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A Comparison of Recognition
And Recall in Different
Sense Department

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A COMPARISON OF RECOGNITION AND RECALL
IN DIFFERENT SENSE DEPARTMENTS

By
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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Arts

in Psychology

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HEAD OF DEPARTMENT OF Psychology
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A COMPARISON OF RECOGNITION AND RECALL IN DIFFERENT SENSE DEPARTMENTS.

I. INTRODUCTORY

The psychology of memory has now several considerations to offer which tend to separate recognition and recall as more different in both structure and function than is usually held. It is a common observation now that it is easier to recognize than to recall; that a thing that cannot be recalled at all in terms of imagery may still be quite easily recognized when seen or heard again. The determination of how much recognition exceeds recall in this sense, if it can be measured, is partly the problem of this experiment. In the sense departments of smell and vision for instance, recognition is much higher than recall. Also things seen are better recalled than things smelled. Can we expect then that recognition exceeds in one sense as well as in another? It has not been very long a generally accepted fact that in recognizing a stimulus no imagery of its previous presentation need be present as a part of the memory process. This form of recognition demonstrates the existence of a form of memory in which free imagery does not occur. It has made possible the re-interpretation of animal consciousness in a most fundamental way. The phenomenon of learning in animals has seemed to many, perhaps most, to require the existence of some sort of recognition of past experience. But it no longer required the assumption of free imagery, and it makes recognition without free imagery the more fundamental form of memory; one with which a recall process need not necessarily be
It used to be assumed that recognition always implied imagery, but this is not necessarily the case. Here we are dealing with a distinct type of mind, one which can only deal with stimulus present at the moment. From these facts and interpretations a number of problems arise. We may name as just the problem of the more accurate determination of the quantitative relation in general between recall and recognition, how much more can be recognized than can be recalled in terms of free imagery? Second is the question of the relation of this quantitative difference for the different sense departments. Is the difference between the amount that can be recalled and the amount that can be recognized the same for all sense departments? From the biological interpretation of memory just suggested it might be supposed that this would not be the case. But also from individual development and experience it is conceivable that we would have less use for free imagery in one sense department than we would have in another. For instance, we are familiar with the meagreness of olfactory imagery as compared with visual imagery. Do we expect that the recognition of odors is in equal degree behindhand when compared with the recognition of visual stimuli? To these we add a third problem, that of the introspective analysis of the mental processes involved in recall and recognition in the different sense departments and in the recall and recognition of different kinds of material in the same sense departments. This last is of special interest from the standpoint of methods that have been used in different memory investigations. For instance if the figures of this investigation were taken without the subjects making careful introspections throughout the procedure, we could not determine to
any great extent what the mental processes were from the figures alone. It is naturally assumed that we recall things heard in terms of auditory images only. Introspections show that auditory recall is a very slight factor in such recall. In the same way differences between the mental processes used in familiar words to be recalled and recognized and unfamiliar nonsense syllables ought not be inferred without introspection. Perhaps the most important part of this investigation is in the interpretation of mental processes by introspections and the corresponding application of these interpretations to the results found.
II. RECOGNITIVE CONSCIOUSNESS.

a. General Definition.

When the ideas of certain objects and processes of the outside world appear in consciousness, they have attaching to them a mark or sign of familiarity. This sign has been called the local sign, very similar to localizing cutaneous impressions or visual impressions in that nature of familiarity. So the problem of recognition is similar to that of localization, where in each case, a particular idea or group of ideas which differ from others in the fact that it is marked or qualified in a particular way. The mark is a conscious process or group of processes, and the business of the psychologist, in each case, is to analyse and reconstruct it.

The characteristics of recognition might be well illustrated and brought out by an example. Let it be the visual perception of a word written on a paper before you. This visual perception is supplemented by a number of centrally aroused processes. As soon as the stimulus is received other and central processes come with it.

Wundt distinguishes direct and mediate recognition. For him direct recognition consists of a fusion of the perceptive process and the image of the stimulus in question as perceived before. Mediate recognition consists of this fusion plus ideas of circumstance in which the stimulus was formerly perceived.

Titchener carries out the distinction of different forms of recognition a little further. He notes that from one point of

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vision recognition may be definite or indefinite. It is indefinite when the only supplement of the given idea is the word "familiar." We may pass some one on the street and recognize the face but not the name. Less indefinite are those cases of recognition in which the presented idea calls up a general classificatory term, for instance the recognition of a person by his occupation at the moment, or the clothes he wears which bear out his probable vocation. On the other hand recognition may be definite when the supplementary ideas may be so numerous that the given idea calls up quite definite situations and incidents in our past experience. When we classify recognitions as definite and indefinite, we are thinking of them as already completed. From another point of view recognition may be classified as direct or as mediate as Wundt has done.

The difference between recognition and recall is plainly stated. The recognition of an idea comes through the means of the second stimulus which must be present for recognition. The recalling of an idea is without the presence of this second stimulus and is centrally aroused.

b. Analysis of Recognitive Consciousness.

In the analysis of recognitive consciousness several phases are brought to light. It was mentioned that the visual perception of the word was supplemented by other centrally aroused ideas. At the same time that this association is being formed, still other elements enter. These contain, beside the pleasantness of familiarity, a complex of organic sensations. Then all these factors unite in giving us a "recognition." Every recognitive experience is pleasant, although its pleasantness may be outweighed by the
unpleasantness of the recognized idea.

Hoffding in discussing direct recognition and its relation to associated ideas, says there is a clear and self-evident difference between the known and the strange. This quality characterizing the difference he calls "knownness." He ascribes to direct recognition there general qualities: (1) Any recognition is a complex, yet may be so simple as to enter into consciousness as a unit. (2) This direct recognition does not require any mental process or idea that precedes the phenomena. (3) Introspection does not reveal a trace of an idea that is aroused and through which recognition takes place. When a stimulus is received a second time, it enters consciousness more easily than it did the first. On the mental side, recognition is the correlate of the greater ease of reception of the stimulus the second time.

Lehmann and Hoffding hold two opposite theories concerning recognition. Lehmann contends that recognition is a case of association by similarity and is always of the indirect form. Hoffding objects to postulating this form of association, reducing all to association by contiguity, and contends that recognition may be direct as well as mediate. He took a series of grays and compared results in this way. If a constructed series of five grays, that number will be equal to the number of names for shades of grays—black, white, neutral, light and dark grays. In six and nine numbers, we have no names for the grays. We recognize more accurately in the five series because we have names to recall with the shade. In everyday life if we recall the name of a thing that means that we recognize it. In the series of nine

2. op. cit. p. 428. 3. op. cit. p. 198.
grays he arbitrarily associated some name with each gray numbering each gradation. With a number associated he recognized better than
without and association of a number.

In a second series of experiments Lehmann found that seven
per cent of 62 odors were recognized without association. If
these cases were genuine, his theory is disproven. The familiarity
generally is given immediately with the sensation. He throws off
these seven per cent because other observations show they are not
direct. (Sometimes the subject would call an odor familiar after
some time—it takes time to call up associations). A good number
of instances in which images were called up were evident. A person
would say imagery had no connection with the odor. Such things
indicate that familiarity of sensation goes with the sensation
that the odor arouses, and that in these cases in which the sensa-
tion is familiar but arouses no association, the familiarity is
connected with the association that remains below the threshold
of consciousness. The observer searches for association; if these
cannot be found at all, the sensation remains unfamiliar, but if
they are found, the sensation becomes hereby familiar. This ex-
planation is as possible a theory as Hoffding's theory of recogni-
tion. It has extra advantages and is based on experimental results.

Gamble and Calkins have taken up the Lehmann-Hoffding contro-
versy and have also performed experiments to test the point in dis-
pute. They conclude against Lehmann's theory although their re-
results are quite the same as Lehmann's. They note that recognition
without association does occur. That unfamiliar odors should never
be accompanied by right associated ideas, but the results do

1. Kritische und experimentelle Studien über das Wiedererkennen.

2. Vorstellung beim Wiedererkennen und beim
Ziel.
include such cases. For instance in their results, the cases of unknown odors give 36.5%, with right associations; 21.2%, with wrong; 42.3%, with no associations at all. The association with the name for the odor is of no particular help in recognition. Also, they conclude that recognition does not depend on associated ideas, because such accompanying ideas which are not only clear but correct occur with consciousness of unfamiliarity, because associations which are clear enough to be reproduced not always occur in those cases in which the subject noted the sequence they stated that the accompanying ideas followed the recognition. Lehmann did not make this discrimination.

They made another experiment to determine the influence of the name on the recognition of the second stimulus. They point out, or did Höffding, that Lehmann overlooked the possibility of the difficulty of holding a series in memory may increase in geometrical rather than arithmetical proportion with the increase of the length of the series. With reference to the experiment in which he associated a number with each gray of the series, Lehmann assumed that the association between the gray and the number had already been made. This may not have been so. They tried to arrange their experiment to overcome some of these difficulties of Lehmann. They had three kinds of series of stimuli, nine in each. The first was a series of grays, the second a series of blues and purples, the third a series of odors. Half of each were associated with names, the other half were not. The general introspection after the series confirms the conclusion that is to be drawn from their table of results. They conclude while associations of any sort

1. op. cit., p. 188. 3. op. cit., p. 168. 4. "Über die Bedeutung von Worterkennung für die Unterscheidung von Qualitäten sukzessiver Reize." Zeitsch. f. Psychol. u. Phys. de Sin. 33. 1905 p. 160
are an aid to recognition, the name of the stimulus is of no greater value than any other association. Here they agree in part with Lehmann, for he says all cognitive consciousness depends on association, and the name is a prerequisite. They say all associations are an aid but not necessarily a prerequisite, and the name is of no greater value than any other association.

We may turn over to a special consideration of the image and its function in cognitive consciousness. When we recognize a stimulus as one of a past experience, is an image of this stimulus as previously perceived included in the present recognition, and what is its function in this total memory consciousness? The foregoing discussion has implied that this image forms a part of the fusion complex that Höfding and Wundt call direct recognition or that it follows the perception of the stimulus and is then one of the association called up which make the recognition indirect or mediate. In several experiments the assumption of the presence of the image has been the means of explaining the decreasing accuracy of recognition with the increasing lapse of time. Thus Lehmann explains such results of an experiment as follows: "In the act of comparison the second sensation is always compared with the memory image of the first, and inasmuch as the memory image must be fainter than the present sensation, the latter will be estimated proportionately stronger, i.e. it will be overestimated. As the memory image sinks towards zero with the increase of time elapsing between the two sensations, the more pronounced will be the overestimation of the second sensation." Lehmann notes that the simplest experimental conditions for the investigation of this

I. op. cit. p. 75.
point is given by a toneless sound such as that of the sound pendulum, or better yet, the fall-phonometer used by Starke. *The latter explains his results in the same way as does Lehmann those of other experiments. He says: "If judgment is given immediately after the impression of the second stimulus, the latter will be perceived in its immediate intensity, whereas the first sound being merely in the field of consciousness, can be compared only as the memory image with a second. But inasmuch as the memory image of weaker intensity as compared with the immediate impression, the influence of the time order must show itself in the over estimation of the second sound. Thus we are led to argue from his results that the memory image faded with such great rapidity in the time order *norm-variable* that the sound of a ball falling 200 mm. appeared no stronger after an interval of less than one second than that of the succeeding ball falling 85 mm. i.e.-the first sound must have lost about 57% of its original intensity. It further appears that when the time order *variable-norm* was used, the first sound faded comparatively slowly, so slowly that at the end of the time interval, the variable 209 appeared like the norm 200. That is, the variable had 'faded' only to the extent of less than 5% of the norm. In the second case the attention was directed more closely to the variable. That is, the first sound, than to the norm, and that therefore the former was held more strongly in the forms of consciousness. We find conducive evidence in his results that the discrepancy in 'fading' in the two time orders is not due to a change in the direction of attention.

In a series of articles contributing to the analysis of visual perception, he discusses recognition. In the comparison of two stimuli it has always been assumed that the image of the first stimulus is present when the second is given. Introspection does not verify this assumption. He says: "I have made numerous experiments with the method of right and wrong cases, on discriminability in the different sense departments, but have never been really able to determine that a conscious image was still present at the appearance of a second impression. On the other hand I have been able to determine the absence of such an image with considerable certainty, when my attention was especially directed to it." He does not deny that imagery of the first stimuli is sometimes present, but he merely cites these casual observations from other experiments and instances in everyday life which show that such imagery is not always present in recognition. The general trend of his argument is, that the image is of no great use when it is present.

Mac Dougall notes that an act of recall which completely failed when approached through central associated ideas may be aroused and carried through by sensory stimulation. The two processes are so independent that there may be habitual recognition of classes of impressions which are apparently irrecoverable as mental images in the type of mind to which the individual belongs. In other words, one may in many instances fail to recall and yet will easily recognize. Mac Dougall performed an experiment on the quantitative relation between recall and recognition. It consisted of ten series of presentations, as many as possible of which

2. Mac Dougall "Recognition and Recall." Journal Philos., and
were reproduced through recall. Two sorts of material were used—visual and auditory. (1) Ten monosyllables were simultaneously exposed for ten seconds, after which the observer wrote down what he recalled in a minute. For recognition, the ten syllables were mixed with an equal number of other monosyllables and the whole was presented. Twenty seconds were allowed to elapse between the first and second presentation or recall and recognition. (2) In the auditory series ten words were read out at the rate of one a second and reproduced as before. The following are his results:

<table>
<thead>
<tr>
<th></th>
<th>Recall</th>
<th>Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Visual</td>
<td>56.9%</td>
<td>77%</td>
</tr>
<tr>
<td>II. Auditory</td>
<td>53.5%</td>
<td>74.15%</td>
</tr>
</tbody>
</table>

Roughly, one half and three fourths of both respectively, were recalled and recognized. He thinks that the difference between recognition and recall was here related to phases of waning in the system of after effects of the original impression which has had a continuous existence during the intervening period but is on the way to extinction from which revival is impossible. Investigations are dependent on the stages of fading presented by an elementary memory of this sort. In the whole series of impressions 257 are already dead in the sense that they can neither be voluntarily produced nor even identified. If this is so the proposition of words correctly and incorrectly recalled and of those recognized would be a function of the temporal phase presented at the moment by there disappearing after effect and not a true phenomenon of memory.
III. METHOD AND PROCEDURE.

This experiment was conducted, not with the purpose of getting norms but to make a detailed analysis on the part of each subject of the various processes entering into the learning, recalling and recognizing of the material used for the experiment. It was the intention at the start to have three observers throughout, and this number was adopted. Two were students, one of whom was a young lady, who is designated as A in the results; the writer as B, and the instructor in charge as C.

Perhaps this experiment differs from others in the larger degree of the use made of introspection. Each step was carefully examined by the observer, and he was told to lay special emphasis at times on certain points, the clearness of which was desired before further progress could be made. It was found that each observer's introspections varied largely in some details, while all could be brought together on some points, allowing some general conclusions.

The material used was of two kinds: words not exceeding five syllables and familiar to the average person, and nonsense syllables of three letters each. The latter contained one vowel, which was uniformly distributed through the total number of syllables by arranging one third of them with the vowel at the beginning, one third with the vowel in the middle, and one third with the vowel at the end. Fifteen words or ten syllables constituted the series to be learned. Three columns of "fifteens" and "tens" respectively made up the Major memory sheet to be used in learning. One of these columns was, in the case of words, mixed with thirty other
new words to constitute the R, or recognition sheet; and in the case of syllables, the ten were mixed with twenty new ones to constitute the R sheet. Thus the total number of words on the R sheet was forty-five, and on the R syllable sheet, thirty syllables. These were mixed in irregularly so that the subject would not know when a familiar syllable was coming. With respect to the vowel arrangement, the three types of syllables were also mixed in irregular order.

The same sort of material was used for experimentation in the visual and auditory senses.

For the visual presentation of words and syllables we had the use of a special apparatus which threw into the observers view each successive unit of the series at regular intervals. The exposure was for one second only, with a three second interval of rest before the next word or syllable, as the case might be, was dropped into view by the apparatus. This procedure constituted the learning process. As many repetitions of a series were given as might be determined by the observer. He was to have no repetition after he could, with the presentation of each word or syllable recall the next in order before it was presented. Between these repetitions of series, thirty seconds were given by adjusting the apparatus for the most exposure and during this interval the subject was allowed to recall what he had seen. As a rule, the word series was given first. When the subject had learned this to his satisfaction, he was to allow no thought of what he had learned to enter his mind until the following day. On returning to the laboratory the second day, he immediately proceeded to recall both series. With this finished, the R sheets, containing the material
learned, were shown to him on the apparatus, and he was to choose the words or syllables learned from those given, and immediately record them on the sheet of paper lying before him.

The auditory presentation was very simple. The only apparatus used was a metronome which the experiments followed in reading the words or syllables to the subject. This was enclosed in a box and so placed as to make it inaudible to the subject. The words and syllables were spoken clearly and distinctly, the number of repetitions in learning being determined in the same way as in the visual presentation. Thirty seconds were given between repetitions, and in all other respects also the procedure was the same as in the visual presentation. Not less than ten groups of fifteen words, and ten groups of ten syllables were given to each subject, for each of the visual and auditory presentations. In a number of cases it occurred that all of a group were recognized the following day. For these, extra groups were given, but in the average given in the tables below the results of all are included, for reasons stated there.
IV. ANALYSIS OF RESULTS

a. Introspection on Learning, Recall and Recognition.

The following summary of the introspections of the subjects A, B, and C is perhaps the most important part of the work included in this paper. Each heading is to be considered as related to the senses experimented upon, and according to the different materials used. There will be therefore a large number of variables which must be considered in drawing conclusions.

A. Learning.

"What is done in learning?" is the question to be met at this point. In learning visual material, A records the process as one which simply fixes on some definite picture of some object named early in the series and attempts to connect every other word in the series with this picture. Each word is at first pronounced, and then visualized, and then brought into some associative connections.

With B the letters of the syllables were always vocalized and some vocalizing was done in learning words. The associations formed after a grouping of each word in the series about some central thought. If the words had absolutely no connection with this central idea, they were allowed to drop out of the learning for the time being and then placed in a group by themselves. If it was found that the whole body of words could form no "story" or strong associations, the words were learned in consecutive groups, and no group left until completely memorized. Visualizing words was done in all cases. The vocalization of syllables was much more pronounced than in learning words, but the associative connections
were far less. The syllables were spelled through audibly by the subject. Often they formed abbreviations for words and in such cases were memorized as such. Thus the association of the word itself was an aid to learning. As in the case of the words, the syllables were visualized first, often as they stood in their places on the column; at other times, without any fixed rule, merely as individual syllables. Generally the attempt was made to keep them in their proper order.

No additional introspection is given by C except that he was conscious of the associative connections in words given for learning before the recall of the next word in each case. The visual images of the words were less definite and clear than in the case of the syllables, and their pronunciation follows more readily, sometimes preceding the visual image of the syllable. The words were learned by associating them together in series, for instance, an adjective applied to the one following. The syllables were spelled through, and not pronounced except where the vowel was in the middle and they too were often associated with outside things through abbreviations, and the like.

The learning for auditory presentation included largely the methods used in visual presentation, but there were some particular introspections that we desired to make to answer the following questions: 1. What occurs when hearing the material pronounced? 2. How are the associations made—visual or auditory words or concrete images? 3. In the recall during the three seconds is the process visual, auditory, or vocal? A finds that each word is pronounced as soon as it is heard. This does not seem to count in the later process, but seems to be necessary to bring the concrete
image up. B, when hearing the words immediately attempted to place them in some associative connection. The process of learning is then, as follows: 1. Immediate visualization of the word. 2. Vocalization. 3. Concrete image where possible. 4. Second visual image in connection with the word following or words following or preceding it in order. At times the associations were vocalized in learning the words. C rather tended to associate the words throughout in orderly groups of three or four and quite often through concrete visual images. The visualizing of words during the three records intervals were strikingly less prominent than was the case of the syllables. Usually only a very vague visual image of the word was present and the vocal-auditory process was about simultaneous with the visual. The pronunciation was a more or less automatic process, the effort being largely directed to the visual imagery and associative connections. The attempt was made to visualize the words in columns as they were heard. The associative connections were suggested at once on hearing the word. These connections were aided largely by visualizing back the words during the recall interval, to the beginning of the column to fix the connections more definitely. In general all subjects followed the method given below in learning:

1. Visualizing the word.
2. Suggestion of concrete object, where possible.
3. Revisualing of the word.
4. Motor image or vocalization.

In learning syllables, vocalization seemed to take a prominent part with all subjects. With A and B the learning in all cases was
done by repeated vocalization of the letters plus the motor image of the syllable where possible. Alliteration seemed to be an aid to memory here, but there seemed to be with all very slight or no associative connections at all. The syllables were visualized as they were pronounced, and during the three second recall interval the attempt was made to visualize the next one. The auditory images did not seem to come in at all. Attention was directed but very little toward getting associative connections between the syllables. Those present came in mostly of themselves.

b. Recalling.

There is no striking difference in the method of recall for visual and auditory materials. With A, there was a strong motor tendency in recall of words with but very slight visualizing. Those words which were not associated with any other seemed to disappear. In the associations involved in the series, it was found that the words grouped themselves more in the arrangement of relation between themselves than in the order of the column. With B in recalling words there was some vocalizing but mostly visualizing. The former was used only as an aid after the word was recalled to make sure of it. He attempted to get the forgotten by repeated vocalization of those already recalled. The same association or train of ideas was started as an aid to bringing into consciousness the words that belonged in the series. Observation on recall of words by C include the use of a method of visualizing in a vertical column, although the order of recall was irregular. His recall was almost purely visual, with motor images used only as an aid.

With the syllables in the case of A there was a more marked
tendency to spell and to relate syllables to each other by means of a common letter. Those which in any way suggested a word were remembered easiest and the word suggested was remembered first. The visual image appeared first and was aided in recall by vocalization. The same was true with B and C, the visual image coming first and vocalization later for verification. The visualizing was done largely without associative aids and by placing the words in their proper places in the column.

As was stated, the recall of auditory material was found to be practically the same as that of the visual. Perhaps a slight variation in some instances might be noted for the words. At times it would be the concrete image that would appear before the visual word, and these followed by vocalization. A remembered the words largely by their associations. In her case the actual visual word seldom came up before the concrete image. The words were recalled by visual imagery of the scene originally suggested by the word, while in the syllables the visual image of the syllables themselves come up. With B the vocalization of words in recall seemed very slight. Recall was aided by placing the words in their order in the column, also by vocalizing words recalled in the exact measure of time in learning them. This served in some cases to bring back other associations than those remembered without special effort. Vocalizing however played but a minor part, and then only as an aid to verification.

With C, in the auditory recall, the auditory image of the sound as heard from the experimenter never entered, but was gotten voluntarily. The vocalization of the word recalled follows the visual image very readily. In most cases there is a vague, rough, visual
image of the word which precedes the vocalization of it. The auditory image is considerably more prominent than in the syllables and follows the visual image more readily. The motor image is often almost simultaneous with the visual image. The motor image followed the individual vocalization of the word. The vocal-auditory image was more clearly connected with the visual image than in the case of syllables and more frequently simultaneous with the visual image. The latter is relatively less prominent than for the syllables.

In the recall of syllables, the visual image is always first and the vocal-auditory image follows much more prominently than for the words.

With A, the recall of syllables was entirely through the visual picture of it, aided by mental pronunciation. The same can be said of the other subjects. Recall was visual, verified by vocalizing and placing syllables in their position in the column. With C the visualization of letters was first in all cases of recall of syllables. The vocal auditory follows very closely.

c. Recognizing.

Recognition for words and syllables in both the visual and auditory senses bear strong resemblances. Some words were recognized directly through the visual presentation without the associated ideas being present at all. In these cases it was direct. The vocal auditory image usually followed very closely after the visual image.

With syllables the vocalization was not used except as an aid to verification. There is but very slight aid from any associative connections, except where the appearance of an unrecalled word in
the series appears on the R sheet and sets up the connection with the other unrecalled words of the series.

When the subject hears the sound in the recognition series, does he have to visualize to recognize or can he recognize direct? A answers that some words are recognized by the picture they bring up or visually. B found that some words were recognized immediately without visualizing or vocalizing—merely at the sound of the word. In general however, the visual image of the word was first and vocalization followed slightly, if it was used at all. C recognized some words at once on hearing them before the visual image came up. Some come up simultaneously with the hearing and some were not recognized until definitely visualized. The pronunciation of words played but very little part; no attention went to this.

With the syllables recognition comes in every case only with visualization of the syllable. The visual image comes with the sound and recognition is through this in every case. Pronunciation played little or no part in recognizing. The spoken sound is in some cases an aid to the verification the decision of correctness of judgment.

b. Objective Results.

In considering the objective results the main points in the foregoing introspective analysis should be kept in mind. The latter has shown that the processes of learning, recalling and recognition all change with the nature of the material and with the manner of presenting it. The significance of these changes should be measured by the degree in which they influence the objective results. We may take up first the amount recalled with
reference to these changes. The same will next be done with the amount recognized.

1. The amount recalled. We may proceed at once to the figures in the amount recalled.

<table>
<thead>
<tr>
<th>TABLE I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
</tr>
<tr>
<td>Words</td>
</tr>
<tr>
<td>Syllables</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Difference</td>
</tr>
</tbody>
</table>

This table shows in percent the amount recalled for words and syllables for both auditory and visual presentation, the differences in percent as indicated and the average for the three subjects being taken.

First let us look at the difference between words and syllables recalled, regardless of the sense to which they were presented. The average amount of words recalled was 55 %, as compared with 45 % for syllables, or a difference of 10 % increase for words. This may be explained by two factors that entered into recall. The first of these is the unfamiliarity of syllables. It will be remembered in their nature, while the words were familiar to all subjects. Again associative connections in learning were few for syllables. Occasionally one would be an abbreviation, another would have an individuality that would make it stand out above the rest, but on the whole, no outside connections came to the aid of memory in learning. The words, however, were distinctly associated
in a majority of instances either with each other in a series, or with outside connections, stories, and the like, that made them much easier to recall. To recall one of the series was often an aid to bringing up several others which were grouped about it.

The table shows that 58% of the words and syllables were recalled for visual presentation as compared with 42% for auditory presentation, or an increase of 16% for the former. The procedure of the experiment is concerned in this point. This was conducted for the first half of the time on visual presentation.

A general practice effect on each subject was the result, so that contrary to what one might expect incident to experience, by the time the auditory material was given, all of them were learning the series with a smaller number of repetitions, but also with a greater degree of concentration of attention. This consequently affected immediate recall favorably and delayed recall unfavorably. It was easier with practice to recall material just learned with less repetitions as time went on. The subject felt as sure of what he was learning as he previously did when commencing the experiment at the first part of the year, when he was given a larger number of repetitions. However, on the next day when he attempted to recall the series given, he found no prominent groups of words or syllables present that had as a whole been fixed in mind by the less numerous repetitions with greater concentration of attention. Aside from this the greater importance must perhaps be attributed to another factor, where influence would be in the same direction. This is the different manner of learning the auditory material. In learning, it was found that the material was memorized through visual imagery associated with the words and
syllables rather than by direct auditory images. This visualizing took a considerable portion of the three seconds before the next word would be read, and thus eliminated a good many associative connections that otherwise would have entered. Thus in the immediate recall of learning, the subject had less time to dwell upon what he had heard and applied his thinking to the visual images called up. Again in the delayed recall, it was found by introspection that these images were not recalled by sound, but by the similar visual associations used the day before. Recall then was not direct in either case.

It is also to be noted in this connection that for visual presentation there is a difference of 17% between the amount recalled of words and syllables, as compared with the 3% for auditory presentation; and 23% more words recalled visually than auditorially as compared to 9% syllables. In both instances, more words were recalled for visual material than for auditory. It was the experience of all subjects that less time was given to associative connections in auditory learning, the elimination to some degree being due to the lessening of time for immediate recall. It was found also that there were fewer associative connections made for words in auditory learning than in visual, due in part to the less concentrated attention resulting from practice.

2. The Amount Recognized.

<table>
<thead>
<tr>
<th></th>
<th>Visual</th>
<th>Auditory</th>
<th>Average</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Words</td>
<td>90</td>
<td>88</td>
<td>89</td>
<td>2</td>
</tr>
<tr>
<td>Syllables</td>
<td>80</td>
<td>74</td>
<td>77</td>
<td>6</td>
</tr>
<tr>
<td>Average</td>
<td>85</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>10</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In this table, similar to Table I in its arrangement, the difference in percent in recognition is shown between words and syllables and between visual and auditory presentation;

The average percent recognized for words for both presentations is 89, and for syllables 77, or an excess of 12% for words over syllables. Here we have brought to attention again the fact that the words were familiar and the syllables unfamiliar. Direct recognition was easier for the familiar material. Perhaps the more important of the two reasons for this difference was the indirect recognition for syllables. While for visual presentation the recognition was always direct for both words and syllables, for auditory presentation the recognition was always indirect, through the visual imagery of the letters.

The difference between 85% recognized for visual presentation, and 81% recognized for auditory presentation shows an increase, though not large, of 4%. In the visual presentation recognition is always direct. The subject does not need to turn his attention from the visual stimulus before him, as he does in the auditory recognition to the visual imagery that must be brought back from learning in the day before to verify what he has heard. To this matter indirect recognition in auditory presentation might also be added an additional facotor—that of a less number of repetitions in learning and therefore a less degree of familiarity with the material presented.

The difference between words and syllables for auditory presentation was 14% and for visual presentations 10% showing a greater variation for the auditory presentation. This may be explained first by the indirect recognition of syllables invariably
through visualizing plus vocalizing. It was found that in visual presentation recognition was direct and therefore a nearer approach to the percentage of word was possible. Second the recognition of words was about equally direct and indirect, thus slightly lessening the possibility of accurate determination of correctness.

3. Quantitative Relation of Recall and Recognition.

<table>
<thead>
<tr>
<th>TABLE III.</th>
<th>Recalled</th>
<th>Recognized</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>58</td>
<td>85</td>
<td>27</td>
</tr>
<tr>
<td>Auditory</td>
<td>42</td>
<td>81</td>
<td>39</td>
</tr>
<tr>
<td>Average</td>
<td>50</td>
<td>83</td>
<td>33</td>
</tr>
</tbody>
</table>

Table III shows by comparison the amount of visual and auditory material recalled and recognized, with an average for recall of 50% and for recognition of 83%, or an increase in amount recognized of 33%. By way of explanation there are three conclusions from the introspective results that must be considered. First, recall was found to be dependent on associative connections. One of these connections might involve several terms one of which considerably aided memory in bringing back the others. With associative connections gone, the degree of recall was greatly decreased. Secondly, recognition was quite independent of associative connections. No special effort was needed to enable the subject to correctly determine whether or not the word or syllable presented to him was one already learned. Often as the material on the recognition sheets were presented, one familiar word would bring a number of others to view and he would be prepared for immediate recognition. Thirdly, the familiarity of the material affects recognition. After the subject had recalled a certain amount of
it, he was better prepared to judge with certainty what was to be next given to him.

An important result obtained in this experiment was that the visual process in learning and recalling was substituted in recalling auditory material. To but slight degree, was the auditory material ever recalled directly as an auditory image. The material was transposed into terms of visual imagery as a means of fixing associations and enabling the subject to have them surrounded by associations that would enable him to reach for them, so to speak, with less difficulty. In comparing the figures, therefore, for visual and auditory presentation it should be borne in mind that we are not comparing visual recall and recognition with auditory recall and recognition. With the exception of the auditory recognition of words in some cases, the recall and recognition is visual in both cases. For the recall the comparison is that of a visual recall of mind stimuli with the recall of visual imagery that was associated with auditory stimuli in learning. For recognition the comparison is of quite the same order. This is a direct answer to one of the questions aimed at in the study. Put in brief form, it may be stated that there is no auditory recall, and for nonsense syllables there is no auditory recognition.

4. Individual differences.

The study has brought out a significant fact in regard to individual differences. The objective results allow two generalizations. First, individual differences are greater for recall than for recognition. Second, they are greater for words than for nonsense syllables. The next table gives the figures on the first point.
TABLE IV.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Recall</th>
<th>Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>56</td>
<td>88</td>
</tr>
<tr>
<td>B</td>
<td>41</td>
<td>81</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>82</td>
</tr>
<tr>
<td>Mean variation</td>
<td>5.3</td>
<td>3.0</td>
</tr>
</tbody>
</table>

This table allows the conclusion that the individual differences are greater for recall than for recognition. The percent recalled by each individual of visual and auditory material taken together was averaged and the mean variation from this average was found to be 5.3. In the same way the percent recognized was averaged and the mean variation found to be 3.0.

TABLE V.

<table>
<thead>
<tr>
<th></th>
<th>Words</th>
<th>Syllables</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>79</td>
<td>65</td>
</tr>
<tr>
<td>B</td>
<td>66</td>
<td>56</td>
</tr>
<tr>
<td>C</td>
<td>69</td>
<td>62</td>
</tr>
<tr>
<td>Mean variation</td>
<td>5.0</td>
<td>3.3</td>
</tr>
</tbody>
</table>

In a similar way the individual difference was shown to be greater in the recall and recognition of words than it was in the same four syllables. The average of each subject was taken for the percent of words recalled and recognized in the visual and auditory presentations; a general average was taken of the three subjects together, and the mean variation found to be 5.0. The similar mean variation for syllables was found to be 3.3.

Both conditions shown in Tables IV and V may be traced to one
course, namely, to differences in associations, or rather, dependence on associative connections.
V. SUMMARY.

This investigation may be summarized first in regard to the introspections taken on learning, recall, and recognition, and second with respect to the relation between these introspections and the objective results.

The learning is a process of visualizing and vocalizing both words and syllables, and for the former largely a matter of associative connections, for the latter very few. The process of learning words is as follows: 1. Immediate visualization of the material. 2. Vocalization. 3. Concrete imagery where possible. 4. Second visual image in connection with the word, following or preceding. The method of learning syllables differed in the third and fourth points. At point 3, the syllable was revisualized, at 4, vocalized.

There is no striking difference in the method of recall for visual and auditory materials. Each were recalled in terms of visual imagery. Vocalization was used only as a verification of this imagery after it was recalled. Associations of the learning process were found to be a great aid in recall, and in many cases the recall depended upon them entirely. In recognizing, it was found to be the rule with few exceptions for the subject to recognize directly in visual presentation and but to a very slight degree in auditory presentation. The latter as in recall was done in terms of visual imagery.

In the amount recalled the difference between words and syllables was due largely to the familiarity of the former and the unfamiliarity of the latter. The associative connections in
learning were few for syllables and many for words. The difference for recall between visual and auditory presentation was influenced to some degree by the smaller number of repetitions for auditory material, probably due to the general practice effect. Less was recalled for auditory presentation for the reason that the learning was indirect, through associated visual imagery, and the same was true of the recall process. The greater difference for visual presentation between words and syllables arose from the greater elimination of associative connections for words in the auditory presentation.

In recognizing words and syllables, we find a difference due to the direct recognition of the words as familiar material and the elimination of direct recognition for syllables. The recognition for visual material is also greater because it is direct while with the auditory presentation recognition is mostly indirect through visual imagery. The difference between words and syllables is greater for auditory presentation owing to the generally direct recognition of words contrasted to the indirect recognition of syllables through visualizing and vocalizing processes. A greater amount is recognized than recalled from several reasons. Recall is dependent on associative connections, one of which may involve several terms, thus the greater risk of losing several terms through the loss of one. Recognition on the other hand is quite dependent of associative connections, and when the material is presented, it is familiar on the foundation of second presentation. Perhaps one of the most striking results was found in the substitution of visual processes in learning and recalling auditory material. There was no such thing as auditory recall.
The individual differences as already pointed out were briefly as follows—a greater variation existed in recall than for recognition, and also a greater variation for recall and recognition of words than for syllables, both differences due mostly to the individual variations in associative connections.
VI. LITERATURE.

Titchener, "Outline of Psychology. N. Y. 1897

Wundt "Vorlesungen ueber die Menschen und Thierseele." Dritte Auflage, Leipzig, 1897.


Apparatus for Visual Exposure.

A. Large camera, with elliptical opening and eye shade at Al, for observer, and lens at A2.

B. Fall apparatus. B 1. Drop board running vertically between the uprights B 2. Electro-magnets, whose attached levers allow the drop board to fall the distance between two of the pegs with each make and break of the circuit.

C. Contact apparatus. C 1. Electro-magnet, whose attached lever and ratchet wheel (the batteries behind C 2) turns the metal contact disc (C 2) one notch with each beat of the Metronome E. C 4. Contact disc giving one second exposure of a word or syllable with three seconds interval following.

D. Reostat for metronome circuit.

F. Key for simultaneously making and breaking the two independent circuits, in one of which (furnished by storage battery G') are E, P and C 1, in the other (furnished by storage battery H) C 2-3 and B 2.