About Learning and Memory

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7. Human Learning and Memory

SIGNIFICANCE

Many principles of learning are initially derived from animal studies and subsequently attempts are made to seek resemblances with and applications to human life. This procedure has not been always approved by all.

There have been many digs at psychologists who have been sympathetically disposed to experimental work with animals. A philosopher, for instance, jocularly remarked 'one would rather learn from Skinner than from his rats'. Skinner himself has mentioned the lament that 'Pavlov turned man's essential godliness (Hamlet's "How like a god!") into a detestable beastiality (How like a dog!).

Nothing of the sort has happened; heavens certainly have not collapsed. Man continues to be what he has always been basically an animal although of astonishing complexity and of long and varied history.

There is all the convenience in starting with an easy instance (of animal learning) and collecting raw data on the base-line processes which are commonly found in both, animals as well as men. Much useful insight can be obtained by concentrating on those features of learning behaviour which human beings share with rats, pigeons or chimpanzees.

In studying animal learning, quite frequently, we go out of our way to point its resemblances with and applications to human life and learning. There is an essential continuity between the two in respect of explanatory principles and controlling mechanisms. In either case, learned reactions are an outcome of the interplay of organic-genetic sensitivities and capabilities and environmental conditions and contingencies. Basic behaviour unit and modification mechanism—S-R and response-reinforcement respectively, are common to animals and men. The rat learns to press the bar through pellets of food (sound of the dispensing mechanism would also do); the prospective surgeon acquires his skills in the hope of making money or reputation afterwards. In spite of the tremendous complexities of the S and R terms revealed by experimental analyses over years, the S-R unit of the behaviour theory continues to be a useful shorthand device to illustrate different types of human learning including associative learning. In fact, learning processes have been found to be common across different species. The difference, however, is while animal learning remains confined to very
simple forms, human behaviour is capable of the most exquisite, complex and varied adjustments. It is, no doubt, true that animals make various sounds and also react to diverse sounds given out by other organisms. But, none of them except man, has the ability to use words and communicate meanings. An increased cranial capacity with a highly efficient central nervous system, erect posture and opposable thumb have given man a capacity to behave appropriately in the face of constantly changing situations. One may speculate about some sort of inherited language-genes in man, however, something in his genetic make-up eventuates the unique development of language. Verbal responses are some of the most unique and significant activities of man. They probably constitute the major part of his waking life. We speak and are spoken to; we read and write. Most of the instruction imparted and assessment done in our schools and colleges is, in fact, verbal exercise, repeated criticisms of verbal learning, memory work, etc. notwithstanding. It is useful to know that, in a general way, this persistent verbal behaviour (responses of the vocal muscles) is moulded and shaped in the same manner as any other motor response of specified musculature. All verbal associations are formed within the context of a general behaviour theory. Clearly a good memory, an efficient retentive function are of great help in every day life. Teachers, lawyers, newspaper editors, public speakers and, in fact, all brain workers heavily lean on their facility in acquiring and retaining predominantly verbal information. One is rightly disturbed if one’s retentive capacities or the whole remembering function are either undependable or unserviceable and in extreme cases, one may be driven to seek dubious professional advice. In western countries, memory improvement programmes—courses—are commercially available and make sound business. It should be recognized, however, that the most valid principles of verbal learning and memory, scientifically ascertained and tested, are our surest bet by way of efficient memory management. Empirical investigations into the processes of remembering are our trusted guides in the troublesome practical problem of control, training and improvement of memory. Of course one must have the imagination to put to practical use the many small but significant insights that scientific analyses offer.

Till quite late in nineteenth century, apparently, the most perceptive thinkers remained confined to the problem of post hoc associations. Even Galton’s studies dealt with already formed associations and were at a distinct disadvantage from the point of view of studying the learning process or of knowing the actual formation of new linkages or associations.

A more fruitful lead came from Ebbinghaus in the form of memory experiments where the processes directly involved in learning of verbal items were studied by actively manipulating antecedent conditions of contiguity, frequency, recency, grouping, etc. Thus, Ebbinghaus’s experimental techniques and studies may be viewed as original attempts to discover the processes that occurred when associations were actually being formed and which were measured by Galton’s methods and their later derivatives. Later, we may review the interactions between the Galton and Ebbinghaus traditions.
For studying learning in the 'raw' and understanding formation of associative linkages de novo, Ebbinghaus introduced his ingenious innovative invention—the non-sense syllables (e.g. DIB, JAL, VUD, etc.)—which were considered extremely suitable verbal units for memory experimentation, being initially unrelated and of the same size and significance for all. In addition, his other equally significant contributions are designing systematic procedures of study (the so-called experimental methods for investigating problems of verbal learning and memory) endowed with rare power and precision to yield definitely measurable scores and detailed classical findings regarding the way memory (in a restricted sense) operates. Indeed, he laid the foundations of a new association science.

Most unexpectedly, stimulation and support for this new science of memory came from Pavlov's epoch-making conditioning researches. The continuing theme of contiguity—the primary law that associations are formed on the basis of nearness of experiences in time or in space—is also the critical conditioning principle. Basically, conditioning is establishing an associative relation between the conditioned stimulus (bell) and the unconditioned stimulus (food) through their repeated pairing so that, in due course, the former takes the place of the latter. We shall have many occasions to feel the impact of Pavlovian behaviour theory on the subsequent growth of memory studies.

MEMORY: PRELIMINARY DEFINITIONS

Memory is a single discrete word; this, however, does not mean that it stands for some clearly and definitely identifiable unitary process. In fact, it is a multiplex, diverse process consisting of numerous part processes.

In common parlance, the word 'memory' is freely used with many different connotations. Think of all the different situations in every day life where this word is used. The concise Oxford Dictionary lists a few of them: Memory often means the faculty of reviving past incidents in an individual's life—a person has a convenient memory in the sense that in an opportunist manner, he recollects only what is to his own advantage. Some persons seem to have a remarkable power to remember what to do and precisely when. It stands for a stretch of time or history as when the orator says 'from times immemorial ...'. Figuratively, for the computer technologist, memory definitely points to the place where data are fed into the machine—the place of information storage. It may signify an act of earnest dedication as 'in fond memory of'. It is also used, as the same source tells us, in the sense of posthumous fame as 'his memory has been savagely censured and then completely obliterated'.

Apparently, the meaning of the term memory changes according to the discipline in which it occurs. Biologists speak of it as an attribute of some life forms in virtue of which their behaviour becomes modifiable as a result
of earlier reactions. Biological memory is there if behaviour shows any signs of having learned something or of having retained the effects of past reactions. In this vein one may even speak of organic memory referring to some sort of neural or cortical trace or engram. Biology makes no reference to any intelligent adaptation or awareness and representation of past and present experiences. In the biological use of the term there is no reference to consciousness.

Similarly, expressions like genetic code or genetic memory are metaphorical, referring to certain hereditary chromosomal store of information which steers the growth of the individual organism along phylogenetic lines.

The psychologist naturally regards memory as falling within his rightful domain. However, a unanimous claim of this sort does not mean that psychology is dealing with a unitary function or process denoted by the one word—memory. In fact, more often than not psychologists use expressions like immediate memory, short-term memory, long-term memory, rote remembering, constructive remembering, substance memory, recognition memory, recall, etc. Even when the word 'memory' occurs by itself, it is always understood as referring to and as being inclusive of, all its subdivisions and diverse component processes or mechanisms.

Even in the behavioural science that is psychology, it is open for anyone to suggest an exceedingly broad definition of memory saying that we have an instance of memory whenever present performance shows any influence of the previous responses of the organism. By this definition, Pavlov’s conditioning, Hunter’s delayed reactions and all motor skills for that matter, illustrate the phenomenon of memory. Such a view, however, is not confirming with the rather specific usage assumed in the long line of memory studies starting from the classical experiments of Ebbinghaus. For psychological purposes of scientifically studying human learning, memory has been defined as remembering now what has been learned before. Circularity involved in such statement is disquieting. It signifies the processes of preserving and maintaining effects of earlier learning experiences and later using them in some kind of behaviour. Memory connotes preserving of previous experiences and now expressing them in behaviour. But, remembering here and now what has been previously learned, presupposes that it must have been retained in some form in the meanwhile. Therefore, it would be proper to regard learning, retaining and remembering as constituting memory. Memory and remembering denote the same comprehensive process which includes learning, retention, recall and recognition. According to the classical tradition, these four different phases or stages of memory have been distinguished. It is useful to note that the above-mentioned four aspects of memory function are distinguishable but not different in the sense that they may not be clearly separate in time. There is an inevitable togetherness of memory and learning. Remembering without learning is as unlikely as learning without remembering.
There is remembering in learning which cumulates and is accomplished through many remembering processes. On the other hand, something has got to be learned, in the first instance, so that it could be remembered on a later occasion. An event must be registered before it could be remembered in any form. So learning, registration, acquisition, or forming of impression is the initial phase of memory.

What is registered must somehow be retained, so that it may be actually remembered at some later date. Retention is storing of information. We can never directly measure retention, as we measure the length or breadth of a table. Retention is inferred indirectly. Imagine a person correctly dialing his friend's telephone number; under these conditions, it is reasonable to infer two things—firstly he must have learned his friend's telephone number on some previous occasion and secondly and more relevantly, he must have retained it during the interval when he was not actively rehearsing it. Learning and recalling or retrieving involve tangible active processes; retention in comparison, is inferential and inactive. This has been the classical teaching. Acquiring, recalling, etc. are overt functionings; in contradistinction, retention is implicit, often spoken of, however figuratively, as a storehouse into which items are deposited for safe custody and wherefrom they may be taken out later. At any rate retaining is not active in the sense in which learning or retrieving are actual active processes.

The view that retention signifies a relatively inactive phase may be regarded as being at variance with the Gestalt assumption of spontaneously active memory trace which is supposed to be continually under stress to grow into a better balanced and more unified configuration, in its 'pragnanz' course. The Gestalt model of a dynamic field consisting of autonomously changing memory traces is bound to have great difficulty in accepting the characterization of retention as relatively inert. Elsewhere we have criticized, at some length, the Gestalt theory of memory trace. Here we may be brief and say that Gestalt contributions to the psychology of perception are of the very highest order and have found general acceptance which is not the case with their speculations about transformations of memory trace. Scientific opinion would rather endorse Woodworth's view that but for decay from biological factors, the trace stays unchanged during retention.

We shall consider all these processes in greater detail, at a later stage.

It is useful to begin with clarifying our notions of the processes (memory) we are concerned with. A description which is somewhat closer to human memory, as it is commonly talked about, is that it is an individual's record of his past experiences. What is involved in memory is some kind of reinstatement or revival of earlier learnings. Following phase or stage analyses seem to be both logically necessary and empirically demonstrable. Without doubt something cannot be now remembered unless it was previously learned and in the meanwhile retained in some form. Furthermore, actual remembering may take place via recalling or recognizing. Recall and recognition are two functionally different ways of remembering, the former involves
calling up past experiences in their absence while the latter identifies what is present as having been experienced before. In paraphrase, recognizing is remembering something in its presence, whereas, recalling is remembering it in its absence.

Commonly, these four phases or stages, learning, retention, recall and recognition are said to constitute memory. Memory or remembering stand for the same gross phenomenon or comprehensive process analysable into the above-mentioned, four sub-or-part processes. As is usually put, they are distinguishable but not different or separate in time or in being.

Learning, retention, recall and recognition are sometimes mentioned as the principal sub-divisions of memory; but, this way of speaking is somewhat misleading in that it conceals their essential inter-locking character. They are neither, exclusive classes of memory processes nor any separate spatial compartments; they are inseparably intertwined and literally run into each other. Thus, there can be no progress of learning without the gains of earlier trials being retained and carried forward to succeeding trials. Similarly, the subject may actively rehearse and recall between study trials or even within a trial so that there is always something of the one in the other and vice versa.

Learning process is also referred to as registering, forming of impression, acquisition, information, input, etc. Similarly, retention becomes storage and recall-recognition are rechristened as retrieval processes. Of course, alternative expressions have their respective overtones and individual nuances. However, such verbal exuberance and plural nomenclature permit very definite terminological preferences and even fashions of language. There is nothing wrong in this kind of enrichment of relevant vocabulary. Older psychologists have also freely used words like revival, reinstatement, reproduction, etc., in the context of recall. Always, the anxiety has been to precisely identify and describe the specific process. One has to steer clear of the possible confusions and interferences arising out of the multiplicity of terms of varying shades of synonymity and similarity. A sensitivity and feel for words may enable us to distinguish, for instance, that the word revival indicates a comparatively covert process whereas reproduction is a particularly overt form of the recall process.

MATERIALS USED IN VERBAL LEARNING AND MEMORY EXPERIMENTS

As said earlier, verbal responses, perhaps, constitute the major part of man's waking life. Thus, scientific study necessitates their measurement, scoring, etc., which, in their turn, require standardized units. Ebbinghaus gave one such unit—the nonsense syllable—which needs a little introduction. No doubt, words in a language are also discrete items which can be numbered or counted but the difficulty in the case of their learning under controlled
conditions, is that they have variable previous associations and connotations. For this reason, they are not of equal difficulty or value for different subjects. In requiring the subjects to study words, we cannot be too sure that all of them are starting from the same base. Words may have differential connotative and emotive loadings. Moreover, individuals may have their likes and dislikes for certain words. Ebbinghaus, therefore, wanted to eliminate these troublesome variations in meanings, etc., so that he could study the laws of 'pure' or 'raw' learning uncontaminated by earlier language habits. He thought that his invention of nonsense syllable provided such standard verbal materials in equal units, of the same difficulty.

A nonsense syllable is prepared by placing a consonant on either side of a vowel as in DIB, JAL., etc. Considerable research has been done/is being done with the help of nonsense syllables. It was, however, soon realized that nonsense syllables do make some sense to some persons. In other words, they also have meaning. A nonsense syllable BIS, for instance, may mean biscuit to someone. These considerations, however, do not detract the value of the original discovery of nonsense syllable by Ebbinghaus.

If verbal units suggest associations and do possess meanings, why not measure and quantify them? It is wrong to classify verbal items as either meaningful or meaningless. Meaning, association value are matters of degrees. Verbal elements may have more or less of them. Subsequently, attempts have been made to compute association values, meaningfulness and other characteristics like pronounceability, frequency of occurrence in language, of verbal items including words. In recent work along with the classical nonsense syllables, these other kinds of standardized materials are increasingly being used. In addition, other meaningful (poems, prose passages) and meaningless (CCC trigrams, disyllables, nonsense figures) materials have been in use with greater emphasis on standardization, as of late. CCC trigram consists of three consonants in a row as GJF; gokem, tarup are examples of disyllables which are also called paralogs. Ebbinghaus and many early inventive memory psychologists have handed down some experimental methods for the study of memory which are in no way inferior to other procedures in scientific excellence and definiteness. These procedural matters are now our immediate concern. Some more common procedures of presenting verbal stimulus materials follow:

**METHOD**

It has long been recognized that there is so much of science in a discipline as there is mathematics in it. Whatever the present state of imperfection of this science of human learning and memory, its founding fathers-inventive Ebbinghaus and other early, innovative memory psychologists have given it a good quantitative orientation and start in their methods of studying memory which may be held as models of possible scientific excellence in
Learning Time Method

The term "Learning Time" is often used in educational contexts to refer to the duration of time allocated to the learning process. This concept is crucial in understanding how effective learning can be achieved. The Learning Time Method is a structured approach to enhance learning efficiency. It involves setting specific time frames for learning activities, ensuring that each session is dedicated to a particular topic or set of objectives. This method helps in maintaining focus and maximizing the absorption of information.

In the context of the Learning Time Method, it is important to consider factors such as the learner's background, the complexity of the subject matter, and the learning style. By dedicating specific time periods to learning, one can ensure that the content is thoroughly absorbed, and any questions or doubts are addressed in a timely manner. This approach is particularly useful in disciplines where comprehensive understanding is required, such as science, mathematics, and foreign languages.

In conclusion, the Learning Time Method is a valuable tool for improving the efficacy of learning. By allocating dedicated time slots for study, learners can enhance their comprehension and retention of material, leading to better academic performance and a deeper understanding of the subject matter.
cally shown the item which gives him additional practice. In case he says something, the next exposure confirms or corrects him. To put it differently, in serial learning, the subject must keep one step ahead i.e. while he is being given No. 1 member, he has to reproduce the No. 2 member. Similarly, he is to remember and report the third unit when he is being shown the second and so on. In this way, trials are repeated till a specified level of mastery (like one errorless recitation) is attained.

It is said that each element of the series is both a stimulus (as it cues the subject to anticipate the succeeding unit) and a response (as it is reproduced while seeing the preceding one). However, recently this interpretation of serial learning is being questioned and the issue as to what exactly is the stimulus in serial learning appears to be quite complicated.

**Paired-Associate Learning**

Often we learn and remember things in pairs e.g. foreign words and their equivalents in our own language. Similarly, the shopkeeper knows and recalls the various articles in his shop together with their prices. Pairs of diverse elements make a typical experimental paired-associates lesson and the subject's task is to learn to relate the two elements to each other for every pair. Generally, in this method nonsense syllables, words or words and numbers etc. are shown in pairs and the specific task is to connect or associate the two members of the pair together. In the first trial, all pairs constituting the lesson are presented. From the second trial onwards, only the first member, the stimulus (S) member of each pair appears on the memory drum and the subject's task is to reproduce the second, the response (R) member within the given interval. In short, the subject has to learn all the S-R associations, so that on presentation of any stimulus member from the series, he must be able to respond with its appropriate R-member. Far or near associations among individual members or their associations with definite positions in the series are eliminated; main interest is in connection between members of a pair. For this reason, pairs are not presented in the same order in successive trials. A different random order is used for each trial. If a fixed or constant order were used the subject may try to recall the response members on the basis of their position in the series and may not at all connect to their respective stimulus terms. In effect, the subject would be following the serial learning procedure and not paired-associates method in which it is necessary to vary the order of pairs from trial to trial.

In the paired-associates procedure, besides memory drum, simple cards or projectors may also be used as presentation devices. Materials for presentation (through the memory drum) have to be prepared and displayed in a special way: First only the stimulus term shows through the window of the memory drum, all by itself and then follows the complete pair of the stimulus and response units. The subject must produce the response term while the stimulus term is being shown alone within the standard time interval after which the memory drum moves to the paired stimulus-response
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In words and their r knows and re- their prices. Pairs of dicates lesson and s to each other for words or words t is to connect or first trial all pairs for trial onwards, only for what appears on the second, the response has to learn all stimulus member from complete R-member. Far associations with ast is in connection presented in the utterer is used for each may try to recall the series and may not as the subject would associates method material to trial.

Uniform or Random Order of Presentation

Very early in the planning of a study, the experimenter has to take a general procedural decision as to whether he is going to present the list items in a constant, uniform or random, variable order. In the former case, the same sequence of items persists from trial to trial; in the latter, the order is randomly changed. Learning processes differ significantly in the two types of stimulus presentation. With uniform order of items, associations of different strengths are formed between them and also between the items and definite positions in the series. If presentation follows random order subject's primary concern is learning of the items themselves. Uniform order of presentation goes with serial anticipation while random order of presentation is suitable for paired-associate learning.

Free Learning or Free Recall

Words from a list usually exceeding normal remembering ability are presented, one by one, each for a short time and the subject is asked to write down as many of them as he can remember, in any order. The distinguishing feature of this method is the freedom to reproduce the stimuli in any order the subject wishes.

Free learning is perhaps the easiest learning task. Score is the number of items correctly recalled. More than one trial on the same series with different orders of words may be used to study the course of improvement in free recall learning. Almost any mode (visual or oral and memory drum, tape recorder or any other device) of stimulus presentation may be employed.

Common practice is to give the verbal stimuli in a sequence, one following the other, however, in some situations the method of complete presentation is also recommended. The subject is given the whole series or the entire lesson and he is permitted to study it at his own rate. Typically, time allowed is a minute or so, but within this time-limit, there is no other constraint on subject's learning behaviour. Afterwards he is asked to reproduce as many members as possible. In olden days, free recall method was more commonly called the method of retained members.

The method of complete presentation is somewhat defective in that it has little control over the study time allotted to individual items: the subject may devote more time to some items and 'jump over' others. This creates difficulties in the way of interpreting results. For instance, we cannot draw any firm conclusions regarding the relative difficulty of items within the list as learning is importantly determined by study time.
The chief merits of this method are that it very much resembles the rather unspecified class-room learning and testing and is applicable to different kinds of materials—meaningful materials like prose passages, words, nonsense syllables, etc. Free learning is widely used in recent experiments in studying the influence of organizational factors in memory.

Some have contended that although this has been called the method of retained members, actually it does not measure retention but only recall. For, sometimes there is retention of an item although it is not recalled at a given moment. Its recall at some later time proves its retention during the interval.

This method has been called by various names. Multiplicity of names (free learning, free recall, method of complete presentation, method of retained members) resulting from different emphases or minor procedural variations need not confuse the beginner. Essentially they are one and the same.

**IMMEDIATE MEMORY SPAN**

Measurement of memory span is the experimenter’s answer to the question “how much material can an individual comprehend and reproduce without any error after one hearing?” To find out how long a series of numbers (digits) the subject can recall errorlessly after one presentation, in other words, to measure the memory span for digits (numbers), the experimenter prepares strings of random numbers of increasing lengths, say, from 4 to about 11 or 12. He then calls these numbers one by one and asks the subject to immediately say them over again in the same order. Starting from the short number sequences, he proceeds to the longer ones in an attempt to test the limits of subject’s ability. The immediate memory span is measured by the longest list which the subject can recall without any error. Had the subject cleared all the sequences as far as and including, say, 7 numbers and always failed whenever taken beyond that limit, his immediate memory span for digits would have been 7. It may, however, happen that a subject might perfectly recite a relatively longer sequence but may fail on a shorter one. To guard against such irregularities the subject is given more than one list (usually three) of each length and his average span is calculated on the basis of some acceptable statistical procedure.

Following simple method may be used in computing digitspan. Suppose three sequences of each length are given with 3/4 credit for any errorlessly reproduced list. Imagine a subject perfectly recalling all lists up to and including 5 numbers. We, therefore, give him credit of 5 as a base value. Assume further that he performs correctly on two out of three six digit lists: does not succeed on any of the 7 digit series and that once again and once only, has success with 8 and never thereafter. In such a case, his final score in the immediate memory span test (digits) would be $5 + \frac{3}{4} + 0 + \frac{1}{4} = 6$.

Like the threshold, immediate memory span can also be determined by methods of psychophysics e.g. the method of constant stimuli.
Serial learning is mainly studied through anticipation method and hence it was mentioned there as well. After a few serial presentations (usually one or two) of the entire list, the subject tries to tell the next item before hand. If he delays or shows indecision, he is immediately and swiftly promoted or else he may either say the right or wrong element in which case also he is quickly corroborated or corrected. Thus, each trial serves dual function of a practice trial and of a test of retention. In this manner, the series is run through several trials until the subject correctly anticipates all items without any prompting.

Anticipation procedure is an improvement over the learning time method in that it enables us to determine when exactly the list is learned as also to map more accurately the detailed course of learning. We may study how the learning of the whole lesson is advancing as also how its each individual unit is faring. An item is correctly recalled on trial 3. Will it be correctly reproduced on all subsequent trials? How secure and stable is the learning of individual items? If there are any ups and downs in remembering behaviour (behavioural oscillations), what is their nature? Which positions in the whole series are easily mastered and which others offer greater difficulty? How much improvement accrues from a trial in the initial or final stages of learning? The method of anticipation enables us to investigate some of these interesting questions. Memory drum is especially suitable for presentation of verbal stimuli according to anticipation method. Total time or trials, the number of errors committed or prompts required in attaining the standard of mastery are some of the possible scores of this method.

The Anticipation Method

Retention, as we shall have occasion to see later, cannot be directly gauged. It has to be approached only indirectly through saving, recall, recognition and such other methods.

Suppose, initially a lesson is learned to a criterion in ten trials. After twenty four hours, it is relearned to the same level in five trials. Quite obviously there is a net saving of five or 50 per cent trials. The difference between the first learning trials and the relearning trials is saving. Per cent saving is computed by dividing the net difference by the number of initial learning trials and multiplying by 100. We should expect variations in per cent saving if original learning and relearning are scored in other units such as time or errors.

Some further refinements appear to be indicated: relearning measures should be properly compared not with the original learning scores but with current learning values on an equivalent task because in the retention interval, the person might have actually become a better learner-a more practised learner through what has been called learning-to-learn. The stipulation that initial learning and relearning should not be on the same task becomes
quite imperative when circumstances of successive learnings vary significantly through the action of some independent variable. Imagine one is interested in finding how much of a lesson learned under the influence of a drug is retained after a specified interval. Simply comparing learning and relearning measures may not suffice. A more efficient strategy might be to require a person now to learn a different but equivalent lesson and to subtract the relearning values from the learning scores made on the new matched task. The difference so computed will enable us to settle, with greater confidence and validity, the issue 'how much is saved on account of previous learning, in comparison with current learning of an equivalent lesson?'

Recall Method

Recall is reproducing earlier learned reactions. It is the most frequently used test of retention. If a subject learns a list of 12 nonsense syllables to a criterion of one perfect recital and can produce six of them the next day on a recall test, his recall score is six items or 50 per cent. In this method, the experimenter asks the subject to speak or write all items of a previously learned lesson which he remembers. The number of correct responses is the recall score which is also the most common index of retention.

We try to recall matter from books, notes, lectures, etc., while writing answers in the essay type of examination.

Recognition Method

In relearning and recall, the subject is required to produce the stimuli. Recognition test does not call for any such production. The subject merely identifies the stimulus as having been reacted to before. For example, we start with a serial learning task in which 15 words are shown one by one. Next, these correct words (previously learned) are randomly put along with 15 new words and all of them are exposed one at a time, asking the subject to pick out the ones which he recognizes as being the old items, present in the learning list.

The easiest way of scoring is to compute the total number of correct recognitions. However, there are difficulties about this. Such a simple measure would have been alright had the subject never wrongly identified any of the new items. But, in fact, he often recognizes falsely (as sometimes we 'greet' perfect strangers as old friends and feel embarrassed afterwards) for which he must be made to lose points. This is done by subtracting the percent of items falsely recognized from the percent of correct recognitions. Right-wrong yields a better score.

Such an adjustment is necessary because it may happen that a subject is right by chance although he does not know for certain that the word did occur in the previous learning list. All the same he gets credit for recognition which is not his due. In other words, there is scope for guessing in recognition test and some allowance for this has to be made to obtain true
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The main interest here is not in the verbal units (the subject does not have to produce them but they are handed over to him) but in the production of the original serial order or of any order or arrangement, for that matter. Suppose a subject has learned a set of verbal units in a definite sequence. After some time he is given the items and asked to arrange them in accordance with the original order. Interest lies in seeing if specific associations are followed. Several scores are possible e.g. a simple count of the number of items placed in their proper positions; each attempt to reproduce the original arrangement may be regarded as a trial and the number of such trials required to reach a perfect reconstruction are some of the various measures.

This method can be used not only with verbal units but also with physical objects, patches of colours, forms, etc.

A CRITICAL NOTE ON MEANING

Whenever social scientists consider any academic issue like, say, 'the determinants of social status', their discussion again and again veers round some basic definitional problems such as the meaning of status. Somebody then tries to distinguish not with any conspicuous success, statuses from roles and positions (close associates). Another thinker suggests that status can be understood only in terms of the interrelations involved in the processes of production—ownership of means of production, ownership of surpluses that are generated etc.—all the associations of the Marxian model come rushing in. Then somebody, probably with a sociological background, reminds that ritual status is different from status which is dependent upon wealth and power or authority. Ritual status is again dependent not only upon personal cleanliness but on ideas of purity of blood, which is really its status, family and kinship considerations and so on—the way is opened for the entire sociological context, thought and idiom.
If as Bartlett has suggested "It is fitting to speak of every human cognitive reaction, perceiving, imagining, thinking, reasoning as an effort after meaning" it is even more proper to say that every meaning quest is carried out through associations, chains of associations and associative net-works.

In a sense, the most elementary form of verbal learning may be said to consist of the process of attaching a name to an object as in Gagne's well known example where a youngster is shown a triangular object and is told it is a tetrahedron. Under proper conditions, on later seeing the three-dimensional thing, second time, the child will call it a tetrahedron. At this basic level of naming or labelling, verbal learning is learning of meanings.

**Meaning and Meaningfulness**

Although everyone agrees that meaning is the single most important factor influencing verbal learning, no one seems to know anything definite about it. Almost every attempt to define the meaning of meaning starts with the proposition that the word is used in diverse senses. It is a definite understatement to suggest that 'there are at least as many meanings of meaning as there are disciplines which deal with language' because, students of each subject do not always agree upon the precise definition of meaning. Obviously there are a great many different aspects or components of meaning.

It is often so difficult to find a generally acceptable use of the word 'meaning' that individual seekers are driven, in despair, to a purely personal view of meaning. 'What anything means depends on who means it'. In this sense, meaningfulness of material is an individual affair related to the particular associations of the subject. Meaning as intention or purpose may be subsumed under this personal view of meaning. Meaning referring to an intended event is illustrated by such statement as 'mark his expression; he definitely means harm to you'. We may reinterpret the words as wilful injury is their strong associate.

Still within the general associative framework, meaning refers to use of a sign or token of some event or occurrence. Meaning in this sense of index, pointer or symptom, is illustrated by 'falling mercury in the barometer means rain' or 'full moon means a big tide'. Similarly, in Pavlovian conditioning, as popularly stated, the bell means food. In examples of this sort, the proposition that one kind of phenomenon $x$ means another type of phenomenon $y$ amounts to saying that $y$ is often or invariably associated with $x$. In the above given example, Pavlov even explicitly stated that there is an associative linking or typing up of the apparent effects of bell and food in the cortex. Pavlov speaks of conditioned stimulus as a "sign", "signal" or "symbol". This leads to meaning as whatever is referred to, signified or expressed by words or other signs. Meaning in this sense is whatever is represented by symbols; words have meanings in virtue of their representing things.

One of the most important manifestations of meaning is the sign—significant relation—the use and function of symbols. The symbol is thus under-
stood as a sign of what it stands for. These signs or symbols may be single words or more complex expressions like sentences or other signalling devices. Commonly, the meaning of a sign is whatever it is intended or agreed to refer to or signify, express or indicate. Complex sentences or passages comprising many sentences, may be the conveyer of diverse meaning such as:

(i) cognitive meaning i.e. communication of (true or false) information as conveyed by propositions of empirical sciences e.g. ‘with constant practice more items are recognized than recalled’; (ii) directive meaning, i.e. carrier of order or request e.g. Thou shalt not kill; (iii) emotive meaning, i.e. indication or arousal (not description) of emotion, emotional mood or emotional attitudes. Purely emotive words stand for nothing, have no symbolic function. They have only an emotive use, serving only as emotive signs, expressing our aroused emotional attitudes and exciting similar emotional states in other persons and perhaps, inciting them to appropriate actions. The concept of emotive meaning has its most important application in reference to what are called values. ‘Worth predicates appear as funded affective-volitional meanings.’ The word ‘beautiful’ has a strong emotional significance and definitely leaves a trail of affective meaning; (iv) a communication may carry all these and other kinds of meaning, as does, for example, the speech of a popular leader or journalistic writing. Often, the meaning of an expression is a function of and changes with the conditions under which it is uttered and the mental make up of the persons who speak and listen to it. The most serious remark, made by a person who is popularly known as a comic writer and orator, may provoke laughter. Meaning in such broad sense is discussed under pragmatics—a division of semiotics which is a general theory of signs.

However, for certain important purpose of logical discourse, linguistics including preparation of dictionaries etc., it is convenient to stick to a purely semantical conception of meaning which eliminates all reference to the users of symbols and exclusively interprets the meaning of an expression, as some object, attribute or other entity signified by that expression. Semantical meaning applies to the relation of signs to their significates.

Most writers have distinguished between two kinds of semantical meaning: reference or denotation (explicit identification of the referent) and sense or connotation (intention, attribute) or the denotative and connotative meanings. As the logicians commonly say, a word denotes an object and connotes an attribute. The denotative meaning of a term is that to which the word points. Connotative meaning refers to the attributes.

Recently along with logicians, philosophers and linguists, psychologists have started taking more and more interest in the problems of meaning. During the past two decades, they have written more about meaning and meaningfulness than during the preceding 70 years. It is now commonly conceded that, meaning and change in meaning, whether it is called ‘attitude’ or ‘value’, importantly determine human activity.
In the specific psychological context, mention may be made of Tichener's context theory of meaning. Psychologically, it is said, meaning is context. Core experiences-sensations and images-acquire meaning by way of contextual associations.

In perception, or groups of sensations and images, "the associated images form as it were a context or 'fringe' which holds together the whole and gives it a definite meaning" and it is "this fringe of meaning that makes the sensations not mere sensations but symbols of a physical object." Thus, when we get certain sensations of orange colour and brightness, the contextual smell and taste images are also aroused and these enable us to 'place' or 'recognize' the object i.e. give the meaning of a juicy fruit of orange to our visual sensations. According to Tichener, perceptions have meaning; not sensations. As Boring has said, "It takes two mental processes to make a meaning. When a sensation or image is added to a sensation or image, one has a meaning in the form of a perception or an idea".

A number of psychologists simply considered associations-multiple associations, differential associations-as being of especial importance in mental organization. Some of them tried to control and neutralize the previously formed connections; (Ebbinghaus) and others with their peculiar bent for measurement, attempted to number and scale the associations and association values (Glaze 1928, Hull 1933, and others). Eventually, psychologists became interested in the problem of measurement of meaning.

So far as experimental psychologists were concerned, the work of Glaze with all its methodological weaknesses and short-comings, marked crossroads and a turning point. Calibration and indexing of meaning/meaningfulness became an experimental necessity for the discovery of quantitative laws concerning verbal learning and memory. By and large, psychologists chose to steer clear of the profoundities and perplexities of the philosophical problems of meaning and more humbly, concentrated on meaningfulness in terms of its defining operations, an excellent summary of which is given by Underwood and Schulz (1960).

One of the better-controlled attempts in this direction was that of C.E. Noble (1952). Assuming that meaning is a peculiar relation between terms and emphasizing the connotative rather than the denotative properties of meaning, so that, a word with many connotations is more meaningful than one having few, he asserted that the logical relation of signification is coordinated with the psychological process of association. Meaning, or better, meaningfulness (which is symbolized by m) is measured by number of associations.

Noble (1952) preferred to define meaningfulness (m) as the number of associates which a verbal item elicits in some standard interval of time (60 seconds). Meaning/meaningfulness is interpreted simply by counting the number of associations-associative links or habit-bonds (following Hull) with no thought for their content, depth or intensity. The defining characteristic is number—sheer frequency of associations-without any consideration as to what the associations are.
There have been always persistent, strong and altogether understandable inhibitions against accepting sheer number as definitive of meaning/meaningfulness.

High reliability (over .96) is claimed for this M-Scale; but, how about its validity? Operational definitions and exigencies of experimentation are all right but cognitive-conceptual analyses cannot be really kept out for long. It is not all frivolity to question by way of criticism of Noble's views "if jelly, jewel and heaven have the same M-scores, do they have the same meaning?" Associations are personal and transitory depending upon the contingencies of experience; can they validly index and exhaust meaning which must be comparable across different individuals and situations.

Osgood (1953) was concerned with meaning and its measurement rather than with meaningfulness and its index. He analysed meaning of concepts into multiple dimensions in semantic space with a certain primacy for its affective property (the intensity factor). Osgood takes recourse to a different measurement procedure called the semantic differential (SD) where a concept or word is thought of as a determinate point in tridimensional semantic space and is describable by some minimum number of attributes (evaluative, potency and activity factors). Osgood's semantic differential rating scale, attempts to obtain a measure of the meaning of concepts. The assumption underlying this scaling procedure is that, the meaning of an object for a person includes not only the more obvious denotative meaning which he can readily state but also more subtle connotative meanings which he can less easily describe. To estimate these significant connotative meanings an indirect procedure is adopted, in which, an individual assigns to any word, say kitchen, a number of scale values along 20 bipolar adjectives like good-bad, strong-weak, active-passive, etc. The meaning of the concept for an individual is the pattern of his scores on these different, adjectival, seven-point, rating scales. The SD scale might be regarded as a special case of constrained or controlled associations, in as much as, the subject is asked to judge to what extent a given concept, say, a University teacher, can be correlated with positions on specified bipolar scales. Thus, if Noble used free associations, Osgood used controlled associations for the purpose of calibration of meaning.

Semantic differential scale has not gone unchallenged; from Noble's side the compliment has been returned that if mother and music have the same SD profile, does it signify their essential identity of meaning? The general criticism is that what the semantic differential measures is not meaning, but, basically, the emotive influence of words. Osgood may concede this point but may insist that evaluative or affective meaning is a highly significant feature of verbal materials and verbal behaviour. All these attempts at measurement of meaning are quite reliable and useful as they were intended to be. The dimensions identified in these procedures are truly found to determine diverse relationships in learning and remembering of verbal materials. More of this, however, will be considered later.