Temporal integration and behaviour*

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When the President of your Society is confronted with the task of delivering a presidential address and repaying as best he may the honour of having been elected your President, he is rather in the position of the clinical psychologist's patient to whom a T.A.T. is being administered. After coping with a series of moderately, but not wholly, ambiguous pictures, he is suddenly confronted with a blank card. What else can the poor patient do then but release the bees in his bonnet! Similarly, what else can a president do when, no longer assisted by the agenda headings that served to guide him at council meetings, he is confronted with a blank hour and told to talk. I may say that I should not have ventured to release the particular bees I propose to release had I not heard them buzzing in better bonnets than my own.

1. Introduction

I want to explain first why I have chosen to speak on the topic of temporal integration in spite of the fact that what I have to say is of a groping nature, and my experimental results only tentative.

It is just over a hundred years since the idea of psychology as a science as distinct from a philosophy of mind became firmly established. In this country J. S. Mill in his *System of Logic* (1843) proposed that there is, or may be, a science of human nature, and adopted the then unfashionable term "Psychology" to denote it. But alongside the abstract, general science of psychology Mill set a more concrete science, closely in touch with the realities of human life, which he termed "Ethology". The tension latent in Mill's distinction—the tension, in fact, between the demands of scientific method and the appreciation of the richness of human individuality—has been endemic throughout the development of psychology and has been a major source of the division of psychology into rival schools of thought. One thinks of Dilthey's protests against the aridity of the Wundtian experimentalism of his day; of the recent rise of the psychology [2]of personality as a reaction from the reduction of behaviour to linked muscle twitches; and, to give contemporary instances, the protest of Ketchum (1955) to the Canadian Psychological Association against the assumptions of learning theory, and Cantril's (1955) eloquent plea for a humanistic psychology.

There always has been, and there still is, a danger of psychologists splitting into two insulated groups, one dedicated to scientific methodology in all its rigour and purity, the other to understanding living human beings, their achievements and their problems. Such a split would, I think, be unfortunate for psychology, even if it made the life of future B.P.S. presidents somewhat easier. The record of humanistic psychologies is not encouraging. Their claims are enticing; their performance distinctly dusty. By now it

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should be clear that psychology cannot afford to compromise on the matter of methodology and techniques, nor hope to find short cuts to its goal.

But this is not the whole story. It is easy to oversimplify the methodology of science; to lay too much stress on formal precision and to ignore components which in the actual advance of science are of at least equal importance. To be brief, and perhaps dogmatic, the great scientists have always had an eye for significance. They have seen just where to apply their scientific method and tools. And this eye for significance has derived primarily from two things: from the fact, firstly, that they have been reflective thinkers, often indeed dreamers; and, secondly, from their deep and intimate first-hand acquaintance with their subject matter. It is just these vital components which our scientific purists in psychology are in danger of excluding, and which the humanistic and clinical psychologists help to contribute. It is for this reason that the interaction of psychologists of different persuasions, whatever the tensions between them, is so important, and why the boundary which Mill drew between an abstract psychology and a concrete ethology must not, if we can help it, lead to divorce.

But let me come to my point, which is to justify my choice of subject. I can see only one way of narrowing the gap between the scientific and the humanistic psychologies, and that is through a gradual encroachment of scientific techniques upon territory already roughly mapped by humanistic insight. This means in effect a constant search for concepts which, while capable of scientific definition and employment, nevertheless possess humanistic implications in the sense that they throw light upon the peculiar or, as they are sometimes termed, the higher attributes of men. The concept of temporal integration, which I have taken as my theme, is, I suggest, such a concept.

II. The Meaning of Temporal Integration

Instead of beginning with a definition or an abstract discussion of the meaning of temporal integration I will begin with some illustrations, and first of all with a very ancient one, a subtle introspective description of temporal integration by St. Augustine (397).

> [3]"I am about to repeat a psalm that I know. Before I begin, my expectation alone reaches itself over the whole; but so soon as I shall have once begun, how much so ever of it I shall take off into the past, over so much my memory also reaches; thus the life of this action of mine is extended both ways; into my memory so far as it concerns that part which I have repeated already, and into my expectation too, in respect of what I am about to repeat now; but all this while is my marking faculty (attentio) present at hand, through which, that which was future, is conveyed over, that it may become past; till the whole expectation be at length vanished quite away, when namely that whole action being ended, shall be absolutely passed into memory. What is now done in this psalm, this holds too throughout the whole course of man's life."

We have here in these words of St. Augustine a clear account of the integration of expectation, present action, and immediate memory into a temporally extended whole, which serves to guide the course of the recitation.

My second illustration, if you will forgive the incongruity of the sudden leap from a father of the Church to myself, is a simple experiment of my own.

A series of approximately 2,500 letters on a continuously moving tape is passed through an aperture at the rate of 100 letters a minute, the aperture being large enough to expose five letters at a time. Fig. I shows the first 120 letters of the series: it cannot,

of course, reproduce the serial nature of the exposure, which is an essential feature of the experiment; but it does serve to bring out certain characteristics of the series.

P X F F R U Q Z S T N F F R I E K F F R
D M H F F R I D M F F R J C B F F R G L
A F F R Q N S T V Y F F R Y Q O P W S F
F R H E M F F R M B A F F R W Z N V Y Q
F F R W Q N T Y Z F F R A B H F F R S Y
N V T P F F R T Z W O Q N F F R N Q Z O

FIG. I

The FFR series—the first 120 letters in the series, which is shown on a moving tape in a single continuous line.

Double F is repeated at intervals: it is invariably followed by R. The intervals between F F R are either long or short. At the beginning of the series the long intervals contain six letters, and the short intervals three; the length of the intervals gradually increases until at the end of the series they consist of eight and five letters respectively. This long-term trend cannot, [4]of course, be shown on the slide. The long intervals are always filled with letters from the second half of the alphabet (N-Z, excluding R) arranged at random, no letter being repeated within any one interval. The short intervals are always filled with letters from the first half of the alphabet (A-M, excluding F) also arranged at random, with the one exception that A is always followed by B and vice versa, unless A or B immediately precede F. Long and short intervals are randomly arranged. The series, therefore, in more ways than one is only partially predictable. The subjects are simply asked to comment at once on any feature which strikes them as significant, and given no further instructions as to what to look for.

I do not intend to give a full report of this experiment here, but merely note that all my subjects (the majority of them first-year psychology students) without exception very rapidly structured the series. F F R were always separated out. All the subjects at some stage or other counted the letters between the F F R groups, and the counting never included the F F R groups themselves. There was therefore objective evidence that the F F R groups were differently regarded from the rest of the series, and the series structured round them.

Now grasping the pattern of the series in this way is more than, though it may be based on, an associative probabalistic process. All but one of my sixteen subjects learned to associate A and B (in seventy-three out of ninety appearances of either letter A and B are conjoined in the series). But this did not lead to any structuring of the series round A and B. A and B remain part of the series and are counted when counting takes place. F F R stand apart as a result of a reorganization of the series as a whole. This patterning cannot be a perceptual patterning because the number of letters perceived at any one moment is limited to five. It is a temporal patterning, extending from the past to the future, the discovery of a repetitive rhythm which though not perfectly regular does

follow certain ascertainable rules. The process which enables a series of successive events to be patterned in this way may be appropriately termed temporal integration.

My third and most familiar example of temporal integration is the production and comprehension of speech. Speech consists of sequences of words; and if it is to be intelligible these words must be grouped in recognizable syntactical patterns as well as in patterns of meaning. To grasp these patterns requires an integrative process which, because of the sequential nature of speech, is necessarily a form of temporal integration, involving, as in the case of St. Augustine's recitation, both memory and expectation. Attempts have been made to explain the coherence of normal speech by the statistical interdependencies among successive items in a verbal statement and the weaker influence of more remote associations. Such statistical structure does exist, and explains a variety of phenomena, such as speed of recognition and level of difficulty. But explanations wholly in terms of statistical frequency of association fail to account for the logical coherence of rational discourse, and Lashley (1951), who has reviewed some of the literature on this topic, has argued that "any theory [5]of grammatical form which ascribes it to direct associative linkage of the words of the sentence overlooks the essential structure of speech".

Whatever the theory, however, it can be shown by George Miller's method of approximation that temporal span is necessary to account for the sequences of normal speech. What Miller (1951) calls a zero-order approximation to normal English picks words at random from the dictionary. A first-order approximation takes account of the relative frequencies of occurrence of individual words; a second-order approximation of relative frequencies of pairs of words, the word "of", for instance frequently being followed by "the" but very rarely by "pullulation". Higher approximations get closer and closer to normal English. A fifth order approximation, which can be produced by getting different persons to choose each next word in the context of the preceding four, is still nonsense, but not necessarily ungrammatical nonsense. Here is a short example of a fifth-order approximation obtained by Miller's method:

> "The town is situated on a conspicuous building ornamented with pillars shaped like those of my professor."

To produce and to understand rational speech involves a much longer span of temporal integration than the artificially restricted span which in effect is the outcome of Miller's method.

There is, of course, a great deal of material relevant to the problem of temporal integration in the literature on speech disorders. In particular it is the capacity for temporal integration which seems to be impaired in the type of aphasia termed by Head (1926) "semantic". It is described by him as "due essentially to want of power to combine mentally into a single act a series of relevant details . . . want of ability to appreciate and retain the ultimate significance of intention of words and phrases combined in normal sequence". And it is linked to disturbances not only of speech but of other activities involving temporal integration; for instance, an inability to assemble articles requiring an ordered series of moves, to play games like chess and cards, or to reproduce the plan of a building which cannot be viewed at once and comprehensively.

In the light of these illustrations perhaps temporal integration may be provisionally defined as the formation of contemporaneous patterns of action and meaning when the units from which these patterns are constituted are serially ordered and in temporal succession. In the very brief time available to me this evening I want to do three things: firstly, consider the historical roots of the concept and the obstacles which have for long

prevented its development; secondly, illustrate its experimental potentialities; and thirdly, discuss its wider psychological implications.

III. Historical

First, then, some history. At the risk of distortion, I must work with broad and rapid brush strokes.

Modern psychology began when Hobbes brought motion into the mind, and mind became no longer a collection of faculties but a train of thoughts, a succession or sort of discourse. Two problems followed: how is this [6]train or succession guided? How is continuity maintained? To the first question Hobbes gave a clear answer. The second he largely evaded.

With Hume (1740) there were no evasions. He found "nothing but a bundle or collection of different perceptions which succeed each other with an inconceivable rapidity, and are in perpetual flux and movement". It is "the successive perceptions only that constitute the mind", and "our notions of personal identity proceed entirely from the smooth and uninterrupted progress of the thought along a train of connected ideas".

From the time of Hume onwards the primary nature of temporal succession was commonly recognized. For Kant it was the special mark of the "inner sense", and hence of all experience. For Bain, Spencer and J. S. Mill successiveness was the basic character of psychical life, and at the end of the century William James vividly described the stream of consciousness. Kant was the first to see that, given succession as a primary datum, an indispensable condition of experience was synthesis or integration; for the purpose he postulated complex transcendental machinery, which is perhaps not really so much more outrageous than the hypothetical constructs of some psychologists!

For two generations after Kant British Associationists, as T. H. Green (1874) complained in his weighty introductions to Hume, failed to come to terms with the issue. J. S. Mill (1865), indeed, looked and retreated. He saw the need for "a permanent something contrasted with the perpetual flux of sensations and other feelings or mental states which we refer to it", but had nothing better to suggest than "a permanent possibility of these states". "The paradox that something which *ex hypothesi* is but a series of feelings can be aware of itself as a series" he regarded as the final inexplicability.

After 1870 the problem could no longer be ignored. Ward, Stout and James all grappled with it in their various ways. For Ward (1886) there was a persisting subject and a memory continuum resulting from the continuity of attention. For Stout (1896) noetic synthesis implied the determination of a train of thought by the central idea of the whole topic. Two factors, in particular, were involved, conative continuity and primary retentiveness, which he held to be the foundation of meaning, and which was indeed apart from the lack of expectancy a direct anticipation of the concept of temporal integration.

"The last note of a melody (remarked Stout (1899)) may be and often is the only note of which we are aware at the moment it strikes the ear. Yet in it the entire melody is in a sense present. It comes before consciousness as part of a quite specific whole, and derives a specific character from its place in that whole....This cumulative effect of the preceding phases of a conative process on the succeeding may be called primary

retentiveness, in order to distinguish it from the retentiveness which is involved in reproduction and association."

James (1890) was more radical, and proposed that passing thoughts in some mysterious way both inherited the title of all past thoughts and also contained "vast premonitory glimpses" of what was to come.

[7]The weakness of all these proposals, as well as of the German theories of apperception, was their abstract nature and lack of experimental support. Before the end of the century, however, experimental evidence was forthcoming. G. E. Müller and Schumann (1894) in a famous series of experiments demonstrated the fact of serial grouping in the learning of nonsense syllables, and showed that grouping could override contiguity. The Würzburg psychologists established the existence of persisting determining tendencies directing and integrating associative successions, and on the basis of clinical evidence Head (1920) proposed his theory of the schema.

Nevertheless in the two great contemporary movements of Gestalt psychology and behaviourism the concept of temporal integration never quite emerged. Though the concept has affinities with Gestalt theory, though Humphrey (1933) and Katona (1940) came close to formulating it, and though we find references to action patterns and the organization of simple rhythms in their writings, the Gestalt psychologists, largely owing to the extraordinary dominance of spatial concepts in their thinking, failed to develop their theories in this area. Behaviourism, on the other hand, in the form of learning theories has shown an increasing proclivity towards temporal concepts, such as antedating reactions, expectancies and pure stimulus acts, and in one study at any rate, O. H. Mowrer's "Time and Integrative Learning" (1945), we have a direct attack at the rat level on the problem "of integrating the future and the present, of learning how to surmount the natural limitations imposed by the naturally given gradients of reinforcement". It is doubtful, however, whether, owing to the limited temporal capacities of animals, including even the primates, animal experiments can contribute more than foundations—valuable and indeed indispensable as these are—to our understanding of temporal integration. Lloyd Morgan in his pioneering work on comparative psychology (1930) pregnantly observed that the emergence of higher levels of mentality was closely linked with the grasping of the time plan of events, with retrospective memory and reflective anticipation, and Piaget's studies of the child mind have amply confirmed Lloyd Morgan's observations. For Piaget (1947) characterizes the first and essential difference between sensori-motor and conceptual intelligence thus:

> "Acts of sensori-motor intelligence, which consist solely in co-ordinating successive perceptions and (also successive) overt movements, can themselves only be reduced to a succession of states, linked by brief anticipations and reconstructions but never arriving at an all-embracing representation; the latter can only be established if thought makes these states simultaneous, and thus releases them from the temporal sequence characteristic of action."

It is at this latter level that temporal integration proper emerges with what Piaget calls "an all-embracing representation", and it is this level that animal studies by their very nature cannot elucidate.

With the recent writings of Hebb (1949), Lashley (1951) and Fessard (1954) the concept of temporal integration has emerged into clearer [8]daylight. But it is strange, in spite of what Lashley terms "the ubiquity of the problem", and in spite of its being a required corollary of the Hobbesian train of ideas that for so long "it has [again in

Lashley's words] been largely ignored; it is not even mentioned in recent text-books, nor is there any significant body of experimental studies bearing on the problem". We can only speculate on the reasons for this. Perhaps faculty psychology was a main culprit—and who can doubt on inspecting the chapter headings of our text-books that the influence of faculty psychology is far from dead? Temporal integration cuts across faculty boundaries. It implies perception of the present, memory of the past, and expectation of the future—stimulus patterns, traces, and symbolic processes—integrated into a common organization. But there is, I think, another reason. In their approach to the more complex forms of learning, memory and thinking psychologists have been unduly influenced by the set exercises of the school classroom, where problems are frozen on to blackboards and exercise books, and lessons can be conned repeatedly until learned by heart. World War II ended the exclusiveness of this preoccupation. Psychologists were confronted with situations that would not stand still, indeed which often moved with dramatic speed. There is no need, and I have no time, to review the reorientation of psychology that became inevitable. Sir Frederic Bartlett (1955) has recently done so authoritatively. Let it suffice to note that the investigation of skills, mechanical devices for prediction and control, theories of communication and the renewed study of language, studies of decision making, and finally progress in the understanding of the neurological basis of memory and integration have all contributed to the recent emergence of the concept of temporal integration. But as we look back over the history of our science, and this is why I have ventured to include this historical section in my address, we can see that the concept was implicit from the beginning and potentially of central importance throughout modern psychology.

IV. Experimental

I pass on to some experimental applications and illustrations. Although my experiments are of a preliminary nature and mostly on a small scale, it seemed probably more interesting, and perhaps one step nearer to the light entertainment appropriate to a Saturday evening, to say something about them rather than to leave the matter on an abstract plane. But I hope you will take this as in the nature of a workshop visit rather than as a display of finished products.

Temporal integration is involved in various forms of judgment, one form, important in real life, may be termed the summative judgment. Consider what is involved in answering the question, "Have you done a good day's work today?" It is necessary to cast one's mind back over the day, summate the various jobs of work done or left undone, and to compare the total with a norm or standard. Now it has been pointed out by Helson (1948) and others that in making psychophysical judgments the pooled effect of previous judgments determines what has been called [9]adaptation level or frame of reference. In Helson's experiments, however, the focus was on the effect of past experience on the assessment of a present stimulus, not on the summated series of past events as such. But it is precisely this which is often important. We are constantly having to summate our experiences, evaluate them, and make predictions as to the future on the strength of them, and in doing this we necessarily have to integrate temporally separated events.

Let me demonstrate a simple experimental parallel to this situation. The square on the first slide is the standard (the good day's work). The next three slides show in succession three shaded areas. After they have been shown to you, add these areas

together mentally, and then say whether they amount to a good day's work (i.e. whether their sum is equal to, larger than or smaller than the standard) (Fig. II).

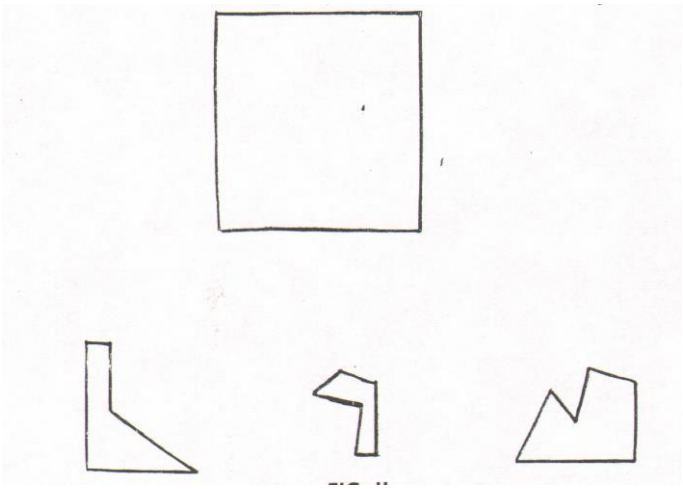

FIG. II

The large square is the standard and shown first. The three small pieces are shown on separate cards in sequence. Is their sum greater or less than the standard?

That is an easy example. The next one is of a slightly different sort and a good deal harder. Each slide is divided into two halves, A and B. On each half there is an irregular pattern of dots. The dots are of three sizes; each size of dot is given a numerical score, 3, 2 or 1 in decreasing order of size. You are shown a series of ten slides. You will not have time to calculate the scores precisely. At the end of the series you are asked to say which side you judge to have the higher score. The series shown was a difficult one. The mean score for side A was 9.0 with a standard deviation of 3.7, the mean score for side B was 10.5 with a standard deviation of 3.8. The difference between the means was thus only 1.5 and the standard error [10]of the difference 5.3. Each side had five "wins", but side B had a better "goal average" (Fig. III).

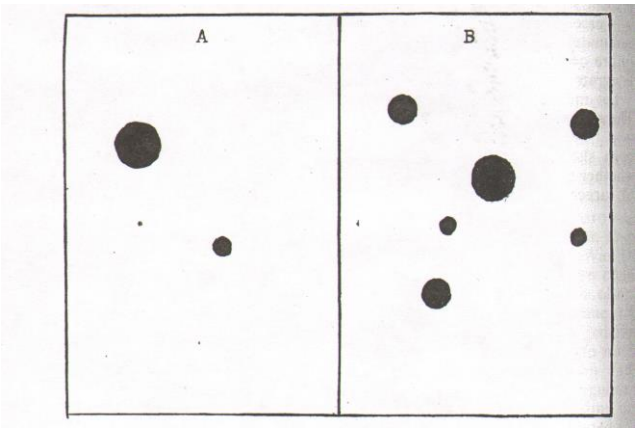

FIG. III

Sample Card. The large dots = 3; middle size = 2; small = 1. A series of ten cards is shown in rapid succession. Is the total score on side A larger or smaller than on side B?

Now in making summative judgments in real life we make extensive use of symbolization. Our experiences get verbal labels, and these assist identification and recall. In the typical psychophysical experiment, on the other hand, the stimuli are

monotonously similar and not symbolically differentiated. What is the effect in summative judgments of attaching symbols to stimuli?

In the experiment I am to show you the summative judgments take the form of averaging. This again is a frequent form of judgment in real life. For instance, I spend an hour going round a large store; some prices strike me as dear, some cheap; but my impression at the end is that on the average the store is inexpensive. I arrive at this conclusion without actually adding and averaging a representative sample of goods; nor, however, is my judgment just a matter of unconscious pooling, since certain key impressions are symbolically fixated and available for recall. How far does symbolization assist in temporally summative judgments of this type? My experiment was designed to throw light on this question.

My subjects were first shown a code in which each letter of the alphabet was represented by a square. The letter A was represented by the smallest

[11]

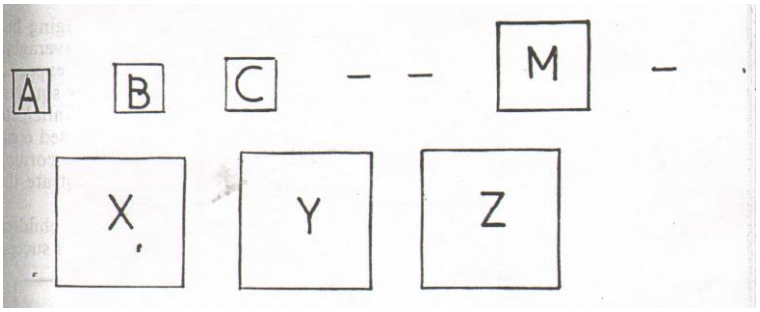

FIG. IV

Part of the code sheet for the Coded Squares experiment. Each letter in the alphabet is represented by a square with sides 1/30 inch larger than that of the preceding letter.

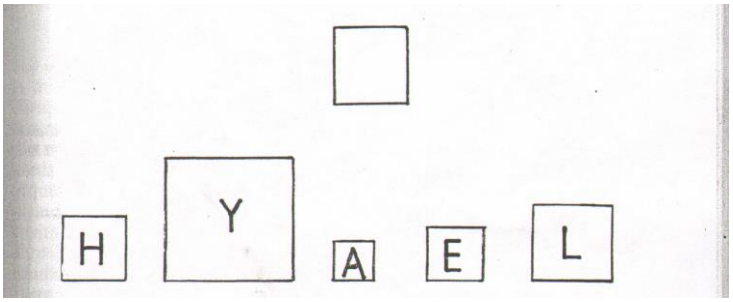

FIG. V

The square at the top is the average in size of the five coded squares at the bottom.

square, and each successive letter by a square slightly larger than the previous one. The meaning of average in this context was then demonstrated and the subjects were given some practice in simultaneous and successive averaging. In simultaneous averaging the squares to be averaged were presented on the same card and displayed for thirty seconds. In successive averaging the squares to be averaged were presented one at a time at six-second intervals. The averaging was done under two main conditions: firstly without attached symbols; secondly with attached symbols, the letters forming a word

which was announced to the subjects beforehand. After the presentation of the squares subjects had to select a square judged to be the average of those presented from a randomly arranged unsymbolized set of squares on a tray. The hypothesis I wished [12]to test was that symbolization would assist in successive averaging but make no difference in simultaneous averaging. In simultaneous averaging the judgment is essentially perceptual. In successive averaging I expected that the symbols would assist in the identification and recall of the squares, also, as the subjects were told the word beforehand, they could anticipate the approximate sizes of the squares they were to be shown. I used eight ten-letter words which were allocated to the different conditions according to a predetermined experimental design. Figs. VI and VII illustrate the material.

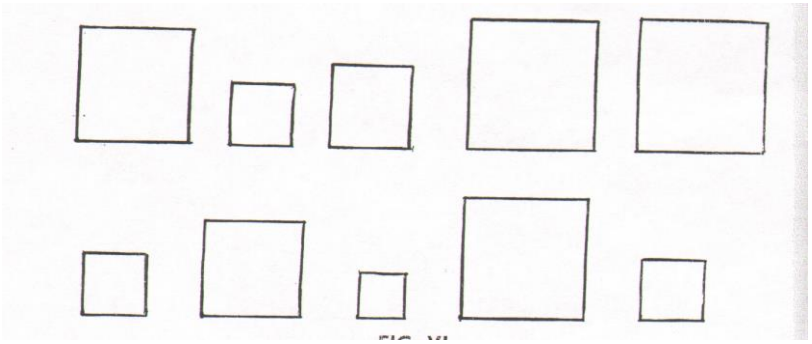

FIG. VI

Uncoded word. (Rejuvenate.) The word is shown under two conditions: (i) simultaneous with all the squares on one card; (ii) successive, with one square on each card in series. In each case the average size has to be judged.

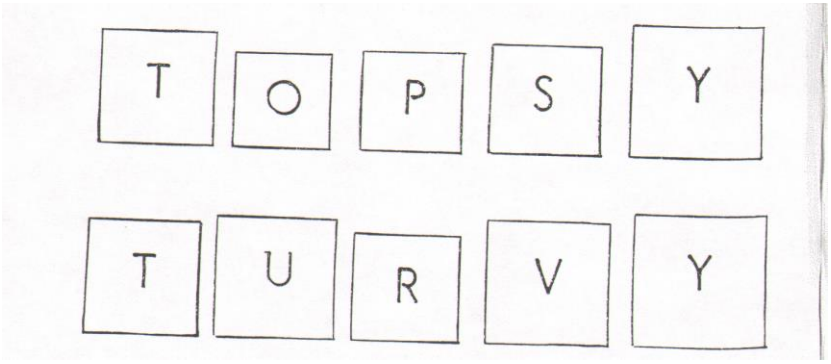

FIG. VII

Coded word. Shown as Fig. VI under two conditions simultaneous and successive.

So far my results have worked out this way: with adults and older children (aged 13-plus) significantly more accurate judgments in the case of success-[13]ive averaging have been made with than without symbolization. With younger children (aged 1–12), however, the judgments with symbols have been slightly less accurate. In the case of simultaneous averaging I anticipated that the symbols would make no difference; in fact they proved a marked hindrance to both older and younger groups, the judgments being significantly better when the squares were shown without symbols. I intend to publish a fuller account of this experiment at a later date after having examined larger and more representative samples of subjects. It does, I think, provisionally confirm a statement

made by Nissen (1951) that symbolization is “an instrumental aid to the integration of temporally separated experiences”.

My next experiment, with a rather different type of material, was designed to test the hypothesis that individual subjects differ in their capacity for temporal integration. Modern developments such as cybernetics and information theory have led most unfortunately to the depreciation of individual differences. The variability of the biological model has been replaced by the uniformity of the mechanical model. Indeed the value of the whole Galtonian tradition has been denied even by psychologists in this country.

I chose, therefore, material which has been much used by information theorists, namely spoken language subjected to interruptions. Now the comprehension of spoken language, as we have seen, involves the grasping of patterns of syntax and of meaning, and this implies temporal integration. The tendency of interruptions (or noise) is to disrupt this pattern, rather in the way that the superimposed lines in the Gottschaldt experiment disrupt the basic visual figures. I took four short descriptive passages each of approximately forty words in length and interrupted the passages by interspersing two-syllable nonsense words (paralogs) or two-syllable words taken at random from the dictionary. The interruptions were either frequent (after each word of the passage), or less frequent (after every second word of the passage). Each passage was given under four conditions—with frequent or less frequent interruptions of either paralogs or random words. The passages were all recorded on a wire recorder and played in a standard form and according to a predetermined experimental design. There were sixteen subjects who each listened to one passage under each condition, and had to reproduce as much as possible of each passage (but not the interrupting paralogs or random words) immediately after each passage was played. To illustrate the material I quote from the beginning of what proved to be the easiest of the four passages with the less frequent interruptions. First with interrupting paralogs:

> Cotton goods SUGID cannot be LOCOL made everywhere
>
> RULEB. For spinning CUMOZ and weaving LECOP...

The same passage with interrupting random words commenced:

> Cotton goods DEVOTE cannot be FAULTY made everywhere
>
> CONSTRUCT. For spinning BATTLE and weaving DISTRESS...

Now an analysis of the results of this experiment showed that there was a significant difference (5 per cent level) between the difficulty of the [14]passages. This was probably linked to the degree of redundancy of ideas in the passages, and perhaps to the clarity with which the subject matter of the passage was stated in the first few words. The differences between the conditions were not significant, except in the case of the condition involving frequently interrupting random words, which was harder than the others. All the conditions showed a significant loss of not less than 40 per cent when compared with a control passage without interruptions. But the largest source of variance was between the subjects themselves. This was significant at the 0.1 per cent level. All the subjects were university students, but the best subject under interrupting conditions reproduced 6_ times as much as the weakest, a far greater range of difference than under normal conditions. This indicates that there are large individual differences in the capacity for temporal integration, particularly under conditions of difficulty, and suggests that use might be made of this principle psychometrically and perhaps clinically.

For some years I have been working at the construction of tests which incorporate the principle of temporal integration. These tests are still in an experimental form, and I cannot yet say a great deal about them. I will, however, illustrate two kinds of material.

The first test, which I name "The Letter Families Test", has been prepared in two trial forms, a fairly simple version for use with average adult populations, and a more complex version suitable for research purposes with university groups. The test has affinities with the "Letter Grouping Test", which formed part of Thurstone's Primary Mental Abilities battery. But unlike the Thurstone test the items are successively presented, and the task is not to pick out the unlike item but to abstract the common principle of arrangement present in all the items of the series, and then select or reject the items of a test set.

I illustrate first with an example from "Letter Families Test A". The six demonstration cards, which are shown one at a time, are constructed on a common plan and are termed a letter family; the testee has to discover the plan of the family, and then say whether the test items which follow are legitimate or illegitimate offspring. The whole test in its experimental form consists of ten such families. Together with a battery of other tests it has been administered by Dennis Bromley of my department in Liverpool to a population of 256 adult subjects ranging in age from 17 to 82. With age held constant the correlations between the Letter Families Test and the Wechsler Bellevue EQ was 0.67 and between Letter Families and Progressive Matrices 0.45. A factor analysis has not yet been carried out. The test proved a tiring and difficult one, particularly for older subjects, and twenty-one subjects with an average age of 73 failed to score at all. Bromley's figures suggest that a mental age of at least 12_ years is required to cope with even the easiest items in the test. On the basis of Bromley's detailed analysis it will be possible to construct a revised version of the test, eliminating some less satisfactory items and improving reliability (at present 0.87).

[15]

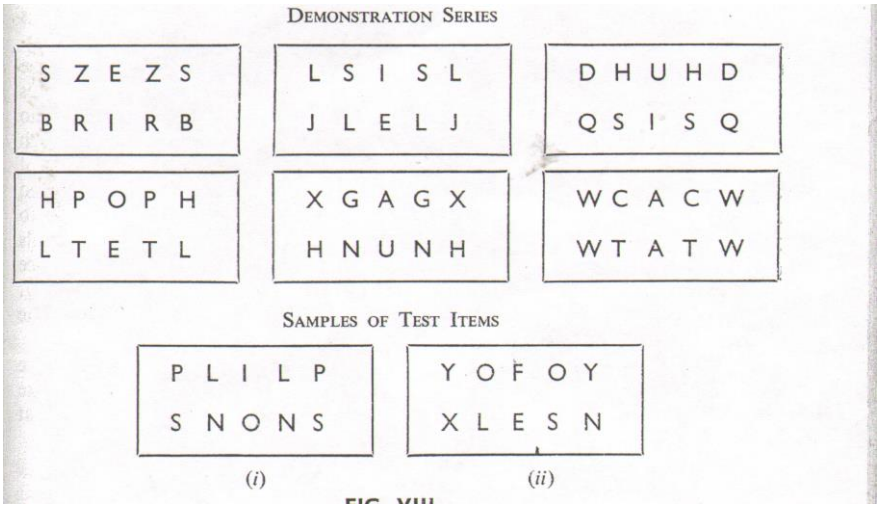

FIG. VIII

Letter Families Test A. The six items at the top are a demonstration series. Below are samples of (i) a correct item, (ii) an incorrect test item. All the items are shown serially.

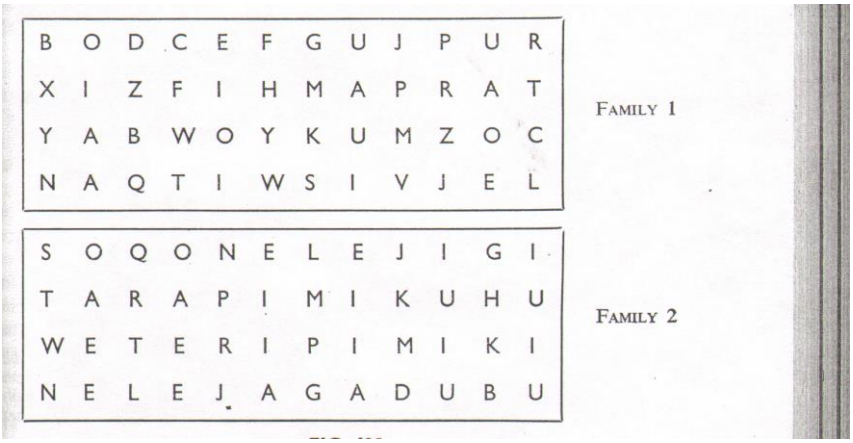

FIG. IX

Letter Families C. Samples of items from two families. The pattern of consonants and vowels is in this case different in the two families.

The harder version of the test brings in several additional features. Each item contains a larger number of letters: the demonstration series [16]contains the members of two families randomly intermixed. Some items belong to one family, some to the other. It is like a communal dwelling house in which the children of two families have to be sorted out on the basis of family characteristics. The dwelling-house is run on moral lines and there are no illegitimate offspring. Instead of having a test series to select from, testees are required to state verbally the principles upon which the families have been constructed, and to give birth to a new member of each family. This, of course, is slightly time consuming, but has provided useful information. The test has been given in an experimental form to groups of university students and sixth-form grammar school pupils numbering nearly 100 in all. The correlation with verbal tests of intelligence (Moray House and Otis) was 0.40 and with Progressive Matrices only 0.27. The group, of course, was a selected one, but in the same group the correlation between Moray House and Otis worked out at 0.88.*

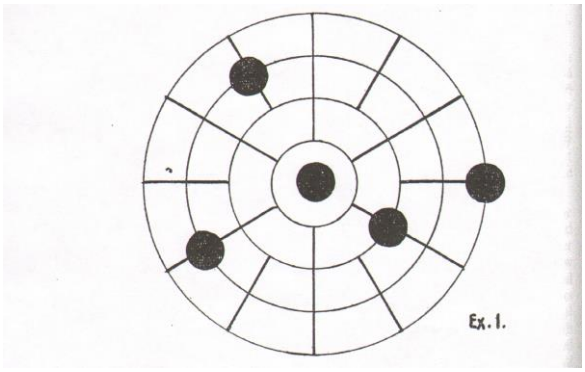

FIG. X

Sample matrix from the CVR Test. The dots are "events". "Locations" are where orbits and radii intersect. A set of matrices is shown in series. Constant events stay at the same locations; variable events move according to rules; random events appear unpredictably. After seeing a series of matrices the subject is asked to predict as far as possible the next two in the set.

* The tests were given in various ways and the correlations are based on the scores of thirty-two grammar school boys only.

Finally I should like to demonstrate one item from another test I have christened the CVR test. On a series of matrices, which look rather like spider's webs, "events" are located. Some are constants (C) and occur at [17]the same locations on each successive matrix; some variables (V) moving in accordance with ascertainable laws; and others random (R) occurring wholly or partially unpredictably. The subject has to watch the series of matrices and then on two blank matrices fill in predictions of what the next two in the series might look like. There are a number of conventions and general rules of the game (e.g. that variables cannot change orbits, nor move more than three places at a time round an orbit) which the subject first has to master. The test, which again is only in an experimental form, then consists of two practice and ten test series. The correlation of this test with standard intelligence tests administered to the same university and grammar school groups as the Letter Families was surprisingly low—only 0.19 with Moray House, and a nearly zero correlation of 0.05 with Progressive Matrices. With a spatial test (N.I.I.P. Group Test 80) the correlation was 0.22. This suggests that the CVR test is measuring something rather novel, but exactly what I am not certain. The correlation with the Letter Families was only 0.28. In its present form the reliability of the CVR test is not very satisfactory, being only 0.78.

However, I do not lay much stress on these numerical results. These tests are still wholly experimental, and my object in showing them was to demonstrate that the concept of temporal integration can be employed experimentally and need not remain in the philosophical clouds.

V. Wider Implications

If I may crave your indulgence for a few moments longer, I should like to conclude by briefly alluding to the wider psychological implications of the concept of temporal integration, since it seems to me that here its special value lies.

Temporal integration essentially involves the formation, from temporally disparate units, of configurations in which the present moment and immediate stimuli lose the dominance they possess at the perceptual level. The capacity to form and to scan such temporal configurations frees the organism from control by the present situation, and is the foundation of most of man's characteristic attributes. For the behaviour of the normal human adult takes place in an extended temporal framework. A promise made years ago, and nowhere objectively recorded, may influence a man's actions for the remainder of his days; long-term goals and aspirations may be major regulators of his day-to-day conduct. The whole aspect of the world can be changed by a future event known to be immanent—the certain knowledge, for example, that one has not long to live. About the hardest thing for the adult to do is to immerse himself wholly in the present; even in his relaxations he tends to be goal-directed and time conscious, to be imbued with some sense both of history and of futurity.

By contrast animals, even the primates, live mainly in the present. They are sense-bound; learned reactions are tied to present stimuli, or subject to but short delay; anticipations are brief. Kohler's (1925) observation is classic: "A great many years spent with chimpanzees leads me to venture the opinion that besides in the lack of speech it is in the extremely narrow [18]limits (in time) that the chief difference is to be found between anthropoids and even the most primitive human beings". In confirmation

of this observation we find the temporal maze is a peculiarly difficult task for animals; and that the capacity for delayed response is far less than with quite young children.

Hebb (1954) recently put the matter thus:

> "The problem of consciousness is not only a problem of integration, that is, the finding of an area or a system in which diverse things may be brought together, but also a problem of temporal order. As far as integration as such is concerned, you can find it in the flat worm or in the spinal dog, but we cannot assume that this is consciousness. If we make a separation between an organism such as man, in which we are sure of consciousness, and lower forms in which consciousness is doubtful or negligible, we find that the greatest difference in behaviour is the complex temporal integration in the higher animal—implying a series of events going on in the cranium which are to some extent independent of the environment".

If Hebb is right the concept of temporal integration is likely to illuminate many aspects of human psychology—language, for instance, conceptual cognition, planning and foresight. It reopens, moreover, neglected approaches to the study of emotion. You will recollect that Shand (1914) named an important group of human emotions, e.g. hope and disappointment, "prospective emotions of desire", and that to these McDougall (1919) added a group of retrospective emotions, e.g. regret and remorse. Few psychologists except Stern, who included a chapter on "The Temporal Reference of Feeling" in his *General Psychology* (1938), have paid much attention to the Shand-McDougall scheme. Yet explanations in terms of physiological concomitants and expressive movements have not taken us far in the understanding of the more complex human emotions. Temporal reference may, after all, hold the key to a more fruitful interpretation.

But more than this temporal integration may not impossibly throw light on some of the primary problems of personality development and break down. Bowlby (1951) recently noted that the young child's personality develops hand in hand with a sense of continuity in time. The deprived child never acquires this sense, and remains at the mercy of momentary impulses. An important factor in the development of a sense of continuity is the constantly recurring presence of the mother, who thus acts as what Bowlby terms "a psychic organizer" to the child. A year before Bowlby published his report Lauretta Bender (1950) had noted essentially the same thing. "Defect in time concepts is one of the most significant problems", she writes, in children isolated from the mother. "This may be related to lack of identification as a continuous temporal process . . . it appears that we develop our time concept from passage of time in our earliest love relationships, in the going and coming of the mother. These children do not remember the past; they cannot benefit from past mistakes; consequently they have no future goals and cannot be motivated to control their behaviour for future gains."

[19]In breakdowns of personality, both mild and severe, temporal disorganization is a common feature. Schizophrenic patients tend to lose the sense of temporal sequence, "the ability to enmesh the flux of activity within a temporal schema", as Heinz Werner (1948) puts it. After frontal lobe operations and brain damage there seem also to be temporal disturbances which generally go with an inability to plan and anticipate. And is not the difference in the capacity for temporal integration the common feature of Goldstein's distinctions between concrete and abstract behaviour?

Even in milder forms of personality disturbance temporal constriction is commonly reported. Professor Hamson (1955), of Cambridge, who was himself a prisoner of war,

states that the mark of transition from the mental daze that follows captivity was that "the prisoner no longer lived from day to day passively largely or with exclusively immediate object, but began to plan so far as he might and to dispose of himself and his circumstance over some span of time and with some variety". Or consider *les clochards*, the Parisian down-and-outs recently described by Schneider (1955), whose horizon is the moment, who have no history, nor aspirations, but have surrendered unconditionally to the passage of events.

Finally, observe how temporal integration within the individual mind is supplemented and supported by society; by official time measurement and by calendars, by records of the past and by blueprints of the future; by the whole ordered scheme of regular and timed communal activity, about which Norbert Wiener has proposed some interesting speculations in his recent Fawley lecture (1955).

According to Mowrer (1950) "the essence of integrated behaviour is the capacity to bring the future into the psychological present". Perhaps we might extend Mowrer's analysis and say that integrated behaviour involves at the human level at least three things: it involves the assimilation of the past, both personal past experience and, as man cannot function except as a social being, the accumulated traditions of his community; it involves, secondly, prudence and foresight; and, thirdly, it involves the sense of self-identity and continuity. If we are to explain behaviour in its most characteristically human forms without having recourse to animism it is to the concept of temporal integration that we must turn. It is because it seems to me among the most promising immediate lines of advance in psychological theory that I have ventured, with a full awareness of my inadequacies, to speak this evening about temporal integration and behaviour.

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