RECOGNITION AND RECALL

THE influence of a perceptual stimulus in facilitating the process of imaginative reproduction is matter of common observation. It is often of great practical importance, since an act of recall which completely failed when approached through central association may thus be effectively aroused and carried through. The name which can not, by the greatest racking of memory, be brought back to consciousness is thus uttered spontaneously and without hesitation when the bearer is again met face to face. The same name, when it has thus escaped memory, may be instantly recognized and identified with certainty the moment it is uttered by another. So pronounced is the independence of these two processes that there may be habitual recognition of classes of impressions which are apparently irrecoverable as mental images in the type of mind to which a given individual belongs. One who is incapable of calling up any distinct visual imagery recognizes without hesitation the objects and persons of his surroundings; one who can not carry a single tune in his head need have no difficulty in identifying an air when it is heard again.

The supplemental processes through which any element of a previous content of consciousness is appropriated and identified may be aroused through either central or peripheral connections. Stimulation of the latter type is, of course, much more likely to be effective than that of the former. When one has failed to recall a given fact even after all the remembered associations have been passed in review as possible cues, the desired connections are likely to shoot home if some element of the original situation is actually re-presented instead of merely reviewed in imagination. The sight of the common friend who made the introduction may help one to a name which resisted recall even when the personality of the introducer was invoked in memory to aid the process. The occurrence of an associate of a given conscious context in the form of an original sense presentation so far surpasses the efficiency of voluntary imaginative recall in breaking down the inner resistance which exists in such cases as to place it in a separate class from the latter.

The general nature of the supplemental process may, for our purpose, be regarded as the same in the two cases. In both the sense of familiarity is aroused in connection with the conscious content in question; its appropriation may take place with equal sense of security in the two instances; and its identification consists always in the establishment of certain thought-of connections which give it a definite place in the web of past experience. But the arousal of these processes takes place in very different ways in the two cases, and it

may become a matter of importance to determine quantitatively the efficiency of the two forms of stimulus, central and peripheral, in giving rise to those associated activities upon which these mental functions depend. To this end the writer had made under his direction a series of observations concerning the relations of recall and recognition which were carried on during some four weeks, but the results of which can be regarded merely as a preliminary report having no final value so far as its quantitative features are concerned. The record, nevertheless, seems justified as a suggestion concerning, and contribution towards, any more systematic investigation of the matter which may elsewhere be undertaken.

The experiment consisted in the presentation of a series of ten words, as many as possible of which the observer was afterwards called upon to reproduce through voluntary recall, in the one case; or, in the other, to identify when re-presented as part of a larger group. Two observers took part in the investigation. The materials were presented in two forms, first as a visual and second as an auditory content. In the former case ten monosyllabic words were simultaneously exposed for a period of ten seconds, after which the observer wrote down all he could recall of the series within a minute's time. For the recognition test, after a similar exposure the ten words were mixed with an equal number of other monosyllables and the whole group was then presented to the observer, who indicated all those which he could satisfactorily identify as having formed part of the original series. On account of the time involved in this second arrangement of material twenty seconds were uniformly allowed to elapse between the close of the first presentation and the beginning of the process of recall or identification. In the auditory series ten words were read out at the rate of one a second, and reproduced as before in the case of recall, or identified in a series of twenty which included the original ten and was read aloud slowly by the conductor of the experiment.

An obvious comment upon the conditions of experimentation as thus described concerns the apparent disparity of alternatives in the two cases of recall and recognition respectively, and the influence of this factor upon the results. In the former case the series of possible choices is limited only by the whole number of monosyllabic words which might occur to the mind of the observer within the given time, and is therefore indefinitely great. In the latter case, on the other hand, it is known from the outset that the entire series of ten words is comprised within a total group of twenty; in consequence of which fifty per cent. of correct judgments are in the long run to be expected even when the selections are determined by chance. It might appear, therefore, that in interpreting the latter results the

presence of a large constant error due to this factor must be taken into account. Such would be the case if the observer were required each time to select ten words out of the given twenty; it would, indeed, be necessary to consider it if he were found habitually or frequently completing a series of ten in his identifications. But not only was the subject not required to select ten words under these conditions; he was also cautioned to indicate only those words of which his identification was reasonably certain. He knew, to be sure, that somewhere within the group of twenty words the whole original series was to be found, but as the problem in the case of each word as it came under consideration was the simple one whether or not it could be recognized as part of the original series, this knowledge would affect his judgment at most only as an obscure disposition to cast the benefit of doubt in favor of, rather than against, identification. The observers themselves were unaware of the presence of this prejudicial element in their judgments, and it is safe to say that the percentages here given represent with reasonable accuracy the proportion of actual identifications in recognition as well as in recall.

The results of the tests can be stated in a few words. Those in the visual series are given in the first table below; those in the auditory follow in the second. All the quantities are in terms of percentages of correct judgments, and represent the average of the series of individual tests.

TABLE I.

Observer.	Recall.	Recognition.
A	54.3 per cent.	69.7 per cent.
B	59.5	84.3
Average	56.9	77.0

TABLE II.

Observe	Recall.	Recognition.
A	50.0 per cent.	74.0 per cent.
B	57.0	74.3
Average	53.5	74.15

The individual observers present different levels of accomplishment, *B* making the higher, *A* the lower, percentage throughout the whole series of variations. The average number of correct judgments is greater in the visual series in both recall and recognition. The difference in the number of correct judgments made in recall and recognition respectively, all cases included, is 20.37 per cent., an average which is composed of two practically identical constituents, namely, 20.1 per cent. in the visual, and 20.65 per cent. in the auditory series. Roughly, then, where a little over one half the orig-

inal matter was reproduced through voluntary recall, three quarters were recognized when represented as part of a larger context. This difference is probably decidedly less than would have been predicted by most persons, and there is, of course, reason in ordinary cases to believe that out of the whole series of instances in which one's memory is at fault concerning a name, date or the like, recognition would unhesitatingly take place in a much larger majority of cases than this were the number or term actually furnished to its seeker. But these are cases in which the whole system of connections which the name has had in our experience is well defined and persistent, only for the time being it is dormant. Like a trigger which hangs fire, the associate linking the present thought with the desired context fails to complete the connection. But this inward resistance once broken down, we *know* that the mind would be flooded with a wave of instant recognition and appropriation.

Under the conditions here in question, on the contrary, the terms to be recalled or recognized have no such mooring in the mind. They are presented under conditions of time and association which, except in accidental cases, allow no fixed connections to be formed. The general character of the processes involved, as well as the quantitative value of the difference presented by recall and recognition under the conditions obtaining during the present experiment, indicates a dependence upon other determinants than those which differentiate these functions in their relation to well-known terms which have been forgotten. Instead of persistent connections which have for the present been blocked, it is probable that here the quantitative difference between recognition and recall is related to phases of waning in a system of after-effects of the original impression which has had a continuous existence during the intervening period, but is on the way to an early extinction from which subsequent revival will be impossible. A certain violence or duration in an impression appears necessary in order that any permanent record of it shall be made in memory. Of the multitude of faint and evanescent stimuli which do not leave any such persistent trace it is to be observed, as various writers have pointed out, that if attention be not turned to their character until after the stimulus has been removed, it is still possible during a subsequent period, which is, indeed, commonly very short, to catch their echo, as it were, still reverberating in consciousness; but that if a greater delay occur before the attempt is made the form of the impression will be found to have been lost beyond recall.

The indications are that in the investigation here reported the results are dependent upon the stages of fading presented by an elementary memory of this sort. In its relation to the content repro-

duced in the process of recall the original material comprises three classes of data—first, words correctly reported; second, those not recalled at all; and third, words not correctly reproduced but represented by substitutes resembling those originally given, as 'sot' for 'sit,' 'fad' for 'pad,' 'hug' for 'mug,' and the like. The proportion of such errors nearly equals the difference between the percentages of words correctly reproduced through voluntary recall and words recognized upon re-presentation. The fact that the total number of words set down, including both perfect and approximate reproduction, thus roughly equals the proportion which the observer is able to identify amid a larger group suggests the inference that of the whole series of impressions received under the given conditions —some 25 per cent.—are already 'dead,' in the sense that they can neither be voluntarily reproduced, nor even identified upon representation, while of the remainder a certain proportion, though beyond the reach of direct associative recall, are still 'viable,' capable of arousing the supplementary processes of recognition on the renewal of the sensory impression. If this be so, the proportion of words correctly and incorrectly recalled and of those recognized would be a function of the temporal phase presented at the moment by these disappearing after-effects, and not a true phenomenon of memory. It would, therefore, be impossible to apply the results, without verification, to subsequent processes of reproduction proper in their relation to recognition. There remains the question of the period during which the excitability due to the original impression persists in such cases. The rapid initial decline in the memory content described in the classic investigations of Ebbinghaus is perhaps a reflection of this process of fading, and in its curve indicates its temporal progress. As the bulk of recorded experiments on memory and association depend upon reports made within the probable limits of this dissolution process, it is to be considered whether the formulæ which they have afforded—the laws of recency and primacy, for example—do not need revision before they can safely be applied to the more permanent content of associative memory.

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DEFINITIONS OF INTENSITY

IN this paper I investigate the meaning of intensity (intensive quantity or magnitude) as a scientific category; that is, intensity as used in psychology and physical sciences. Most of the definitions hitherto given seem obscure, even contradictory. For instance, one authority says intensities are in no sense measurable; another that