the largest measure of improvement at age 10.

The next test deserves a small corner only, partly because of the few examples given and partly because it is not such an adequate type of test as some of the others. The word "era" apparently was not at all well known, and from the results it would appear that there was a tendency to put the unknown first. Where it was not put first, it was dommonly put immediately before century. There is once more decided improvements recorded at the years 9, 10, and 11, especially for 10.

TABLE 12 - ARRANGING in ORDER.

Age.	Score for Time Series					Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.
	2	1½	1	½	0				
17+	7	3				20	19	95	
16	7	3				20	19	95	- .83
15	10	2				24	23	95.83	15.83
14	30	20	6		4	120	96	80	5
13	42	94	9		11	312	234	75	2.58
12	49	90	5	2	19	330	239	72.42	8.92
11	21	74	6	1	24	252	160	63.5	18.5
10	5	48	13	9	36	222	100	45	22.27
9		28	7	1	74	220	50	22.73	20.06
8		2	1	3	106	224	6	2.67	.75
7				1	25	52	1	1.92	

The next test took the form of completing sentences, a choice of words being given and the correct one to be underlined. For the sentences involving time words or time ideas, of which the first sentences proved the most difficult, the following table

shows much the same characteristics as the preceding ones.

TABLE 13 - COMPLETION of SENTENCES.

Age.	Score for Time Sentences 5	4	3	2	1	0	Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.
17+	9	1					50	49	98	-2
16	10						50	50	100	1.67
15	11	1					60	59	98.33	6
14	49	8				3	300	277	92.33	2.07
13	108	32	10	3		3	780	704	90.26	5.9
12	102	32	13	6	7	5	825	696	84.36	3.41
11	71	26	11	7	4	7	630	510	80.95	25.46
10	27	29	11	7	10	27	555	308	55.49	32.4
9	7	11	8	7	10	67	550	127	23.09	21.56
8					4	107	560	8	1.43	1.43
7						26	130		0	

Then follows a definite vocabulary test with time and other words mixed. The detailed table of results from which the table proper, as given below, has been constructed, will be found in Appendix 3.

TABLE 14 - MEANINGS.

Age.	For Time Words Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.	For Other Words Possible Score (c)	Actual Score (d)	% d to c.	% Improvement.
17 +	60	54	90	8.33	40	40	100	1.5
16	60	49	81.67	1.11	40	39	98.5	2.67
15	72	58	80.56	23.34	48	46	95.83	25
14	360	206	57.22	8.93	240	170	70.83	3.04
13	936	452	48.29	12.33	624	423	67.79	9.76
12	990	356	35.96	4.35	660	383	58.03	6.25
11	756	239	31.61	6.84	504	261	51.78	11.69
10	666	165	24.77	10.68	444	178	40.09	9.64
9	660	93	14.09	14.56	440	134	30.45	23.09
8	672	17	2.53	- .67	448	33	7.36	-3.22
7	156	5	3.2		104	11	10.58	

The order of difficulty among the time words was "time, simultaneous, duration". Most pupils found trouble in defining time as was to be expected. Two answers from among the many given were that "time is something no man can stop" and that it is "measurement on a clock". It would appear, and all experience would lead us to expect, that abstract words are the ones which give rise to difficulty; concrete words are more easily defined, especially among the younger children. It is hardly fair to institute a comparison between the time words and the other words, for they were not balanced against one another in regard to difficulty. Even from a superficial glance the other words appear easier and should render higher percentages, an expectation which is borne out by the table. The percentages, d to c, exceed those of b to a by about 15 on the average, which is, however, curiously similar to the result found for Table 10. The column showing the percentage improvement gives for time words marked increases at 9, 10, 13 and 15, and for other words at 9, 11 and 15.

From Section B we may conclude that though the tables may show different ages at which the particular test can be done satisfactorily, nevertheless the improvements in ability to perform the test occur about age 9. In all seven cases that age shows a greater advance; in two cases age 13, in five cases age 10 and in four cases age 11.

In the third section of Test 1, the children were asked to obey some simple instructions and to exercise some simple reasoning with time words and ideas. This was to ensure that they could really use the words and ideas, the meaning of which they had been asked in one form or another in the preceding section. The results of this test are as follows:-

TABLE 15 - INSTRUCTIONS.

Age.	Score 4	3	2	1	0	Possible Score (a)	Actual Score (b)	% b to a	% Improvement.
17+	8	2				40	38	95	
16	8	2				40	38	95	5.42
15	9	2		1		48	43	89.58	15.83
14	29	14	7	5	5	240	177	73.75	2
13	45	56	33	15	7	624	429	68.75	6.48
12	31	63	36	26	9	660	411	62.27	3.54
11	18	43	37	21	7	504	296	58.73	8.73
10	7	38	32	16	18	444	222	50	20.68
9	3	13	26	26	42	440	129	29.32	13.92
8	1	6	7	33	65	448	69	15.4	-1.9
7		2	2	8	14	104	18	17.3	

Two points alone deserve mention; the higher age, on the whole, of achievement in this test, and the chief increases in improvement showing themselves again at ages 9, 10 and 15. The first instruction deceived many of the pupils, probably those who were casual thinkers; the third instruction was the most difficult one, no less than 21 out of 22 being wrong in a sample group.

For the reasoning test, the results give a table as below:-

TABLE 16 - REASONING.

Age.	Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.
17+	100	90	90	3
16	100	87	87	15.33
15	120	86	71.67	7.17
14	600	387	64.5	4.31
13	1560	939	60.19	.19
12	1650	990	60	7.53
11	1260	661	52.47	13.1
10	1110	437	39.37	20.28
9	1100	210	19.09	12.04
8	1120	79	7.05	6.55
7	260	13	.5	

The ages showing greatest improvement are one year later in this test, ages 10 and 16 as against 9 and 15, but the general features are the same. Time words and ideas for reasoning give age 12 as that at which the knowledge of time may be said to be developed. As for the items of the test, the last two were too difficult for those under 14, while the seventh one caught the easy thinkers at all ages. Taken together these tests would confirm what the previous section has led us to surmise, the close similarity between time learning and other learning, showing that time is a concept slowly and laboriously acquired by children in the ordinary course of learning. So far from being an innate gift, our knowledge of time lags behind that of other ordinary matters.

The final section of Test 1 was an absurdity test. A passage dealing with the Battle of Bannockburn was written containing many absurd and wrong statements. The Battle of Bannockburn was chosen as the subject because it was a topic about which most children in a Scottish school would be likely to know something. This had the advantage of familiarity. These absurd statements whether connected with time or not, were to be underlined by the pupils. Burt (12) considers the absurdity test a very good one

for intelligence, and so this test was designed to test the child's ability to use knowledge of time and to distinguish a historical epoch from the present.

In marking this test, the child's score was arrived at by deducting the number of incorrect underlinings from the number of correct underlinings. That gave the number of absurdities which he had correctly determined. Where, for instance, there was a choice to be made, as, "Sunday, the 12th of June", "Sunday, the 23rd of June", dependence was placed on the child's general historical knowledge that the battle was fought about Midsummer Day, a fact always stressed about this battle. It is also commonly known that the Scots spent the Sunday in prayer and preparation, so that the difficulties of the passage are reduced for school children.

The score, then, was reckoned as the number of absurdities found minus the number of correct statements underlined as absurd or wrong. A detailed table of the scores made at various ages will be found in Appendix 3, and from this the following summary table has been constructed:-

TABLE 17 - ABSURDITIES.

Age.	Possible Score (a)	Actual Score. (b)	% b to a.	% Improvement.	Score for Time Words (c).	Total Error Score (d)	% c to d
17+	280	178	63.57	-4.29	96	214	44.85
16	280	190	67.86	4.17	96	209	45.93
15	336	214	63.69	23.87	121	257	48.21
14	1680	669	39.82	6.37	369	822	44.89
13	4368	1461	33.45	1.11	805	1788	45.02
12	4620	1494	32.34	6.72	885	1892	46.77
11	3528	904	25.62	5.74	587	1250	46.96
10	3108	618	19.88	8.49	380	884	42.98
9	3080	351	11.39	3.64	195	549	35.52
8	3136	243	7.75	4.04	26	290	9
7	728	27	3.71		25	71	35.2

Though the fourth column shows very low percentages below the age of 15, at which age also the improvement is greatest, the test appears to be quite adequate. The age which shows the next greatest degree of improvement is 10. So far as the last three columns are concerned, we were interested in comparing the score for time words with the total number of ideas underlined as wrong. With

the exception of age 8, and to a lesser degree, ages 7 and 9, there is a remarkable constancy in the percentages yielded, which would suggest that in this test time ideas stand as much chance as other ideas of being noted by children above the age of 10. From the absurdities test, then, we might conclude that for the most part a knowledge of time ideas can be assumed as being adequate from age 10 upwards. The score for the time words was analysed with a view to detecting which ideas were easy and which were difficult. The order of difficulty in this instance proved to be as follows: "Friday, still living, 25th June, 30th February, 12th June, from ten to twelve, 1315, 23rd June, day's march, half an hour, Sunday, morrow, long time, sunset, next morning, December." Putting aside Friday as having undue attention drawn to it, and December for the obscurity of its position in the title, it would appear that the more precise dates were first to attract attention.

Combining the results of improvements for the Test 1, a composite table was constructed.

TABLE 18 - TEST 1.

Age.	Heading and Section A.	Section B - Words.	Section C Reasoning.	Section D Absurdities.	Average %
17+		-1.62	1.5	-4.29	-1.1
16	-5	.74	10.37	4.17	2.57
15	5	14.95	11.5	23.87	13.83
14	-4.57	5.18	4.65	6.37	2.91
13	4.06	7.08	3.33	1.11	3.89
12	2.58	6.32	5.54	6.72	5.29
11	6.41	13.85	10.91	5.74	9.23
10	8.11	18.5	20.48	8.49	13.89
9	14.17	16.59	12.98	3.64	11.85
8	11.07	10.45	2.32	4.04	6.97
7	-	-	-	-	

This table confirms the impressions which slowly grew during the scoring of this test, that, although it may be the case that for most children the more or less fully developed concept of time has been arrived at by the ages of 9 or 10, at which there are increases in improvement, there is also after a period of slow concolidation of the concept, another improvement at age 15. Are we to conclude that this is the normal method or is it exceptional? If it is normal, then is not the conclusion of Sturt that the adult concept can be assumed after ages 9 or 10, perhaps rather too sweeping and dogmatic? Would it not be better to say that, while a comparatively adequate concept has been arrived at by those ages,

the adult concept cannot be assumed until the age of 15? On returning to this point again, and on giving it fresh consideration we are inclined to the opinion that the improvement at age 15 is more apparent than real. It would be exceptional if the age group were thoroughly representative, which we are forced to conclude it is not. And so, after all, we are entitled to conclude with Sturt (41) that a comparatively adequate and adult concept of time has been arrived at by most children at the ages of 9 or 10.

Test 2 was devised upon more normal school lines to test the pupils' knowledge of the conventional scheme of time marking and order as used in dealing with historical time. In some of the tests, very considerable help was given by the dates; in a few instances where simple reasoning rather than mere book knowledge should have been sufficient to give a clue, the dates were omitted. Here purpose rather than memory should have played its part in determining the serial order. A second section was added with a view to testing the adequacy of their historical concepts, and to finding out the methods used in dealing with historical material.

The tables for Section A, question 1, are as follows:- Table 18 gives the results for the arrangement of certain historical events in their proper order for the two cases where the dates are given. The results from which this table and the following one have been constructed will be found in Appendix 3.

TABLE 18 - WITH DATES.

Age.	FOR A/a Possible Score (a)	Actual Score (b)	% b to a (e)	% Improvement.	FOR A/c Possible Score (c)	Actual Score (d)	% c to d (f)	% Improvement.	Average % e and f.
17+	27	26	96.29	-3.71	45	45	100		98.15
16	30	30	100		50	50	100		100
15	24	24	100	14.67	40	40	100	17.2	100
14	150	128	83.33	18.44	250	207	82.8	11.98	84.07
13	438	293	66.89	10.57	730	517	70.82	13.44	68.86
12	483	272	56.32	11.47	805	462	57.38	12.29	56.85
11	330	148	44.85	-3.35	550	248	45.09	- .14	44.97
10	195	94	48.2	-12.91	325	147	45.23	-31.44	46.77
9	18	11	61.11		30	25	76.67		

In the case of these tests it must be noted that no results were obtained for pupils under 9 years of age, for the teachers considered rightly that the tests were of too difficult a nature for these young pupils. Very few below the age of 10 attempted them, but these six being the brightest pupils of their year naturally scored fairly well and so gave absurdly high percentages for

their achievement. They shall be disregarded, therefore, in criticising the tables. There is not the same marked ages for improvement showing in Table 18 as in previous tests, rather a steady improvement throughout. The percentages suggest that where the dates are given (and it would apply equally to historical material of which the dates are known) a knowledge of the conventional scheme can be assumed at age 12.

For material where the dates were not given, the results give the following table:-

TABLE 19 - WITHOUT DATES.

	FOR A/b								
Age.	Possible Score (a)	Actual Score (b)	% b to a (c)	% Improvement.	Possible Score (d)	Actual Score (e)	% e to d (f)	% Improvement	Average % c and f.
17+	27	23	85.18	-4.82	54	46	85.19	-8.14	85.19
16	30	27	90	2.5	60	56	93.33	12.08	91.67
15	24	21	87.5	22.17	48	39	81.25	12.25	84.38
14	150	98	65.33	6.44	300	207	69	20.94	67.17
13	438	258	58.89	7.96	876	421	48.06	6.13	53.48
12	483	246	50.93	- .89	966	407	41.93	14.05	46.93
11	330	171	51.82	20.02	660	184	27.88	7.37	39.85
10	195	62	31.8	-45.98	390	80	20.51	-29.49	26.16
9	18	14	77.78		36	18	50		

A frequent cause of error for age 13 and over in Test 2, A/d, was the placing of John Knox before the Battle of Bannockburn. For age 13 and under a less frequent error was caused by placing the Jacobite Rising much too early. Again discounting the results for age 9, we cannot note any definite age for improvement, though the results for test A/b at first sight suggested a return to the general form for Test 1, nor can we say that there is a definite age at which this type of material can be successfully arranged, though age 13 seems likeliest. The average percentages, it should be noted, are about 13 below those for Table 18; at every age they are lower, as would naturally be expected.

The second part of this test took a somewhat different form. A list of dates was given, also a list of events and from the dates the pupils had to select those appropriate to the events given. In most cases, the choice of date would be guided by memory; in a very few cases, by guess, but as the list of dates exceeded that of events, it was hoped that this factor would be more or less eliminated. As a check, the pupils were also asked to arrange

the events in order; this was to find out which was the easier, picking out the correct dates or giving the correct order of events, and to see whether memory or purpose played the greater part in dealing with historical material.

A table showing the scores of the pupils for choice of dates and for arrangement of the events in order will be found in Appendix 3. These scores give the following percentages for comparison:

TABLE 20 - DATES and ORDER.

Age.	Date Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.	Order Possible Score (c)	Actual Score (d)	% d to c.	% Improvement.	% Date to order.
17+	90	70	77.78	4.78	90	83	92.22	16.22	14.44
16	100	73	73	14.25	100	76	76	- .25	3
15	80	47	58.75	12.15	80	61	76.25	27.45	17.5
14	500	233	46.6	15.5	500	244	48.8	16.88	2.2
13	1460	454	31.1	8.37	1460	466	31.92	1.67	.82
12	1610	366	22.73	5.18	1610	487	30.25	14.25	7.52
11	1100	193	17.55	3.40	1100	176	16	4.77	-1.55
10	650	92	14.15		650	73	11.23		-2.92
9	60	21	35		60	12	20		-15

From the improvements column it is hardly possible to draw any conclusion save that the first, where memory counts, shows a steadier improvement than does the one representing purpose. From the final column, where the percentage by which the order test, purpose, is greater than or less than the date test, memory, is noted, we gather that up to age 11 memory is a factor of greater importance than purpose, but that after 11 purpose is more powerful than memory. Beyond these tentative generalisations it is impossible to go, for the degree by which the one exceeds the other is neither constant nor definite in its trend.

An inverse form of the memory test was used in Section A, 3, where a list of events was given and a select list of ten dates below, to which the appropriate event had to be attached. The results give the following table. Again the scores which form the basis of this table, will be found in appendix 3.

TABLE 21 - EVENTS.

Age.	Possible Score (a)	Actual Score (b)	% b to a.	% Improvement.	% Events to Date.
17+	90	58	64.44	13.33	-13.34
16	100	51	51	11	-22
15	80	32	40	13.4	-18.75
14	500	135	26.6	5.37	-20
13	1460	310	21.23	2.91	- 9.87
12	1610	295	18.32	7.05	- 4.41
11	1100	124	11.27	.65	- 6.28
10	650	69	10.62	-	- 3.53
9	60	13	21.67	-	-13.33

The table would suggest that this type of test is more difficult, for there is a negative sign at every entry in the last column where the percentages for dates are compared with those for events. This would give as an order of difficulty, the events form, the date form, and the order form.

Section B was likewise given over to three main questions. The first asked the pupils to compare various periods of history with regard to length. This was to see if the idea of foreshortening applied among school children; to see whether periods remote in time, or about which fewer facts are known appear shorter than more recent periods to them. As the pupils were asked to indicate the longer period and as those chosen with one exception, occur earlier in history, then an excess of errors would indicate this foreshortening. The results show up as follows:-

TABLE 22 - FORESHORTENING.

Age.	Score 5	4	3	2	1	0	Possible Score (a).	Actual Score (b).	% b to a.
17+		5		4			45	28	62.22
16	2	2	1	4	1		50	30	60
15	1		2	2	2	1	40	17	42.5
14	1	4	7	8	20	10	250	78	31.2
13		2	12	33	50	49	730	160	21.92
12	2	6	24	33	55	41	805	227	28.2
11		3	8	28	36	35	550	128	23.27
10			2	6	16	41	325	34	10.46
9		2		3		1	30	14	46.67

This table would seem to show that for all ages below 16 this foreshortening is a definite fact, but that from 16 upwards, whether due to greater knowledge or greater maturity of intelligence, there is a greater grasp of the reality and significance of historical time.

The second question was an attempt to find out the methods used by children in thinking about historical data. For the most part, however, the results are disappointing; this may be due to the rather unimaginative type of pupils to whom the test was given, or to their difficulty in apprehending what was wanted; or this may be due to difficulties of draughtmanship in the questions, thus (c) do you think of historical dates as arranged in any particular way? yielded no results of importance and is omitted from the tables. Question 2 (a) was a connecting link with the previous section, and gave much the same result, though suggesting a lower threshold, 15 instead of 16 (Table 23)

TABLE 23 - BEFORE or AFTER.

Age.	Score No. Right.	No. Wrong.	No. Un-answered.	% R.	% W.
17+	6	2	1	66.67	22.22
16	7	3		70	30
15	5	2	1	62.5	25
14	19	29	2	38	58
13	22	96	28	15.08	65.75
12	41	89	35	25.46	55.27
11	26	51	33	23.64	46.36
10	14	36	15	21.54	55.39
9	1	3	2	16.67	50

To the second part of the question, which attempted to find out any colour forms for time, the results are meagre, which would show that when Sturt (41) says that spatial representation may not be the only form of representation of time, and suggests colour or sound forms as alternative forms of representation she is suggesting a form which is exceedingly rare and should therefor be discounted in her argument. We can, of course, speak of the colour form only. One pupil had a colour form for some days of the week: Sunday, bright; Monday, dull; Tuesday, blue; Wednesday, crimson, but it did not extend beyond Wednesday, for the remainder were colourless. To two other pupils the seasons were coloured, and to another December appeared white "because of the purity of Christ".

Passing over the third part as unfruitful and coming to the fourth part, where the pupils were asked whether history appears as a series of events moving forwards, the organic point of view, or a series of dates moving backwards, the inorganic point of view, the results are:-

TABLE 24 - FORWARDS or BACKWARDS.

Age.	For-wards.	Back-wards.	Un-answered.	% Forwards.	% Backwards.	% by which F exceeds B
17+	7	2		77.78	22.22	+55.56
16	8	2		80	20	+60
15	6	2		75	25	+50
14	27	20	3	54	40	+14
13	62	66	18	42.47	45.2	- 2.73
12	75	49	41	46.58	30.43	+16.15
11	36	37	37	32.73	33.64	- .91
10	23	14	28	35.38	21.54	+13.84
9	2	1	3	33.33	16.67	+16.66

Judging by the results in the final column, the preference seems to be for the organic point of view, for the events of history as moving forwards rather than backwards except in two instances, age 11, and age 13. As in both cases the percentage is hardly significant our conclusion holds good.

The last section suggested five methods by which events might be arranged in order, and asked the pupils to state which method they took. So far as their honesty can be relied on, and it must be noted many would not like to confess that they did their arranging by guess, the results are:-

TABLE 25 - METHOD of ARRANGEMENT.

Age.	% Guess.	% Date.	% Epoch.	% Person.	% How Long Ago.
17+		88.89		11.11	
16		100			
15		50	12.5	12.5	12.5
14	4	52		14	16
13		51.37	.7	13	12.33
12	.62	52.16	1.24	9.94	8.07
11	3.64	36.36		8.18	15.45
10	1.54	27.7	1.54	3.08	12.32
9		16.67			

Detailed scores in Appendix 3.

But whether we can trust the percentages or not, at least we can say that the order of methods is by date, by how long ago, by persons, by epoch and by guess. The first two are the methods in commonest use.

Finally there was a question consisting of thirteen parts to which the answer yes or no had to be given and testing whether the pupils had a grasp of different epochs in history. In some respects the questions are comparable with absurdities, and the scores give somewhat the same results, a real improvement at 11, and a further apparent improvement at 15.

TABLE 26 - YES or NO.

Age.	Possible Score (a).	Actual Score (b).	% b to a.	% Improvement.
17	117	96	82.07	-3.31
16	130	111	85.38	-1.16
15	104	90	86.54	15.77
14	650	456	70.77	6.49
13	1898	1220	64.28	1.6
12	2093	1311	62.68	4.08
11	1430	838	58.6	6.06
10	845	454	52.54	3.82
9	78	38	48.72	

Detailed scores in Appendix 3.

Though the actual percentages are greater than with the absurdities (see Table 17) or with the time words' score alone in the same absurdity test, there is no real comparison because in this case the apprehension of historical time is alone being tested, whereas other things were introduced into the previous test. This table suggests that there is a fairly good grasp of the main epochs of history by about 10 and 11, which points, as do some of the other tests, to the desirability of not beginning any very exact or scientific study of history before the age of 11.

CONCLUSIONS FROM TIME TESTS.

From the body of results tabulated above, we venture to suggest that the original opinion of time as a concept acquired by everyone in the course of earlier years has been fully borne out. The earlier tests with ordinary time words, whether vocabulary tests or reasoning tests, all point to this conclusion for the general trend of the percentages is the same, normally an increased correct percentage as the age grows greater, with somewhat greater improvements at ages 9, 10 and 11, and again at 15. The first of these improvements is shown in the graph below by a slightly sharper rise for these years compared with the flattening of the curve before and after these years.

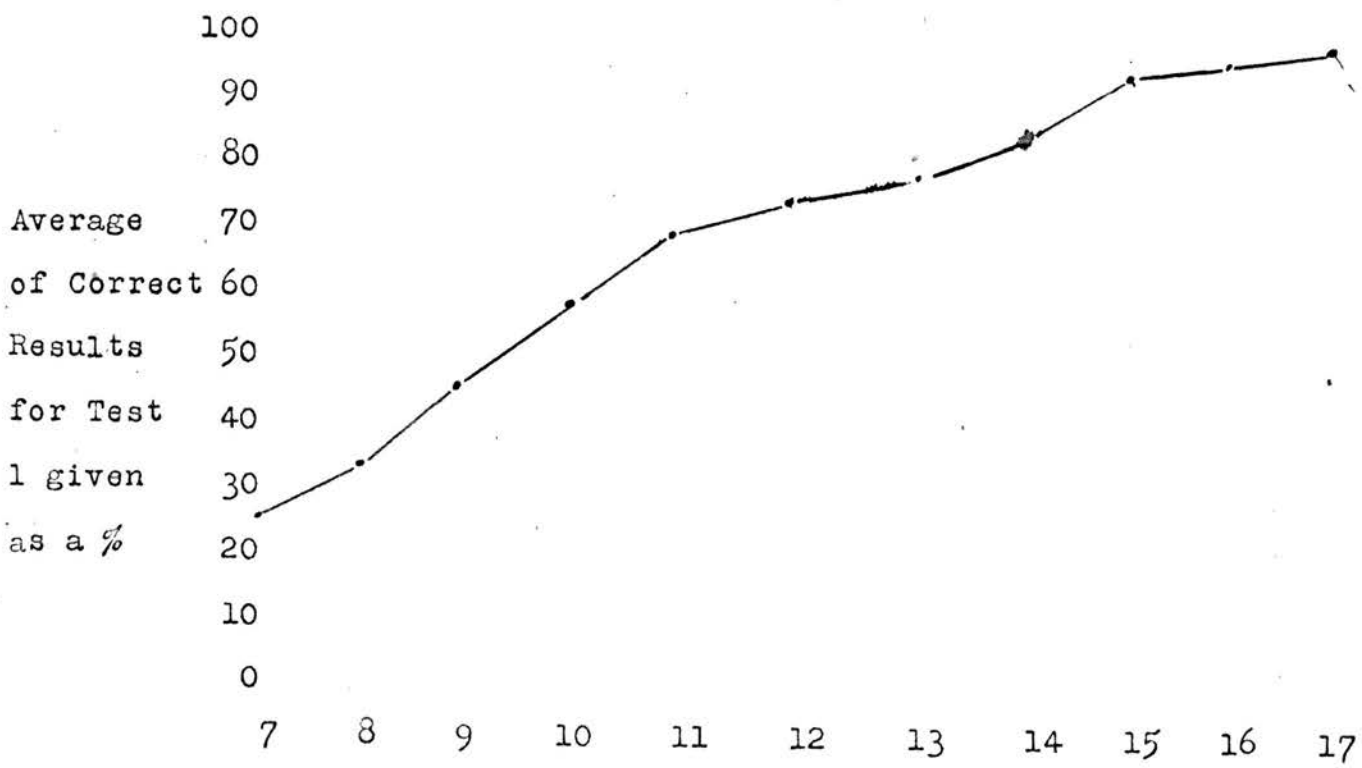


Table from which this graph of correct results for Test 1 is constructed:

Age.	Total of Correct Results.	Average %
17	1473.5	92
16	1453	91
15	1449.3	90.5
14	1290.5	81
13	1231.8	77
12	1163	72.5
11	1093.4	68
10	920.4	57.5
9	721.9	45
8	529.2	33
7	391.6	24.5

As has already been suggested, the improvement at age 15 may be more apparent than real. The amount of selection of the group may be fairly considerable, for, though 60 at 14 may be a fairly large number, it is, on the whole, the best 60 out of, say, 150, so that 90 have left the school and are not included in the test. But even allowing for the influence of this selection, we may be permitted to express the doubt of which we cannot rid out minds that all this improvement is due to this cause. May not some portion of the entire improvement at 15 be due to a real advance in the concept of the children? Unfortunately no test of this will be possible until the school age is raised. The general nature of the graph, however, would suggest that time is a concept built up in exactly the same way, and following the same course of development as any other concept.

In one respect there is a difference, for, where comparison has been made between a child's knowledge of other ideas and words and his knowledge and grasp of time ideas and words, the comparison

has always favoured his grasp of these other ideas. This means that the development of the concept of time lags behind the development of many other concepts. There is to all appearance from our tables a lag in the development of time ideas of about 15% on the average. This would corroborate Burt's statement (12) that "the child's world is becoming more systematically organised throughout school life. His comprehension of space relations is gradually widening, and by somewhat later stages, it would appear that his notion of time pursues a parallel development." This lag would also seem to indicate the inherent difficulty common to all people in building up a satisfactory concept of time; it is not like space or colour, it is not a quality adhering to particular things, but it is an abstract idea permeating our whole waking lives. We can escape from it only in sleep, or in some very special circumstances; it is for all practical purposes omnipresent but it is also intangible, hence arises the difficulty experienced by the ordinary mind in comprehending it, in recognising its parts and in synthesising these into a coherent concept. Sturt says (41) that we can assume for a child of 10 the adult concept of time. From the results of our test, it would seem as if this assumption could be made for most children, for it is true that the elementary ideas can be taken for granted among children of 10 years of age; the common, everyday terms are familiar to them; they possess a sound, working concept. Such is the main conclusion from Test 1.

In addition, there are some educational and other conclusions of importance, which we shall now proceed to set down. First,

from the main conclusion, it follows that a sound knowledge of the conventional time scheme, its language and its meaning should be inculcated in our school children before the age of 9 and that this should be added to by bringing in the abstract notions and words and consolidated between the ages of 9 and 11. It is clear that the concrete time words and ideas are known earlier than the abstract ones; words like time itself, simultaneity and duration present very grave difficulties to pupils, even older pupils and adults also failing with these, when asked to d efine them. Time words and their meanings are, on the whole, known at age 9; reasoning and instruction tests to find out whether these words and the ideas they represent are really understood suggest that a year later, age 10, would be more correct at which to assume this ability. The absurdity test also suggests 10 as the age. Second, the historical time scheme should then, after the age of 10 or 11, be stressed as a logical system. There appears to be no real purpose served by attempting an exact study of history in its modern semi-scientific form before the ages of 11 or 12, for the general inability to appreciate and understand the idea of historical time will invalidate all the work we try along these lines. To suggest this idea does not mean that we would deny a place to history of the romantic, story type for pupils under 11 years, but we do suggest that this story type alone has any real significance and value for pupils at these earlier years. Third, the tendency, especially among younger children, to think of Monday as the first day of the week should be checked and corrected because the percentage

of errors when Sunday is thought of as the beginning of the week is less than when Monday is to thought of. Fourth, the ability to tell the time is a later accomplishment than knowing about the day, the season or the month. As it is known that the clock is a later development of time ideas than these, this is the expected result and may suggest the influence of phylogenetic development, the child recapitulating in his own experiences the historical order of the development of time ideas in the race. Finally, there is some evidence also of spatial representation, though the results for Test 2 are very disappointing in this respect. In Test 1, with which we are dealing at the moment, the clock face test yields results suggesting a development of this ability by age 10 whereas the results of the preceding test would not have led us to expect this development until a year later.

The principal interest in Test 2 centres in the relative importance to be assigned to memory and purpose as determining factors in the growth of the idea of historical time. Historical time differs from present time and even from our own past time in that direct or primary memory images cannot be used, nor can secondary images be recalled in order to establish any comparison. No direct or experiential knowledge of historical time is vouchsafed to any of us; we are dependent on indirect and secondary knowledge derived principally from books and on a general feeling that time must have existed before us. Now, so far as our results can be utilised to make such a generalisation, purpose seems to outweigh memory as a factor in our dealings with historical time. Where the facts are given (Test 2, A/a and A/c), it is true that

the results are better than when the arrangement of the events depends on purpose (Test 2, A/b) or on a mixture of purpose and memory (Test 2, A/d), but these former are cases of visual perception rather than of memory. Up to age 11 memory seems to be a greater factor than purpose in helping children to arrange events in order, but after that age purpose begins to play a far greater part. To arrange events in order of occurrence rather than to select the correct dates for them seems to be easier for pupils over 11 years. If we compare tests A/b and A/d, the former, which demands purpose alone as the guiding factor in arrangement, gives results 7 per cent higher on the average than the latter, which makes use of both purpose and memory. The part of this test which gives the most direct evidence on this point is Test 2, A2, and, as already indicated, the conclusion is in favour of purpose as the more influential factor for pupils after the age of 11. This suggests further that Stout (40) is correct in stressing the importance of the conative element in our idea of past time.

It also seems clear from Section B of this test that historical time is subject to the phenomenon of foreshortening, that is to say, a remote period of time equal in duration to a more recent period of time will tend to appear shorter. This phenomenon is not quite so prominent among senior pupils of 16 years of age and over, probably because of their much greater familiarity with the events of history. A younger pupil probably judges the length of a period by the number of events in it or by the space these events occupy in his history book. This would account for the

foreshortening. Senior pupils, on the other hand, because of their wider experience, would be more inclined to think of a period in terms of its initial and its closing dates and so be less liable to fall victims to the phenomenon. Unfortunately, the results of those questions in this test which were devised in order to find out how a pupil thought of historical time proved to be jejune. Neither spatial nor colour forms seem much in use, if we can accept our results. It may be that personal questioning would have elicited more information on this point, but the exigencies of school work prevented such on a large enough scale. It appears to be very difficult for junior pupils, and even for senior pupils and adults, to say just how they think of historical time; few of them are natural introspectionists, interested in the how of thinking. The only conclusion to which we come with any degree of certainty is that teaching should disregard these special forms and concentrate on giving pupils as clear an understanding as possible of historical time by encouraging what has been called the organic point of view, that is, by representing the events of history as a series moving forwards along a straight line, the left-hand portion of the line denoting events B.C., and the right hand portion the events A.D., the future being represented by the projection of this line to the right. Finally, the question on the method of arrangement of events in order suggests that there is a very worthy place in our development of the idea of historical time for good, old-fashioned dates. They are, in the long run, the pegs on which our notion of historical time depends and it would be well if we were frankly to recognise this fact and give

dates once more a fairly prominent place in historical teaching, since, without them, history teaching is robbed of the possibility of inculcating one of its main lessons, the ability to recognise and to distinguish one epoch of historical time from another.

Finally among these conclusions, we would recall the three stages in the development of the concept of time as analysed by Sturt, the simple animal stage, the complex animal stage and the educated adult stage, and we would recall also Stanley's theory of recapitulation, and we would venture to combine these two and arrive at the following conclusion, that we pass in infancy and early childhood through the first of these three stages, gradually passing with the addition of language and symbol into the second stage, which in turn gives way for children brought up amid a normal environment to the third stage, which is completed about the age of 10 for all normal, practical purposes. For a person who wishes a more highly specialised concept, say, of historical time, a further delay for more study and greater maturity is necessary, but for a sound, working concept (and we do not doubt for one moment that time is anything other than a concept laboriously acquired from our own experience and from the experience of others) it is unnecessary to go beyond the one which has been emerging during the first decade of our life.

GENERAL VIEW OF TIME.

With this survey of the work of these writers, let us now consider a general view of time as a subject of psychological enquiry. We must first notice, however, that it is necessary that metaphysical and physical considerations should be put aside. To the philosopher and metaphysician the present cannot have duration; it must be the knive-edge between the past and the future; yet to the psychologist, dealing with things as they are actually thought of by us, the idea of the specious present is a very real, as well as useful, consideration. To the physicist of the older school, time is Newtonian time, that is, "time, absolute, true and mathematical, which flows continuously and equably in itself without relation to any external thing", to the relativist, it is the fourth dimension of space-time; to neither of these objective considerations can the psychologist pay great attention.

What, then, it may be asked, is the psychological problem involved? First, to the psychologist time is subjective, not objective, for if it were the latter, the experiencing mind would be reduced to that of a mere observer; nor is it a quality of objects, for it does not adhere to any particular objects, but is universal. The time which is known to consciousness is proper-time, or interval, as it has been called by Eddington, or subjective time, measured by the number and rate of our physical pulsations and the amount of conscious attention to our own time rate. Now this subjective time has to be brought into some kind of conventional relation with objective time. The accuracy of the

conventional time divisions of hours and minutes is psychologically imposed on us by our upbringing until we imagine that astronomical time is real time, whereas all real time is subjective and remains within ourselves. The adoption of this common or conventional time gets over the difficulties of the differences of subjective times at different moments with the same person, and with different people; but real time is our psychological, subjective time.

Second, we must note that there is no special sense for time. None of the evidence, for instance, brought forward by Winslow Brown (71) seems conclusive. It is usual to demand special organic structure before admitting the existence of a sense, and Brown fails to indicate any special structure. There is no direct perception of time; the perception is of change in things. Writers like Münsterberg, whose investigations were directed almost entirely to the judgment of intervals, speak of a direct time-sense, sensations peripherally aroused by muscular activity. We dismiss the possibility of a special time sense because there is no special organ, but we do not dismiss the possibility of a method of making an automatic succession or time rate estimate to separate one kind of thing from another kind of thing and to separate two things of the same kind from one another. It has been suggested by Dibblee (18) that an explanation of this automatic eatimate may be found in the peculiar and unexplained proximity and relations of the vestibular and auditory sense organs, the former giving the data by recording our organic movements and rhythms, and the latter acting as an instrument of comparison and giving a perception of these rhythms. Our subjective time is probably a compromise

between this physiological time and common, measured time. No doubt Münsterberg would be delighted if he could know of this partial return to his ideas. The third main point is that a past, a future, and a scheme of organisation are all involved in the concept of time. How do we come by this concept of time? There are two answers given, that it is inherent in our minds, a pure a priori form of sensuous intuition in us - the view of Kant and Schopenhauer - and that it is derived from experience, built up by the individual mind and aided by the history of the race - the view of Guyau and Sturt. It is to the latter of these views that we give out adherence; our reasons for doing so have been made clear in the pages dealing with our own tests.

The next question naturally arises; what are the factors involved in psychological time? Kant recognises three modes of time, succession, simultaneity, and duration. This latter, the feeling of enduring, has been called the peculiar characteristic of time. The factors we shall consider are simultaneity, the percept of the present, the concepts of the past and of the future, duration, the perception of the succession of our ideas or serial order, the conscious arrangement of events, the development of conventional time, and the concept of historical time. The psychological causes of the development and discrimination of these various factors are the powers of memory - general retentiveness - and of purpose - the consciousness of, and attention to, instinctive aims.

Let us examine each of these factors separately beginning with simultaneity, which is the basis of primitive time reckoning

as it is concerned with external happenings, and primitive peoples led very objective lives. Broad's definition (11) completely covers this idea: "two sensa (sensible events) would be said to be simultaneous if each completely overlapped the other".

Much more must be said, however, about the present. To the physicist, an instant, (and the present cannot be greater than an instant) is a mathematical abstraction, like points and the line.

To the psychologist it is a matter of perception of a certain interval of finite, though short, duration, the "field of attention" of Bergson. To adopt the words of James, the specious present is the shortest time in which we can experience a mental content. Now, this time has duration, a duration which is peculiar to the observer, though much the same for normal beings under normal circumstances, It is this immediate intuitive perception which has been called the "time sense", but, as we have seen, it is much better to avoid the use of this phrase altogether. The duration of the specious present, according to early writers, like Dietze and James, is 12 seconds. Piéron says the limit to our capacity for direct, naive perceptive reactions to durations appears to be about 5 to 6 seconds. Myers says 4 seconds, with a nucleus of 550". This brief duration, occupied by feeling and extending into both past and present, is, for James, "the original paragon and prototype of all conceived times", but Spearman warns us that, though the specious present is a convenient fiction, it should not absorb the place of the real present, the boundary line between the past and future. A boundary line, however, is too small for consciousness to exist in it and so, for us, as for most

writers, the present is the specious present, an interval of a few seconds which we are able to grasp together as a whole. The present, then, is the "greatest possible duration for a single sensible field" (Broad), the duration with which we are in immediate contact. This specious present is not fixed, but varies according to the nature of our sense experiences, the ease or difficulty of attention and our bodily condition; it may extend to 4 seconds with a great effort of attention.

Closely allied to the present are the past and the future. Psychologically the past is an image, a memory image, and the whole idea of the past is a concept based on these memory images, which are easily distinguished from percepts by a finite time lapse from the latest part of the event. The past has reality, for, if we agree with McMurray that what has significance has reality, the past, which is of immense significance to man, must have reality. Our consciousness of the immediate past, according to Strong, is ideal, is representative, not actual or intuitive. If it were not for memory, (and there is no need to postulate a special time memory), we should never have any consciousness of the past at all. According to Bergson, our memory images are directed into the particular direction of the past by the mechanism of the mind, "la nature". Memory, then, is the chief feature of the past. At first, the memory images are not arranged, but later they are reduced to order, at about the ages of 10 and 11, as we have tried to show earlier by the working of cause and effect. For a fully adequate concept of the past, there must be both reference to a name, or other symbol, and reference to other

associated concrete events. These must be thought of, says James, before the concept can develop. Finally we mote that the memory of past experience, whether individual or historical - for the historical is like the individual past on an extended scale - is a guide to present activity.

The future exists in inference or as moments of the specious present. The development of a concept of the future - "expectation" of James, "becoming" of Broad - depends mainly on purpose, and partly on memory. It depends on purpose because it is related to an unfulfilled purpose, which in turn is made exact by memory.

If we now consider the factor of duration, "cette continuité indivisible de changement qui est le temps", (Bergson, 9), we find that the fully formed judgment of duration is one of the latest developments in our knowledge of time. Duration, like the whole concept of time, is subjective in nature; durations appear to vary according to the number and nature of the events, physical or mental, in them or according to the state of the mind. The nature of duration has been analysed as follows: temporal extension, which it possesses in common with the specious present, awareness of mental events in the mind, a certain amount of fatigue of attention, and certain changes in the external environment. The two main factors on which our estimate of duration depends, appear to be extensity and observed change. The great difficulty of estimating a subjective experience, such as duration, is solved by externalising duration and calculating it from a clock. A direct estimate, without reference to a clock or other objective aids, varies greatly, as it depends on the division of attention

which may be destroyed altogether, between the events and the passage of time as such. It would appear that the factors influencing the estimate of duration are the amount of attention given to the passage of time as such, the number of events, external or mental, filling the duration with the general result of the greater the number of events, the longer the period appears, the quality of the events, meaning their connectedness or disconnectedness, the pleasantness or otherwise of the experience, and finally a comparison of the experienced duration with an ideal scheme. The second and third factors demand a fairly good memory for time durations and an ability in dividing them. The order of influence of the factors may be psychologically as in the order given above, though in actual practice, the second, the number of the events is the most important. For short intervals of from 8 to 12 seconds, the number of events or presentations exercises a constant influence upon the estimate, according to Münsterberg's experiments. According to Myers, attention, the overlapping of memory images, expectation and surprise are the factors, in the estimation of short intervals. Schumann went so far as to make expectation and surprise the crucial elements in time judgment. Myers has also, we must again note, brought forward some evidence for judgment by the absolute impression.

If the concept of duration is of late origin, that of succession is early. To Washburn (176) the psychologically primitive time judgment is that of succession. Time has been defined by McIntyre (122) following Lotze, as a relation or series of relations of succession between events. Lotze (30) finds the reality

of time in the succession of events; for Kant (29) knowledge of succession presupposes that of time, while for a modern writer like Willdon Carr (14) time is the order of successions. Again memory and attention are essential to the consciousness of succession. Dibblee's views on this last point are interesting (18). He says that succession is grasped by selection, through memory, of one kind of sensation, and by concentration of will-attention on that particular kind. He further says that a method of perception of succession is provided for us by the fixing of a physiological time-rate and a psychological time-rate, which is itself a compromise between physiological time and common measured time made by the individual.

In a certain order of events it is said, history exists. Now the unfication of time experiences, the integration of series of experiences, the conscious and definite arrangements of events, into individual or national history depends supremely on purpose, though to some extent on memory. It is habitual for us to make a serial arrangement of events. Now, the means by which this highly organised mental phenomenon, the arrangement of events in order, is made is not clear. The usual explanation, as we have seen,(James,27, Ward,48, Fouillée,22) are "movement of attention", "fading brain states". Stout, following Schumann (153) and Meinong (127), criticises the view that in order to apprehend time sequence, we must necessarily retain in consciousness a group of memory images of varying intensity. In practice we do not start from an event at maximum memory intensity and work backwards to events of ever lessening intensity and greater remoteness. The

vividness of a memory image depends on the character or importance of the event as well as on memory. In arranging events in order we think usually of the most outstanding event, not necessarily the most recent, or we think of the chronological order; in many cases the memory of the time order depends on the conscious invention of some connecting idea or form, or on an arrangement of mental images. Now this special aid is not connected with either "movement of attention", or with the relative clearness of the different memory traces. Clearness of memory does not seem to enter as a factor, and "movement of attention" play a very minor part in arrangement, and even then, they play a part only when the events are very recent. The method of arrangement is really the result of different factors: a direct recollection of the order, a matter of inference based on times or dates or other associations, and is constructed by the aid of various forms of reasoning. Events in a long period are arranged by conventional time marks and by reasoning; in a short period by reference to some scheme of purpose, or cause and effect, by reference to space, and by any apprehended relation between different events, for instance, the arrangement of historical events in order is done by precise dating, the precision depending on the accumulated knowledge and experience of the individual. Of these methods, that of exact dating is the most convenient, and we would add, the most common. In this connection we must refer to Lotze (30) and Guyau's (23) idea that all this ordering of events in time is not really temporal but spatial, "our image of time is in a spatial form". It is true that this manner of representation, whether the line stretch forwards or

backwards, is common, but it is not universal, nor is it the only method of representing time. This very convenient time line idea is a late development and involves reasoning and conscious arrangement.

We are not concerned here with the development of conventional time, except to notice that exact methods of time designation, clocks and calendars, are necessary to enrich and to make more precise our time concepts. The two factors of greatest importance for social life, and so for conventional time, are simultaneity or synchronisation and duration, "when" and "how long". Simultaneity is the basis of the early calendars, with their numberless and concrete points of time for reckoning. Duration requires for its organisation some external process which proceeds with regularity, as the rising of the moon, the rising of some constellation, the equinoxes or solstices, and some unit into which to divide this process. The year has gradually become the time unit.

There is, however, the idea of historical time, on which we have touched earlier. It is really a generalisation made anew by each individual. He begins with his own subjective time, which is gradually unified by him and made subservient to the needs of social life in conventional time. From this individual unified and systematised time to the generalisation of a unitary world time, with a scope far beyond that of individual time, experience leads us. The idea of historical time, of time as existing beyond the immediate necessities of the individual, has arisen through the experiences and needs of the race. This

evolutionary view strikes at that of Kant.

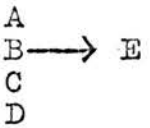
Time we must recognise at two levels, the perceptual and the representative. On the perceptual level, there is in time the attribute of duration or protensity belonging to all sensation, the experience of change or transition and a conative factor, for a present conative process has sufficient unity of its own to give rise to the idea of continuous succession or time. Together these give us a percept of time. But time, as a necessary condition of the real existence of the physical world, is also a concept. It is "an idea of a homogeneous duration", as it has been put by Willdon Carr (14) which is constructed afresh by each individual, the method and the precision of the construction depending on the experiences of the individual, which in turn are influenced by the society of which he is a member. Eddington has written, "We have intimate acquaintance with the nature of time and so it baffles our comprehension". (20). Nevertheless time as experienced has been shown to possess two major and two minor elements, awareness of succession of mental states, awareness that these states of consciousness fill a place in a time scheme, the universalising of the individual time scheme, and a perception of change in external objects. For the individual time is simply the complex of consciousness at any instance, for the psychologist it is an individual, subjective matter, "a state of mind peculiar to the experiencer".

It has been suggested that the concept of time shows considerable development. As early as 1900 Stanley (161) suggested the study of time perception under natural selection, that is to say,

from the genetic point of view, and he found in expectant attention, implying memory and cognition of the break between the real and the ideal, the factor making for this development. The three stages of development have been named the simple animal, when time perceptions are limited to experiende of duration and to vague feelings of familiarity (past) and appetition (future), the complex animal when knowledge of certain marks of time arises along with a wider memory of the past and a definite anticipation of the future, and the educated adult when the unified experience of the complex animal stage has given place to a knowledge of all the factors, when a social and universal time has emerged. From mere perceptual patterns or images, the individual develops first a vague feeling in time and finally a permanent thought pattern of idea outside time. Now, this knowledge of time varies in individuals according to their age and culture. Children forget the passing of time easily, adults rarely do, for they are more conscious of it. The idea of unitary time is an acquired synthesis; our power to apprehend a period of time as a unit depends on memory and attention, which vary in individuals. If the theory of recapitulation be correct and evolution be from the simple to the complex degrees of civilisation and culture, then children should pass, and, as we have seen, probably do pass through these three stages in the development of the concept of time. This may also account for the differing degrees of integration shown by different adults. Our problem, then, has been, does the individual development correspond to the racial development? If we have

shown, as we hope we have, that there is sufficient correspondence to warrant it, we can say that time is a concept built up by our mental powers.

From Sturt's work (41), and from our own time tests, these general conclusions can be drawn. After age 7 there is a general knowledge of time words, the more personally interesting and those relating to shorter periods being better known. Knowledge of naming the year seems to be suddenly acquired about 8, probably because counting in involved and Ballard (4) says counting is not easy or habitual until 8. From about 9 we can assume a knowledge of the conventional scheme of time marking, though it is not until about 10 that it is realised that time is practically universal, the same in all plades. In the understanding of historical time, methods of teaching play a part as well as age, but two main stages can be distinguished; a negative stage up to 8, when the past is a mere storehouse with no order,



and a positive stage about 10 and 11, when definite pictures of successive epochs assume form, A is recognised as preceding B, B as preceding C and so on, A → B → C → D → E. Accuracy of dating improves greatly at this stage; there is also a steady increase in the ability to name a period. Still another conclusion is that time details are remembered with more difficulty than space or other details. A general summary of the development of time ideas among children could be given thus; time knowledge begins to assume its adult form at about 10 or 11, and the relation between this individual learning and the racial development is

sufficiently striking to warrant the conclusion that time is a concept of slow development, a concept based on the perception of the specious present.

APPENDIX 1.

Detailed Tables of Results of Duration Experiments.

Series I. Unfilled Intervals of (a) 30 seconds.

	Under				Correct		Over						
Age	<15 secs	% of Total	16 - 29 secs	% of Total	30 secs	%	31 - 45 secs	%	46 - 60 secs	%	>60 secs	%	Total pupils
10 B	4	13	3	10	3	10	7	22	8	26	6	19	31
G	7	18	4	10.5	3	7.5	3	7.5	18	46	4	10.5	39
11 B	7	20	5	14	7	20	9	26	7	20			35
G	5	15	2	6	1	3	10	29	12	35	4	12	34
12 B	2	3	13	19.5	16	24	21	31	10	15	5	7.5	67
G	3	5	4	7	7	11	16	26	27	44	4	7	61
13 B	5	4	21	19	14	13	30	27	25	23	15	14	109
G	2	2.5	8	9	18	20	26	29.5	15	17	19	22	88
14 B	1	2	9	19.5	8	17.5	10	22	14	30	4	9	46
G	2	3.5	6	10	10	17.5	11	19	13	22.5	16	27.5	58

(b) 1 minute.

	Under				Correct		Over						
Age	<30 secs	% of Total	31 - 59 secs	%	1 min.	%	1.1 to 1.30	%	1.31 to 2	%	>2 mins	%	Total Pupils
10 B			5	16	9	29	4	13	5	16	8	26	31
G	2	5	5	13	15	38.5	4	10	6	15.5	7	18	39
11 B	7	20	7	20	9	26	7	20	5	14			35
G			3	9	7	20	11	32.5	4	12	9	26.5	34
12 B	3	4.5	28	42	13	19	14	21	3	4.5	6	9	67
G	1	2	6	10	15	25	20	32	9	15	10	16	61
13 B	10	9	40	37	12	11	25	23	14	13	8	7	109
G	2	2.5	31	35	4	5	26	29.5	7	8	18	20	88
14 B	4	9	13	28	5	11.5	15	32.5	7	15	2	4	46
G	1	2	21	36	8	14	13	22	5	9	10	17	58

(c) 5 minutes.

Age	Under				Correct		Over						Total Pupils
	<4 mins	% of Total	4 - 4.59	%	5 mins	%	5.1 - 6	%	6.1 - 7	%	>7 mins	%	
10 B	10	32.5	5	16	5	16	4	13	5	16	2	6.5	31
G	12	31	8	20.5	7	18	2	5	3	7.5	7	18	39
11 B	15	43	5	14.5	5	14	4	11.5	1	3	5	14	35
G	13	38	5	15	5	15	5	15			6	17	34
12 B	39	58.5	10	15	5	7.5	4	6	5	7	4	6	67
G	27	44	11	18	9	15	3	5	2	3	9	15	61
13 B	55	50.5	16	15	16	15	10	9.5	8	7	4	3	109
G	33	37.5	21	24	11	12	6	7	6	7	11	12.5	88
14 B	20	43.5	8	17	4	9	4	9	8	17.5	2	4	46
G	18	31	6	10.5	6	10.5	15	26	7	12	6	10	58

(d) 15 minutes.

Age	Under				Correct		Over						Total Pupils
	<10 mins	% of Total	10 - 14.59	%	15 mins	%	15 - 17.30	%	17.31 - 20	%	>20	%	
10 B	2	6.5	7	22.5	11	35.5	4	13	1	3	6	19.5	31
G	16	41	7	18	5	13	4	10	2	5	5	13	39
11 B	7	20.5	5	14	7	20.5	6	17	5	14	5	14	35
G	11	32.5	6	17.5	6	17.5			4	12	7	20.5	34
12 B	40	60	11	16.5	11	16.5			1	1	4	6	67
G	11	18	19	31	12	20	10	16			9	15	61
13 B	28	26	27	25	27	25	14	13	8	7	5	4	109
G	21	24	32	36	11	12.5	7	8	11	12.5	6	7	88
14 B	14	30	10	22	8	17.5	8	17.5	6	13			46
G	6	10.5	25	43	3	5	9	15.5	11	19	4	7	58

Series II. Filled Intervals.

Nature of Filling - Stories. (a) of 30 seconds.

		Under				Correct		Over						
Age		<15 secs	% of Total	16 - 29 secs	%	30 secs	%	31 - 45 secs	%	46 - 60 seds	%	>60 secs	%	Total Pupils
10	B	4	13	5	17.5	2	6.5	4	13	9	30	6	20	30
	G	6	16	4	10.5	3	8	3	8	20	52.5	2	5	38
11	B	4	17.5			3	13	6	26	7	30.5	3	13	23
	G	3	17	2	12	1	6	2	12	9	53			17
12	B	3	8.5	13	37.5	10	28.5			6	17	3	8.5	35
	G	2	8							20	80	3	12	25
13	B			5	26	3	16	4	20	2	12	5	26	19
	G			2	8	4	15	1	4	7	27	12	46	26

(b) 1 minute.

		Under				Correct		Over						
Age		<30 secs	%	31 - 59 secs	%	1 min.	%	1.1 - 1.30	%	1.31 - 2	%	>2	%	Total Pupils
10	B			5	17	10	33	4	13	4	13	7	24	30
	G	2	5	5	13	14	37	5	13	6	16	6	16	38
11	B	3	13.5	1	3	9	39.5	7	30.5	3	13.5			23
	G			2	12	4	23.5	2	12	3	17.5	6	35	17
12	B	6	17	7	20	6	17	8	23	2	6	6	17	35
	G			1	4	1	4	5	20	10	40	8	32	25
13	B			4	20	3	16	10	52			2	12	19
	G			2	8	1	4	4	15	3	11.5	16	61.5	26

(c) 5 minutes.

Age		Under				Correct		Over						
		<4 mins	%	4 - 4.59	%	5 mins	%	5.1 - 6	%	6.1 - 7	%	>7	%	Total Pupils
10	B	11	37.5	4	13	6	20	3	10	4	13	2	6.5	30
	G	12	32.5	8	21	8	21	1	2.5	2	5	7	18	38
11	B	7	30.5	3	13.5	5	22	1	3	3	13.5	4	17.5	23
	G			5	29.5	4	23.5			2	12	6	35	17
12	B	21	60	4	11.5	3	8.5			4	11.5	3	8.5	35
	G			3	12	13	52	2	8	3	12	4	16	25
13	B	6	32	3	16	14	20			6	32			19
	G			5	19	9	35			5	19	7	27	26

(d) 15 minutes.

Age		Under				Correct		Over						
		<10 mins	%	10 - 14.59	%	15 mins	%	15.1- 17.30	%	17.31 - 20	%	>20	%	Total Pupils
10	B	2	6.5	7	24	12	40	3	10	4	13	2	6.5	30
	G	14	37.5	8	21	5	13	1	2.5			10	26	38
11	B			2	9	6	26	7	30	3	13	5	22	23
	G	2	12	3	17.5	4	23.5			2	12	6	35	17
12	B	6	17	4	11.5	15	43	3	8.5	1	3	6	17	35
	G			3	12	6	24	2	8	2	8	12	48	25
13	B			6	32	7	36	6	32					19
	G			5	19	13	50	3	11.5	1	4	4	15.5	26

Series III. Filled Intervals.
Nature of Filling - Silent Reading (a) of 30 seconds.

Age		Under				Correct		Over						
		<15 secs	%	16 - 29 secs	%	30 secs	%	31 - 45	%	46 - 60	%	>60	%	Total Pupils
13	B			3	3	16	16	3	3	8	8	72	70	102
	G			1	1	31	40	12	15	12	15	22	29	78
14	B			5	15.5	15	47	10	31.5	2	6			32
	G			7	19.5	18	50	2	5.5			9	25	36

(b) 1 minute.

	Under				Correct		Over						
Age	<30 secs	%	31 - 59	%	1 min.	%	1.1 - 1.30	%	1.31 - 2	%	>2	%	Total Pupils
13 B			2	2	2	2	39	38	9	9	50	49	102
G			1	1	21	27	22	39	1	1	33	42	78
14 B			15	47	10	31.5	5	15.5	2	6			32
G			9	25	9	25	7	19.5	3	8	8	22.5	36

(c) 5 minutes.

	Under				Correct		Over						
Age	<4 mins	%	4 - 4.59	%	5 mins	%	5.1 - 6	%	6.1 - 7	%	>7	%	Total Pupils
13 B			3	3	25	24.5	9	9	25	24.5	40	39	102
G			27	35	7	9	6	7	11	14	27	35	78
14 B			10	31.5	5	15.5	1	3	8	25	8	25	32
G			7	19.5	9	25	2	5.5	11	30.5	7	19.5	36

(d) 15 minutes.

	Under				Correct		Over						
Age	<10 mins	%	10 - 14.59	%	15 mins	%	15.1- 17.30	%	17.31 - 20	%	>20	%	Total Pupils
13 B			35	34	47	46	4	4	16	16			102
G			54	69.5	21	27	2	2.5	1	1			78
14 B			25	78.5	5	15.5			2	6			32
G			25	69.5	2	5.5			2	5.5	7	19.5	36

APPENDIX 2

The following are copies of the Time Tests referred to in the text on pages 106 to 154.

No. 1.

Name

Age Years Months. Birthday

School Class

Today's date

This book contains a number of question, and you have to answer them as quickly and as carefully as you can. Begin below and go straight on. If any one seems too hard, miss it out; and try the next. Work on until you have finished all you can answer. See now that your pencil is sharp enough. Read the instructions carefully.

Ask no questions at all during the test.

A

1. Is it morning or afternoon just now?
2. Write down the names of the days of the week:
3. Write down the names of the months:
4. What time is it just now?
5. Draw a clock face and put in the hands showing half-past three.
6. When you are 14, will you be older or younger?

B

1. Write down beside each word another word which means nearly the opposite of the one given, as e.g. :- wet - dry,
   white - black.

Noon	Large
Yes	Now

Long	Lost
Early	Day
Hot	Here
Winter	Kind
High	Evening
Sunrise	

2. In each of the first six questions below you have to underline the word in the brackets that goes with the third as the second goes with the first, as, e.g.:-
Prince is to princess as king is to (lady, duchess, queen).

In each of the last four you have to write down the word that goes with the third as the second goes with the first, as e.g.:-

Sailor is to soldier as navy is to . . . ? Ans. - army.

July is to month as Friday is to (day, week, year).

Day is to night as white is to (red, black, clear, pure).

January is to February as Monday is to (Sunday, winter Tuesday, Wednesday).

When is to where as time is to (how, why, length, space).

Heat is to cold as summer is to (snow, spring, winter, ice).

The day before yesterday is to the day after to-morrow as Saturday is to (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday).

July is to June as February is to

Day is to midday as night is to

Hour is to minute as minute is to

Three is to one as yard is to

3. Arrange the following groups of things, beginning with the smallest and ending with the largest, as, e.g.:-

Pound, ounce, ton, stone, cwt. Ans. - ounce, pound, stone, cwt., ton.

Minute, second, hour, year, day

Sixpence, penny, florin, sovereign, shilling

Century, month, era, year, week

4. In the sentences below three or four words have been filled in instead of one. Underline the right word to complete the sentence, as e.g.:-
Snow is (white, red, black), but coal is (white, red, black).

Impatience makes the hours seem (shorter, sad, longer, happy).

Wednesday (usually, occasionally, always) comes after Tuesday.

The first day of the week is (usually, occasionally, always) the wettest.

When it is wet people (usually, occasionally, always) carry umbrellas.

Christmas (sometimes, usually, always) comes in December.

Children born in June (sometimes, usually, always) die in July,

Strong people (sometimes, usually, always) live longer than weak people.

5. Write down opposite each of the following words its meaning:-

Orange

Hour

Dungeon

Daily

Interval

Juggler

Duration

Health

Simultaneous

Time

C

1. Do what you are told in the spaces on the right.

Two day of the week that come together begin with the same letter. Write down that letter twice

Two other days of the week begin with the same letter. Write down the first letter of the day that come between them

If the number of days in the month is the same as the number of days in the year, cross out the name of the day that comes before Wednesday; if not, cross out the day that comes before the day after Wednesday. (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday).

If February comes after January, mark two crosses here ; if not, mark one cross

2. Answer the following. Where suggested answers are given, <u>underline</u> the right answer or the right word.

1. A fast train takes one hour to make the journey from Glasgow to Edinburgh. Mr. Smith left one morning at ten o'clock and arrived in Edinburgh at (nine, eleven, one) o'clock.

2. How many days are there from midday December 29 to midday January 2?

3. Nelson died in 1805 at the age of 47. In what year was he born?

4. What time lies midway between 6 o'clock and 9 o'clock?

5. Why do we use clocks?

i. Because they look nice.
ii. Because they tell us the time.
iii. Because it is pleasant to hear the clocks strike the hour.

6. Suppose it were Sunday to-day, what day would it have been the day before yesterday? (Tuesday, Friday, Saturday).

7. Peter is two days younger than I am. I was born on Christmas Day. When was Peter born? (Dec. 23, Dec. 25, Dec. 27, Dec. 28)

8. Why do people carry watches?

i. Because they tell where a person is
ii. Because they are presents from other people.
iii. Because they are convenient for telling the time.
iv. Because it is the fashion.

9. If to-day were {Friday / Saturday / Sunday} then the day {before / after / preceding} to-morrow would be {Thursday / Tuesday. / Wednesday.}

10. A man, writing on 1st January, 1922, said, "My sister, who {died / was born / was married} on 13th November, {1898 / 1858, / 1900} will be {twenty-five / thirty-three / thirty-four} years old next {year / November. / month.}

D

Here is a story in which there are many things wrong or absurd. Underline all the things you can find that are wrong or absurd.

The Battle of Bannockburn, December, 1314.

As the 30th of February drew near, everything else was forgotten in the preparations for the coming conflict. On Sunday, the 12th of June, 1315, Edward VIII crossed the Tweed at Carlisle, and a day's march brought his magnificent army with sight of Stirling Castle.

Robert Bruce took up his position in the Torwood, a mile or two to the south-east of the Castle. Before the English came in sight he had honeycombed the firm open ground to the north of the Castle with innumerable pits, filled with bombs and much barbed-wire entanglements. On Sunday, the 23rd of June, the enemy came in sight. Embroidered banners floated over the tanks and field artillery, and the sun glinted on the shining rifles of the knights.

Next morning, the 25th of June, the sun set upon the two armies of the English and the French. The trumpets rang out, and the Scots advanced to the attack at 60 miles per hour. A moment later they dropped upon their knees, and, taking off their top-hats, prayed, "O Lord Jesus, may this day, Friday, by others regarded as unlucky, prove fortunate to us." The issue was in doubt for a long time for half an hour from ten o'clock to twelve until the English saw a fifth body of Scots approaching. The English broke and fled.

On the morrow Edinburgh Castle was surrendered by the Spanish Governor whose grandson is still living in a remote part of Scotland.

No. 2.

Name

Age Years Months. Birthday.

School Class

To-day's date.

This book contains a number of questions, and you have to answer them as quickly and as carefully as you can. Begin below and go straight on. If any one seems too hard, miss it out; and try the next. Work on until you have finished all you can answer. See now that you pencil is sharp enough. Read the instructions carefully.

Ask no questions at all during the test.

A

Here are a number of tests connected with history. Do what you are told in each test.

1. Write down the events in the following groups in the order in which they happened, beginning with the one that happened longest ago - furthest away back in history, as, e.g.:-

Wellington.	Ans. -	Caesar.
Cromwell.		Cromwell.
Foch.		Wellington.
Caesar.		Foch.

(a) Henry VII., 1485 Ans.
James I. 1603
William I. 1066

(b) Struggle between the British and French for America. Ans.
Discovery of America
Settlement of America by Europeans.

(c) English Revolution, 1688 Ans.
First English Parliament, 1265
Alfred defeated the Danes, 878
End of Franco-Scottish Alliance, 1560
Landing of Julius Caesar, 55 B.C.

(d) Death of John Knox Ans.
Jacobite Rising under Bonnie Prince Charlie
Union of the Parliaments
Bruce at Bannockburn
Union of the Crowns
Union of the Picts and the Scots

2. From the following list of dates select those appropriate to the events below, and then arrange the events in the order in which they happened.

55 B.C., A.D., 410, 664, 787, 1066, 1164, 1215, 1297, 1381, 1415, 1485, 1513, 1534, 1588, 1603, 1628, 1649, 1688, 1704, 1713, 1759, 1789, 1800, 1805, 1815, 1832, 1884, 1914, 1932.

Battle of Flodden.
First Reform Act.
Magna Carta.
Execution of Charles I.
French Revolution.
Romans left Britain.
Spanish Armada.
Battle of Waterloo.
Treaty of Utrecht.
Battle of Stirling Bridge.

Ans.

3. From the following list of events select those appropriate to the dates below.
Revolt of Boadicea, St Augustine, Synod of Whitby, Treaty of Wedmore, Murder of Becket, Treaty of Northampton, Battle of Crecy, Peasants' Revolt, Joan of Arc burned, Printing in England, Battle of Flodden, Execution of Mary, Queen of Scots, Authorised Version of the Bible, Execution of Charles I., Darien Scheme, French Revolution, Union with Ireland, Indian Mutiny, Boer War, Parliament Act, End of the Great War.

597
878
1170
1346
1475
1513
1649
1789
1857
1911

B.

Answer as many of the following questions as you can. If there are any you cannot answer, or cannot understand, leave them alone and go on to the next.

1. Of the following pairs of events, underline the one which lasted the longer.

Roman Rule in Britain	- British Rule in India
Scottish War of Independence	- Great War
Reign of George V.	- Reign of George III
English Revolution	- French Revolution
League of Nations	- Renaissance

2. (a) Does the world have a longer history before or after A.D.1?

(b) Do you think of the days of the week, or of the months, or of dates as coloured in any way? If so, tell how; if not, leave blank.

(c) Do you think of historical dates as arranged in any particular way?

(d) Do you imagine history as a series of events moving forwards, or as a series of dates stretching backwards?

(e) What method do you take to arrange events in order, e.g. by guess, by the date, by the epoch, by thinking of a person who lived at the same time, or by thinking how long ago?

3. To the following question answer yes or no.

(a) "I invaded Britain in 55 B.C." Could Caesar have written this (in his own language)?

(b) Could Alfred have had the Anglo-Saxon Chronicle printed?

(c) Could William the Conqueror have consulted his watch at the Battle of Hastings?

(d) "The archers must stand in front, and the spearsmen in the rear". Could Bruce have said this?

(e) Could Queen Elizabeth have drunk tea?

(f) Could the Atlantic have been crossed before the time of Columbus?

(g) Could Shakespeare have seen his plays filmed in a cinema?

(h) If you had been alive at the time of the Union of the Crowns, could your grandfather have fought at Bannockburn?

(i) If you had fought at Waterloo, could your son have fought under Earl Haig?

(j) If you had been alive when the Romans left Britain, could your great-grandfather have remembered their first coming to Britain?

(k) Robin Hood lived in 1187. Would your mother be alive then? Would you grandmother be alive then? Would Christ be alive then?

APPENDIX 3.

The following are the larger detailed tables of scores, from which some of the tables given for the Time Tests have been constructed.

TABLE 10A. - OPPOSITES.

Age.	Score for Time Words.								Score for Other Words.							
	7	6	5	4	3	2	1	0	8	7	6	5	4	3	2	1	0
17	3	6	1						9	1							
16	3	6	1						10								
15	7	5							11	1							
14	14	21	15	6	1		2		43	13	1					1	1
13	20	53	58	23	1			1	128	25	2						1
12	18	48	61	27	7	1		3	134	20	3	1	4				3
11	6	26	59	17	11		3	4	86	25	6		1	1		3	4
10	1	16	45	24	11	4	2	8	66	22	6	8			1	1	7
9	1	13	35	22	11	4	3	21	50	20	11	2	1	4		1	21
8	1	5	22	19	5	7	5	47	25	14	9	5	4	1	3	4	46
7		1		1				24		1	1						24

TABLE 11A. - ANALOGIES.

Age.	Score for Time Analogies									
	9	8	7	6	5	4	3	2	1	0
17	1	1	4	3			1			
16	4	3	1	2						
15	4	3	2	1	1			1		
14	3	14	9	16	7	2	5	2	1	1
13		7	32	42	24	23	11	12	4	1
12	3	16	25	33	31	21	12	12	8	4
11	2	4	10	19	30	26	10	15	5	5
10		1	5	11	19	14	21	15	17	8
9		1	2	4	4	7	9	20	28	35
8						1	4	12	35	59
7								4	5	17

TABLE 14A - MEANINGS.

Age.	Score for Time Words.							Score for Other Words.				
	6	5	4	3	2	1	0	4	3	2	1	0
17	5	4	1					10				
16	1	7	2					9	1			
15	2	7	2	1				10	2			
14	1	19	16	10	4	3	7	24	19	6	5	6
13	5	28	28	43	16	9	27	58	49	15	14	20
12	1	19	24	34	20	17	51	52	46	12	13	42
11		9	20	24	14	14	45	33	26	17	17	33
10		4	11	8	23	31	34	11	25	17	25	33
9			4	7	15	26	58	6	8	32	22	42
8					1	15	96	1	2	4	15	91
7					1	5	22			2	7	17

TABLE 16A - REASONING.

Age.	Score										
	10	9	8	7	6	5	4	3	2	1	0
17	2		5	2	1						
16	3	3	2	2							
15	1	3		3	3	2					
14	2	6	16	11	11	4	4	1	1	1	2
13	1	6	27	36	30	29	15	4	3	4	1
12	3	6	26	37	37	25	15	6	6	2	3
11	1	2	15	18	21	27	17	13	2	5	5
10			6	9	12	18	24	14	8	10	10
9			2	1	3	5	15	12	15	18	39
8						1	1	5	16	23	64
7							1		1	7	18

TABLE 17A - ABSURDITIES.

Age.	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
17+					1				3		1	1	2		1	1													
16					2		1	1	2		1		1			1	1												
15	1						1		1		2	1	4		1	1													
14						1		1	3	3	4	7	3		2	6	3	5	1	1	2	3	1	2	2			2	7
13						1	3	1	1	3	3	10	8	9	7	6	6	6	9	16	7	8	12	4	5	6	8	1	16
12		1				2		2	3	4	9	7	6	4	8	8	5	7	9	8	8	8	9	12	7	2	8	7	21
11								2	1	1	2	2	3	5	5	6	1	3	5	7	10	5	6	11	9	7	7	4	19
10							1	1				1		1	1	7	1	8	8	3	8	6	4	6	5	11	6	8	24
9												1	2		3	2		3	1	1	5	5	6	2	5	6	4	3	60
8																1		1	3	4	4	4	7	2	4	3	4	8	66
7																				1			1		1	1		5	17

The score was reckoned as the number of absurdities found minus the number of correct statements underlined as absurd or wrong.

TABLE 18A ARRANGEMENT IN ORDER WITH DATES GIVEN.

Age.	Score for A/a				Score for A/c					
	3	2	1	0	5	4	3	2	1	0
17+	8	1			9					
16	10				10					
15	8				8					
14	40	4		6	41			1		8
13	91	4	12	39	98	4	3	1		40
12	83	4	15	59	87	3	2	2	5	62
11	44	4	8	54	47	1	2	1	1	58
10	27	3	7	28	26	2	2		3	32
9	3	1		2	4		1			1

TABLE 19A ARRANGEMENT IN ORDER WITHOUT DATES.

Age.	Score for A/b				Score for A/d						
	3	2	1	0	6	5	4	3	2	1	0
17+	5	4			4	3	1	1			
16	7	3			6	4					
15	5	3			1	5	2				
14	18	21	2	9	13	19	5	3	2	1	7
13	64	31	4	47	32	31	22	5	7	1	48
12	53	39	9	60	13	33	33	8	4		70
11	43	20	2	65	6	13	11	10	3	3	64
10	11	13	3	38	1	9	3	8	1	1	42
9	2	4			2		1		1		2

TABLE 20A - DATES AND ORDER.

Age.	Score for Dates.											Score for Order.									
	10	9	8	7	6	5	4	3	2	1	0	10	9	8	7	6	5	4	3	2	1	0
17+	4	1	1	1		1				1		6	2				1					
16	2	1	2	2	1	1		1				4	2	1		1		1				1
15			2	2	1	1	1		1			1	4	1	1							1
14	1	6	3	5	7	5	6	3	3	4	7	3	10	6	5	4	1	1	1	2	1	16
13		3	7	15	10	6	18	14	22	32	21	1	16	15	10	8	7	4	2	5	7	71
12			2	5	6	14	15	21	27	32	39		6	12	17	21	4	12	6		6	98
11					3	1	14	18	17	26	31			3	7	3	9	6	3	2	3	74
10						2	3	7	13	23	17			1	2	3	3	2	1	3	1	49
9					1	1		2	2						1				1	1		3

TABLE 21A - EVENTS.

Age.	Score for Events.										
	10	9	8	7	6	5	4	3	2	1	0
17+	1	1	2		2	2				1	
16	1			4		1		1	2	1	
15					3		2	2			1
14			3	1	4	3	8	3	7	8	13
13		1	1	3	2	7	14	28	28	29	33
12		1	1	4	5	5	11	19	30	34	51
11			1			2	2	8	20	34	43
10								4	19	19	23
9								1	5		

TABLE 25A - METHOD OF ARRANGEMENT OF HISTORICAL DATA.

Age.	Guess.	Date.	Epoch.	Person.	How long ago.	No Special Method.
17+		8		1		
16		10				
15		4	1	1	1	1
14	2	26		7	8	7
13		75	1	19	18	33
12	1	84	2	16	13	49
11	4	40		9	17	40
10	1	18	1	2	8	36
9		1				5

TABLE 26A - YES OR NO.

Age.	Score													
	13	12	11	10	9	8	7	6	5	4	3	2	1	0
17+			6											
16		4	4	1	1									
15	1	4		2	1									
14		3	13	11	5	8	6	1	2					1
13		6	25	25	27	19	20	7	6	1	2	2	2	4
12	1	4	17	27	33	28	19	13	8	3	2	1	1	3
11		3	9	17	13	22	15	8	9	6	5	1	1	1
10			3	10	7	10	14	3	5	8	1	1		2
9						3	2							1

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