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O'Brien, Francis John

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*Psychological Dept.*

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BY  
FRANCIS J. O'BRIEN

A Dissertation submitted to the Faculty of Clark University,  
Worcester, Mass., in partial fulfilment of the requirements  
for the Degree of Doctor of Philosophy, and accepted on  
the recommendation of JOHN WALLACE BAIRD.



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# A QUALITATIVE INVESTIGATION OF THE EFFECT OF MODE OF PRESENTATION UPON THE PROCESS OF LEARNING

By FRANCIS J. O'BRIEN<sup>1</sup>

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## HISTORY

The relation of the mode of presentation of a material to the process of learning it has been approached experimentally from various points of view. Most investigators have sought, with a pedagogical interest, simply to determine the mode of presentation most advantageous in learning; a few have concerned themselves chiefly with the psychological aspects of the problem and undertaken to determine the qualitative changes in the complete mental process that arise when the material to be learned is presented to different senses. Our present problem is psychological in this latter sense. In most studies investigators have been content to deal merely with the quantitative aspects of learning and recall, supplementing such data only occasionally by introspections. They have made the analysis of the learning-process almost entirely with reference to the mode of presentation of the material—whether it is visually or auditorially presented, or reinforced by vocimotor repetition, for example—and little with respect to the actual sensory terms with which the learner represents the material to himself. For this latter information, as well as for a complete understanding of the problem, an introspective study is essential.

<sup>1</sup> From the Psychological Laboratory of Clark University. This work was performed under the direction of Professor J. W. Baird.

Münsterberg and Bigham<sup>2</sup> published the pioneer investigation in this field in 1894. They presented digits and colors to their observers in visual, in auditory, and in combined visual-auditory fashion, and tested the learning immediately by a method of reconstruction. They concluded that visual memory is superior to auditory and that material presented to both these senses at the same time is more easily reproduced than material presented only to the one or the other.

Cohn<sup>3</sup> took especial account of the motor factor in learning. Using lists of consonants as material, he compared learning with emphasis upon the vocimotor processes with learning with vocimotor processes inhibited. He sought to secure this inhibition by having the *O* press his tongue against the roof of his mouth, count "1, 2, 3, 1, 2, 3," etc., count backwards, or count by 2's or 3's. He concluded that learning was better when there was no attempt to interfere with vocimotor processes. It is possible, however, that his results were due to the distraction of attention by the inhibiting task.

Quantz,<sup>4</sup> in a study of the psychology of reading, performed memory experiments with visual-vocimotor, auditory, and visual-auditory-vocimotor modes of presentation. He concluded that lip movement is a serious hindrance to the speed of reading and that a combination of the visual and auditory modes of presentation has little advantage for recall over either mode of presentation separately.

Lay<sup>5</sup> studied the mode of presentation most effective in learning spelling, and demonstrated that visual presentation is much more effective than auditory and that the introduction of motor imagery is of considerable assistance in the learning processes. Fuchs and Hagenmüller<sup>6</sup> and Itchner<sup>7</sup> repeated Lay's experiments with certain variations and in general substantiated his findings.

Smedley<sup>8</sup> investigated the memory span of children for five different modes of presentation. He found that he obtained the greatest span with the visual-auditory-vocimotor mode, and that his other modes could not be completely realized because his subjects were unable entirely to repress their vocimotor processes.

Finzi<sup>9</sup> worked upon observational noting and retention as conditioned upon presentative modes. He worked without consideration of the imaginal types of his *O*'s, but concluded that vocimotor and manumotor imagery are least efficient for retention. Some of his *O*'s,

<sup>2</sup> Münsterberg, H., and Bigham, J. Memory. *Psychol. Rev.*, 1, 1894, 34-38.

<sup>3</sup> Cohn, J. Experimentelle Untersuchungen über das Zusammenwirken des akustisch-motorischen und des visuellen Gedächtnisses. *Zsch. f. Psychol.*, 15, 1897, 161-183.

<sup>4</sup> Quantz, J. O. Problems in the psychology of reading. *Psychol. Rev. Mon. Sup.*, 2, No. 1, 1897, 51 pp.

<sup>5</sup> Lay, W. A. *Experimentelle Didaktik*. 3 ed., 1910, xvi+661 pp.

<sup>6</sup> Fuchs, H., and Hagenmüller, A. Studien und Versuche über die Erlernung der Orthographie. *Sammlung von Abhandlungen aus dem Gebiete der pädagogischen Psychologie und Physiologie*, II, 1898, 63 pp.

<sup>7</sup> Itchner, H. Lay's Rechtschreib-Reform. *H. Jahrbuch d. Vereins f. wissenschaft. Päd.*, 32, 1900, 206-234.

<sup>8</sup> Smedley, F. W. *Report of the department of child study and pedagogic investigation*. Chicago, No. 3, 1900-01, 63 pp.

<sup>9</sup> Finzi, J. Zur Untersuchung der Auffassungsfähigkeit und Merkfähigkeit. *Psychol. Arbeit.*, 3, 1900, 289-384.



however, remembered best when motor processes were introduced in addition to the others in the learning.

Kemsies,<sup>10</sup> in a study of school children, concluded that visual presentation was more advantageous than auditory for learning German-Latin vocabularies. Fränkl<sup>11</sup> studied the same problem with more modes of presentation and concluded that Kemsies' conclusion holds for learners of the visual type but that auditory presentation is more efficient for learners of the auditory type. Schuyten,<sup>12</sup> on the basis of a similar experiment, concluded that 'pure auditory' presentation is superior to 'visual plus auditory' presentation. His 'pure auditory' presentation was, however, presumably auditory-vocimotor, and his experiment was made without reference to the imaginal type of the school children.

A more thorough investigation of this problem is Pohlmann's.<sup>13</sup> He worked with six modes of presentation and three intervals of recall. His general conclusions are that auditory presentation is slightly more advantageous than visual for such familiar material as meaningful words, that visual presentation is superior to auditory for nonsense syllables, and that retention is not improved by the addition of the auditory mode or the vocimotor mode of presentation to the visual.

Segal<sup>14</sup> worked with trained *O*'s and with visual and auditory presentation. In both cases he allowed the learner in certain series to use the visual-auditory mode with any imaginal supplementation that he desired, while in other series he required him to avoid vocimotor processes by carrying on simultaneously with the visual or auditory presentation some other irrelevant vocimotor process. He concluded that the same individual may be said to belong to different imaginal types when reproducing different materials, that optimal conditions for reproduction consist of the presentation of the material in the mode that corresponds to the *O*'s type, and that, when presentation is made in a mode different from the *O*'s type, the *O* either may learn less efficiently using the terms in which presentation is made or may immediately transpose the presented material into imagery corresponding to his type. The necessity for taking strict account of the *O*'s type under the particular experimental conditions and the need for a persistent appeal to introspection become apparent in this study.

Von Sybel<sup>15</sup> reinforced Segal's conclusion by an experiment involving six presentative modes. He noted especially that the imaginal type of the learners had to be considered before the most effective

<sup>10</sup> Kemsies, F. Gedächtnisuntersuchungen an Schulkindern. *Zsch. f. päd. Psychol.*, 2, 1900, 21-30; 3, 1901, 171-183.

<sup>11</sup> Fränkl, E. *Ueber Vorstellungs-Elemente und Aufmerksamkeit. Ein Beitrag zur experimentellen Psychologie.* 1905, 256 pp.

<sup>12</sup> Schuyten, M. C. Experimentelles zum Studium der gebräuchlichsten Methoden im fremdsprachlichen Unterricht. *Exper Päd.*, 1906, 3, 199-211.

<sup>13</sup> Pohlmann, A. *Experimentelle Beiträge zur Lehre vom Gedächtnis.* 1906, 191 pp.

<sup>14</sup> Segal, J. Ueber den Reproduktionstypus und das Reproduzieren von Vorstellungen. *Arch. f. d. ges. Psychol.*, 1908, 12, 124-236.

<sup>15</sup> Sybel, A. von. Ueber das Zusammenwirken verschiedener Sinnesgebiete bei Gedächtnisleistungen. *Zsch. f. Psychol.*, 53, 1909, 257-360.

mode of learning could be established, and that imaginal type is not fixed, but subject to change under different conditions.

Abbott<sup>16</sup> studied the nature of the mental processes involved in learning to spell unfamiliar English words. Her work was undertaken in order to test the results of Lay, Fuchs and Hagenmüller, and Itschner. She found, under her conditions, that the initial recall came typically as visual imagery of the letters of the word no matter what the mode of presentation, that the subject would proceed to pronounce the word only as soon as a clear visual image was obtained, that auditory presentation gave rise, by way of visual imagery, to an even more purely visual learning than did visual presentation, and that the mode of presentation appears, therefore, to determine the imaginal terms of the learning in only a small degree.

Meumann's<sup>17</sup> conclusions support the general trend of the foregoing experiments: it is more advantageous for a learner to use imagery corresponding to his imaginal type than for him to attempt the use of imagery in other modalities. Meumann holds that learning is dependent more upon the formation of strong associations than upon the formation of many associations and that therefore the material which is most readily impressed should be used. Frankfurter and Thiele<sup>18</sup> also came to this same conclusion, although they noted especially that the addition of other modes to the natural mode for the *O* increased efficiency of learning. For them the best results were obtained with visual-auditory-vocimotor learning.

#### MATERIALS, APPARATUS, PROCEDURE AND OBSERVERS

In the first half of the investigation we used significant words; in the second half, nonsense-syllables.

##### *Significant Materials*

This material consisted of four-letter English words,—nouns, pronouns, adjectives, verbs and adverbs,—which were arranged in 36 lists of 20 words each of approximately equal difficulty. The lists were divided into three series, *a*, *b*, and *c*, of 12 lists each.

Twelve modes of presentation were employed and in the order given below. The following symbols are used in this paper in abbreviation of the names of the modes of presentation: V=visual, A=auditory, M=vocimotor, m=manu-motor.

1. *Auditory (A)*. *E* pronounced the words, one every 3 sec., to the beat of a metronome. The learner was asked to inhibit vocimotor imagery during the learning.

<sup>16</sup> Abbott, E. E. On the analysis of the factor of recall in the learning process. *Psychol. Mono.*, 11, 1909, 159-177.

<sup>17</sup> Meumann, E. *Vorlesungen zur Einführung in die experimentelle Pädagogik und ihre psychologischen Grundlagen*, II. 1907, vii+467pp.

<sup>18</sup> Frankfurter, W., and Thiele, R. Ueber den Zusammenhang zwischen Vostellungstypus und sensorischer Lernweise. *Zsch. f. Psychol.*, 62, 1912, 96-131.

2. *Auditory-vocimotor* (AM). The same procedure as in the purely auditory presentation (A), except that the learner was allowed the use of vocimotor imagery.

3. *Visual* (V). The series as they were presented visually on an exposure apparatus, one word every 3 sec. The learner was asked to inhibit vocimotor imagery.

4. *Visual-vocimotor-auditory* (VAM). The words were presented to the learner as in the purely visual presentation (V), and as soon as he perceived each word he was required to pronounce it aloud, definitely and distinctly.

5. *Auditory-manumotor* (Am). The same procedure as in the purely auditory presentation (A), except that the learner was required in addition to write the words. The learner was blindfolded, so that he could not see the word he had written.

6. *Visual-auditory-manumotor* (VAm). The procedure here is a combination of the purely visual (V) and the auditory-manumotor (Am) modes of presentation, except that the learner was not blindfolded. (See 7, VMm below.)

7. *Visual-vocimotor-manumotor* (VMm). The learner saw the word and was permitted to repeat it in vocimotor imagery but not aloud; and then wrote it. The O's hand was under a screen, so that he could not see the word that he had written.

8. *Visual-auditory* (VA). The learner saw the word, and at the same time heard it pronounced by E. He was required to inhibit vocimotor imagery in the learning.

9. *Visual-vocimotor* (VM). The learner saw the word and was allowed to repeat it in vocimotor imagery but not aloud.

10. *Auditory-vocimotor-manumotor* (AMm). The procedure is the same as in the auditory-manumotor mode of presentation (Am), except that the learner was allowed the use of vocimotor imagery.

11. *Visual-manumotor* (Vm). The procedure is the same as in the visual-vocimotor-manumotor mode of presentation (VMm), except that the learner was asked not to employ vocimotor imagery in the learning.

12. *Visual-auditory-vocimotor-manumotor* (VAMm). The learner saw the word as it appeared in the aperture, pronounced it aloud definitely and distinctly, and then wrote it; he did not perceive visually the word that he had written.

In the visual presentation the list of words was typewritten on paper fastened to a revolving drum which pre-

sented one word every 3 sec. A space indicated the end of the list.

In the auditory presentation a 3-sec. interval was allowed at the end of the list before repetition of the list.

A list was re-presented until the *O* signalled that he had learned it. The *O* would then immediately recall the series to *E*, who would record the recall, the number of presentations required for learning, the time required for recall, and the number and the nature of the errors made.

We sought in this investigation both a *quantitative determination* of reproduction after a few seconds and after 24 hours, and an *introspective account* of the mental procedure in the learning and in both the immediate and delayed recalls. Thus we hoped to obtain a clearer insight into the act of learning itself, and to clear up some of the differences of experimental results that are to be found in the literature.

Seven graduate students in experimental psychology served as *O*'s. They were all highly trained in introspection. Four of them took part in the entire investigation.

#### *Non-significant Materials*

In the second half of the investigation we used 33 lists of nonsense-syllables. Twenty syllables constituted a list. The procedure was identical with the procedure of the first part with two exceptions. In the first place, the visual-auditory-manumotor presentation (VAm) was not employed because the learner's procedure was almost the same as with the visual-auditory-vocimotor-manumotor presentation (VAMm). In the second place, the *O* could see the word as he wrote it. An apparatus was arranged so that the syllable written by the learner was drawn out of sight simultaneously with the coming-in of the new syllable. We employed for this purpose an endless band of paper which passed under an aperture cut in the table and was actuated by electrical contacts controlled by the exposure apparatus, a Marx machine. Thus we prevented continued visual stimulation.

#### *Ideational Equipment of Observers*

*Observer P.* *P* was of mixed type, with preference for vocimotor imagery, but he was able to use visual imagery readily. When vocimotor imagery was prohibited by the instructions, he reported that it was nevertheless present in most of the learning process, although under certain conditions it could be inhibited. His recalls were always in vocimotor imagery.

*Observer C.* *C* was of the mixed type, but dominantly visual. He used vocimotor-auditory imagery, especially when the material was difficult. In anticipating and recalling, he relied mostly on visual imagery, both of the printed word and in his own handwriting. *C* also employed a visual schema of the list of words frequently in learning and always in recall.

*Observer Fe.* *Fe* was of extreme motor type; in the entire investigation he reported only one or two visual images and these were subsequent upon vocimotor imagery. In no instance was he able to inhibit vocimotor imagery. He always recalled the material by means of vocimotor-auditory imagery or by vocimotor innervation. Frequently he employed a kinaesthetic schema of localization.

*Observer T.* *T* was of the mixed type, but preferred vocimotor imagery. He possessed, nevertheless, a good command of visual imagery and recalled many words in visual-verbal terms. When instructed to inhibit vocimotor imagery, he never succeeded; and he always anticipated the material in vocimotor terms. In cases of difficulty of recall, he employed either a visual or a kinaesthetic schema of localization. All the recalls, regardless of the mode of presentation, occurred mostly in vocimotor and vocimotor-auditory terms, accompanied often by visual-verbal or visual-concrete imagery or meaningful associations.

*Observer Fi.* *Fi* was of the balanced type; she habitually employed vocimotor (auditory) imagery alone in learning but she sometimes used visual imagery alone, especially under the *Aufgabe* to inhibit vocimotor processes. In these latter cases, however, the vocimotor processes were present during the first few presentations. She formed many meaningful associations during the learning. The syllables were generally recalled in vocimotor (auditory) imagery; but visual imagery was present in a few of the immediate recalls. She also employed a visual schema of localization. One olfactory image was reported by *Fi*, the only such image reported in the investigation.

*Observer W.* *W* was of the extreme visual type and in learning and recalling he employed a greater amount of visual imagery than of any other kind. He used vocimotor and vocimotor-auditory imagery to no great extent. Even when permitted vocimotor imagery, he employed it only in the first few presentations. He also employed a visual schema of

localization. He found it impossible to inhibit vocimotor imagery in the first few presentations of a new material.

*Observer S.* S was of the mixed type with a slight preference for the vocimotor imagery. He was able to use visual imagery in learning, but it appeared only after the vocimotor imagery had been present in the first few presentations. In spite of the use of several contrivances, he found it impossible to inhibit vocimotor imagery under instruction. He employed a visual schema of localization.

## RESULTS

### *Summary of Introspections*<sup>19</sup>

A survey of our introspections brings to light the following points:

I. Vocimotor imagery can not be inhibited, at least not in the first part of the learning.

*P, VA.* "During the presentation I focused attention on your voice, adjusting my right ear toward you and holding the auditory stimulus as long as possible; I attempted to anticipate, but when I succeeded the words always appeared in vocimotor imagery."

*T, V.* "In the fore-period there were sensations of pressing my lips together, pressing the tongue against the teeth, kinaesthesia of strains in the muscles of the stomach, and general muscular inhibitions throughout the whole body. This tense state seemed to be an attempt to inhibit vocimotor imagery; but in spite of it all the first presentation of each syllable was followed by a vocimotor-auditory repetition of it."

*C, A.* "In the first part of the learning I found that if I attended focally to the perception of each word and then to auditory imagery of it afterwards, I could not help having vocimotor imagery of it; so in the first 5 presentations at least I had rapid vocimotor imagery of each syllable after it was presented."

*W, VA.* "As soon as the first word was presented I found myself repeating it in vocimotor imagery, then awareness of the *Aufgabe*, present in visual imagery of you. . . . When the next word was presented I found myself repeating it again in vocimotor imagery."

*Fi, A.* "In general I would repeat the syllable and the associated word in vocimotor-auditory imagery, and at the same time I was keenly aware of tensions about my tongue and throat, tensions which would increase at that moment. In some cases the vocimotor image was very slight."

*S, VA.* "As soon as you said, 'Inhibit vocimotor imagery,' I was conscious of a numb feeling in the vocal apparatus. In the first presentation I was aware of a vocimotor image of the word as soon as I received the visual percept. . . . This vocimotor image after

<sup>19</sup> In the following excerpts from the protocols, the letter at the beginning of the paragraph indicates the *O*, and the symbol following the mode of presentation: see p. 252.

the presentation of each word was present, I am certain, during the entire first presentation and occurred very many times during the second presentation."

II. Observers of motor type never wholly succeed in eliminating vocimotor imagery in the learning, even when instructed to do so.

*T, Am.* "After the presentation of each syllable I had vocimotor and auditory repetition of it throughout the whole learning; I prevented movement of lips and actual throat movement, but I could not repress a sensation of movement in the tongue, and auditory imagery often accompanied this vocimotor imagery."

*Fe* was never able to inhibit vocimotor imagery; it was present in all the learning with all materials.

III. With *O*'s of visual type, the words are anticipated in vocimotor imagery; gradually the words appear to consciousness more and more in visual and less and less in vocimotor imagery; finally the words are anticipated in visual imagery only and no vocimotor imagery of the words is present.

*C, V.* "In the first part of the learning I was unable to rule out vocimotor-auditory imagery; it immediately followed the visual perception of the word. But as the learning went on the amount of vocimotor imagery became less and less. In the last 6 or 7 presentations there was almost no vocimotor-auditory imagery; the words were anticipated almost wholly by means of visual imagery."

*W, VAm.* "Vocimotor imagery appeared very seldom after the first 3 or 4 presentations, the anticipation being done mostly in visual imagery."

IV. If *O*'s of visual type attempt to inhibit vocimotor imagery, visual imagery in the learning sometimes becomes less clear; in the recalls the visual image develops more slowly than it does when vocimotor imagery is not interfered with.

*C, A.* Delayed Recall. "All the syllables came in visual imagery but very slowly and in no definite order. . . . Only 4 or 5 of the syllables were definitely localized. Strains in my eyes and consciousness that the words were coming very slowly."

*W, AMm.* "None of the visual imagery was very clear. Accompanying the learning were great strains and unpleasantness; I could not give the words fast because they came in so slowly."

*W, Am.* *W* gave up his attempt to learn the series after it was presented to him 18 times; he said, "I could not learn this series because I was unable to visualize the words as this is the medium I use in learning."

V. In addition to the help obtained from meaningful associations, there is another aid which comes from the vocalization of the words and which we may call a 'motor or kinaesthetic help': on pronouncing the first word the *O* may find his vocal apparatus set to pronounce the following word.

*T*, VM. Delayed Recall. "The syllables before SEC came in very quickly, one after the other, in vocimotor imagery; that is, after pronouncing one word I would find my vocal apparatus set to pronounce the next, and this word was then immediately vocalized. As soon as I vocalized VIT I found my vocal apparatus about to pronounce CAY."

*C*, V. "As soon as I recalled POM I was conscious of eye-movement downward, and vocimotor and auditory imagery of POM; before I finished vocalizing POM the vocal apparatus was adjusted for the pronunciation of TER, and POM-TER were pronounced very quickly, one after the other."

*Fe*, A. Delayed Recall. "The vocal apparatus was set for the pronunciation of a hard *c*-sound. Then I found myself pronouncing COCO."

*Fi*, VAM. Delayed Recall. "WAB flashed in mechanically in vocimotor innervation; after the vocalization of VOQ (which immediately preceded WAB) my vocal apparatus formed for the vocalization of WAB."

*S*, Am. Delayed Recall. "After vocalizing TALL I was conscious of the adjustment of the vocal organs for the *ive*-sound; this was followed by a visual image of FIVE in my own hand-writing."

VI. If given the *Aufgabe* to inhibit vocimotor imagery, the *O* sometimes sets up for himself a new *Aufgabe* to use imagery of another modality.

*P*, VA. "I tried to anticipate, but when I did I used vocimotor imagery, so I stopped anticipating; then I set up the vocimotor-auditory *Aufgabe* to retain the words in visual concrete images."

*T*, VA. "I tried to anticipate, but I found myself using vocimotor imagery. . . . I set up the vocimotor and auditory *Aufgabe* to anticipate in visual imagery but I did not succeed; vocimotor imagery always coming in."

*C*, VA. "There was little tendency to use vocimotor imagery after the presentation of each word; I set up the vocimotor-auditory *Aufgabe* to anticipate in visual imagery; I just sat and looked as the words were being presented, attending very little to the auditory presentation."

*W*, VA. "I then found myself seeking for a way to fulfil the *Aufgabe* [to inhibit vocimotor imagery]; I had a visual image of a sheet of paper and myself; then a vocimotor and auditory, 'Attend to the visual image of the words; never mind the vocimotor image.'"

*S*, A. "I was using vocimotor imagery in learning these words; I then set up the vocimotor-auditory *Aufgabe* to substitute the exhaled breath for the vocalization of the word; the vocimotor imagery became less, and I had a second *Aufgabe* to use visual imagery after you spoke the word."

*S*, Am. "I set up the vocimotor-auditory *Aufgabe* to visualize the words in my own hand-writing; this I did, but I was not able to anticipate in this visual imagery."

VII. Any attempt to inhibit vocimotor imagery makes auditory imagery of the word more clear and intensive.



*T*, Vm. "Following the visual percept of the word there was a vocimotor-auditory image of it. The vocimotor image was much less intensive than the auditory. The auditory image of the word became much more intensive as I was able to suppress the vocimotor."

*C*, Vm. "Later on in the learning the vocimotor seemed to drop out and the auditory image seemed much louder; the vocimotor image almost completely dropped out in the last half of the learning."

*Fi*, VA. "I am quite sure that I inhibited vocimotor innervation of each word, but there was slight vocimotor imagery and very intensive auditory imagery."

VIII. In a visual-auditory presentation an *O* seldom attends to both the visual and the auditory stimuli; he attends either to the visual alone or to the auditory alone.

*P*, VAm. "During the presentation of the words I paid the least possible attention to your pronouncing . . . concentrating attention almost wholly upon the visual perception."

*C*, VA. "During the middle of the series I was not attending to your voice at all but to my own anticipatory processes and to my retaining, in visual imagery, of the last two words which I had just perceived visually."

*Fe*, VA. "My attention was directed much more to the auditory perception than to the visual perception of the word; in fact, once or twice I found that my eyes were actually closed, while I was perceiving the words in auditory fashion only."

*W*, VAm. "For 4 or 5 presentations I paid little attention to your voice; it was by no means in focal perception for at least 4 or 5 presentations; I attended mostly to the visual perception."

IX. In an auditory presentation all *O*'s had great difficulty in distinguishing syllables containing such letters as *d*, *t*, *q*, *c*, *k*, etc.

*T*, Am. "After you pronounced QAZ I wrote it KAZ; the *k* held my attention. Vocimotor-auditory imagery, 'That must be a *q* because there is a *k* later.'" *T* had to reason, therefore, as to the correct spelling of a syllable; the auditory perception made possible at least two spellings.

*C*, AMm. "During the first few presentations the auditory perception was not instantaneous; not definite or clear; that is, not so much the clearness of the sound but rather a lack of definiteness of the letters pronounced. For example, for one syllable I write it at least two ways: BER and BUR."

*Fe*, AMm. "In the first presentation several words presented were capable of two interpretations; e.g., BARN-BARM. This caused nervousness."

*W*, A. "I had great difficulty with the syllables containing either the letters *c* and *q*, *d* and *b*; after perceiving a syllable containing such a letter there was confusion as to what the exact spelling was; this confusion consisted mostly in a fluctuation of the two possibilities in visual imagery."

*Fi*, AMm. "Sometimes I had difficulty in perceiving the word definitely; I would find my vocal apparatus set to pronounce but for no

definite syllable; this setting of the vocal apparatus only appeared when I was not able definitely to perceive a syllable.

S, AM. "In 3 cases it was very difficult for me to get a distinct perception of the words, and I was not able to vocalize them easily; there were elements in my auditory perception of your voice in pronouncing the words which I was unable to reproduce."

X. If, in recalling a series which had been presented to the O in auditory fashion, auditory imagery is present, it is seldom of E's but usually of O's voice.

C, AMm. "The words were recalled in vocimotor-auditory imagery of my own voice; then a visual image of each word in my own handwriting."

Fe, A. "In the immediate recall I made use, as far as I am aware, only of vocimotor-auditory imagery; the auditory imagery was of my own voice."

W, AMm. Delayed Recall. (What was the nature of your auditory imagery? Was it of your voice or of my voice, or of any one else's voice?) "The auditory imagery when it appeared was always of my voice."

Fi, A. "I anticipated every syllable in auditory imagery of my own voice, perhaps a little vocimotor, sometimes 2 or 3 ahead of the actual presentation."

S, VA. Delayed Recall. "I gave the first 3 words from visual imagery, but the word SOIL (the second word of the three) was followed by auditory imagery of my own voice."

XI. Manumotor imagery does not help either in learning or in recalling a list of words or nonsense-syllables.

P, VAm. (Did any manumotor imagery appear in the learning or the recalling of this series?) "I had absolutely no manumotor imagery at all."

T, Am. "The immediate recall of this series was almost wholly in vocimotor-auditory imagery, the auditory being of my own voice; there were no visual and no manumotor imagery present."

C, Am. "I anticipated far ahead of the drum, not attending to your pronunciation until I failed to anticipate; there was no consciousness of any manumotor imagery whatever."

Fe, Vm. (Did any manumotor imagery enter into the learning or the recall of this series.) "No, none at all."

W, VAm. "In anticipating I always set up the *Aufgabe* to call up the words visually; if a visual image of the word failed to appear I attended to my arm; but no manumotor image of a syllable ever appeared."

Fi, Vm. Delayed Recall. "There was no consciousness of any manumotor imagery; in fact, there was no consciousness that I ever wrote the material."

S, Am. "Before I wrote a word I was never conscious of either a visual or a manumotor image of it."

XII. In recalling words between which associations have been established in the learning, the imagery of these words

may appear very quickly, and the association is present only inasmuch as the words appear more quickly.

*P*, AMm. "The first word of an associated group would appear and the remaining words would come more readily with very little attention, one after the other."

*T*, AM. "All the syllables came very quickly, one after the other, but there was no consciousness of their meaningful connection; there seemed to be no meaning attached to the words excepting the fact that they came very quickly."

*C*, VA. Delayed Recall. "There was no visual concrete imagery with the word NUNS; *i.e.*, the visual concrete imagery that appeared to consciousness during the learning process; but as a result of the association made with NUNS and CAPE, the word CAPE came more quickly in auditory imagery after the word NUNS, than was the case where two succeeding words in the series were not associated."

*Fe*, Vm. Delayed Recall. "The meanings were present in the words with which associations had been formed in the learning, as far as I can see, only inasmuch as these words came together."

*W*, VMm. Delayed Recall. "The meaning which was present in the learning of the groups was not clearly present, the effect being that these words appeared very quickly, one after the other."

*Fi*, VA. Delayed Recall. "After a few presentations the associations did not come in with the syllables; the syllables themselves seemed to function just as the meaningful words would have done in carrying meaning."

XIII. When associations have been formed with the words of the series the following phenomenon often appears in the recall: The meaningful association comes first; the actual words of the series come later.

*P*, Vm. (Did any associations appear in the immediate recall?) "Yes. With the words DOTH-KLINK-GLOW the meaningful content came first and the words themselves later."

*T*, AM. Delayed Recall. "The feeling of familiarity was present with most syllables and the meaningful association came in before the nonsense-syllables."

*C*, VM. Delayed Recall. "I set up the vocimotor-auditory *Aufgabe*, 'Try to call up an association and see if the words will come;' immediately 'wigwam' flashed in in visual imagery, but the 'wig' faded out of consciousness very quickly and WAM was clear and distinct."

*W*, Vm. Delayed Recall. "The associations which I had in the learning came in before the words and were followed in each case by visual imagery of the word; the associations always came in in visual imagery."

*Fi*, VAM. Delayed Recall. "I had a vague visual image of some books; this meant for me language-books. Then came the vocimotor-auditory image 'Latin;' immediately QAH appeared in visual imagery."

*S*, VA. Delayed Recall. "In anticipating the series the concrete imagery came in first; *e.g.*, I had visual imagery of some soil and a consciousness, which I can not describe, that the next word was related to soil; following this I had a visual image of a tub of clams; imme-

diately I had an auditory image of the word CLAM; the association immediately dropped out."

XIV. In adding an extraneous syllable to a syllable of the series,—as in the case of making the word 'Berlin' from the printed syllable BER,—a remarkable phenomenon occurs in that, while the intruding syllable may come to consciousness during the act of recall, the *O* never fails to recognize that it does not belong to the series. Although it is present as among the contents of his recalled consciousness of the series, in the recall he never reports the formed word but always reports the syllable which was presented to him.

*T*, *Vm*. "With the syllable JIT I formed the association 'jitney;' JIT was completed by a vocimotor 'ney,' very faint and less intensive than the vocimotor JIT."

*C*, *VAMm*. "With the syllable FEK I had the association 'Fechner;' that is, after the visual perception of FEK there was vocimotor imagery of it; then I wrote it; then I had visual perception of the word I had written with a visual image of NER after the FEK, with vocimotor-auditory imagery of 'Fechner;' the FEK was more clear and definite in the vocimotor-auditory image than the NER."

*Fe*, *VM*. "The syllable JOS was recalled in vocimotor-auditory imagery as 'Joseph,' with the emphasis on the JOS part."

*W*, *VAMm*. "I had several verbal associations present mostly in auditory imagery; for example, LIB='liberal;' the syllable LIB was more intensive than the rest; the latter syllables dropped out very early in the learning."

*Fi*, *VMm*. Delayed Recall. "After I had given XOL-JIT I had rapid vocimotor imagery of 'funny rector;' the nonsense component was emphasized and the completing part of the word was **very indefinite**." (The syllables were FUN and REC.)

XV. The size of the group which is formed by an *O* in the learning is sometimes determined by the immediate memory span of the *O*.

*C*, *VM*. (What determined the number of words which would constitute a group?) "The number of words which I was able to retain in the amount of time I had left after the presentation of one word and before the next one was presented determined in most cases the size of the group."

*W*, *A*. "I tried to retain the words in visual imagery in groups of 5, but in the interval between the presentations of the words I was not able to retain that number, so I set up the *Aufgabe* to divide them into groups of 3; this I did."

*S*, *AM*. "Between the presentations of the words I would repeat about 4 of the immediately preceding words; I could not carry any more in memory. Then I started off with the fifth one as the first of the second group, and so on, until I got 4. This grouping took place in the first presentation."

XVI. The size of the group of words formed by an *O* in the learning may be determined by the number of words that

the *O* is able to anticipate in the interval between the presentations of two successive words.

*P, A.* "I began to combine the words, as many as I was able, between the presentations of two successive words."

*C, VAm.* "Some of the words were learned in pairs, because in joining them together I had time to go over only the word now being presented and the preceding one."

*S, VAM.* "In the first presentation I attempted to recall all the words I had passed up to about the fifth, as I found I was able to retain only this number of words. This threw the series into two groups of 5 each. This I did for 2 or 3 presentations."

XVII. The *O* may set up an *Aufgabe* to divide the series into definite groups. This course makes the size of the groups arbitrary.

*P, VMm.* "I set out with the vocimotor-auditory *Aufgabe* to group the words in pairs."

*T, AM.* (Why was it that your groups contained 4 syllables?) "In the beginning I set out with the *Aufgabe* to group the syllables in fours; during the presentation of the series I just found myself doing it."

*C, AM.* "After I passed the first 4 words I held them in visual imagery and in vocimotor-auditory imagery; this was the result of an *Aufgabe* set up in the foreperiod of the learning."

*Fe, VMm.* "The series were grouped in 5 groups of 4 each in the order in which they occurred." This grouping seems to be the result of an *Einstellung*.

*W, VAMm.* "After you had given me the signal 'Ready, now,' I had vocimotor-auditory imagery of 'Get them by fives right off.' Then I had a very faint visual image of an entire sheet of paper with a schema of 4 groups."

*Fi, VM.* "The words were divided into groups of 4." As this grouping took place in the first presentation, it seems evident that it was the result of an *Einstellung* carrying over from experiences in other investigations in which lists of nonsense material were used.

XVIII. During the act of anticipating, and later in recalling a series, a visual schema of the series is sometimes present, especially for *O*'s of the visual type.

*T, Vm.* Delayed Recall. "A visual schema of a vertical column in front of me appeared in consciousness; the schema became clear as there was eye-movement from the bottom up. The upper part remained very focal, especially the third place from the top. Then *MIH* came clearly in visual imagery (printed)."

*C, VAMm.* Delayed Recall. "Each word came first in vocimotor imagery, followed by auditory and then by visual imagery; the visual image of the word appeared in a visualized column, and as visual attention moved up the column each word came in clearly."

*W, A.* "TINT-ANAL came in in visual imagery on a visualized sheet of paper in front of me, one word below the other."

*Fi, Am.* Delayed Recall. "I had a vague visual schema in which the first 4 syllables stood out more clearly than the rest."

S, A. Delayed Recall. "The first word came on the top of a visualized sheet of paper, the visual image being of the mimetic sort (*f*) and accompanied by vocimotor and auditory imagery of 'ent.' Immediately DENT was vocalized."

XIX. During the act of anticipating, and later in recalling a series, a kinaesthetic schema of the series of words or syllables is sometimes present, especially with *O*'s of the motor type.

P, AM. "Sometimes I stopped anticipating between the pairs and attempted to get a clear percept of each word, localizing them on my fingers; sometimes I did this for two successive presentations."

T, AM. "The immediate recall was as usual in vocimotor imagery with kinaesthetic imagery of tapping in the tempo with which each syllable was presented in the learning."

Fe, VAMm. "There was also present my localizing kinaesthetic schema, present in kinaesthetic imagery of pointing from left to right with my right hand, with eye-fixation at the place where I was pointing. In this process the eye-fixation was much more focal and intensive than the kinaesthetic imagery of pointing."

W, VAM. "Eye-kinaesthesia. I had a visual image of a sheet of paper; then unpleasantness and a sudden shift of visual attention to the bottom of the paper, which meant to me that the words which I had just now recalled did not belong at the top of the list."

Fi, AM. Delayed Recall. "For the first time in the recall I was aware of a vague visual schema which was different from the one I generally use; that is, I was aware of certain regions in the air in front of me, more of a spatial reference to something that was not filled in. This was followed by a kinaesthesia in the neck and eyes of turning slightly to one side in order to fixate this region; perhaps there was actual eye-movement. . . . Then DOY came in in visual imagery."

S, A. "I was conscious of eye-movement up and down this visual schema; the lower part of the schema was focal and the first 3 words were anticipated in visual imagery."

XX. Words which are not recalled promptly are generally preceded, when they are recalled, by a schema which mediates their advent into consciousness.

P, VMm. "When a word did not appear I would focus attention on the finger with which that word was associated; and the word when it appeared would come slowly in vocimotor and auditory imagery."

T, Am. Delayed Recall. "Attention as focused on the bottom of a visual image of a vertical list. Eye-movement up several times, which meant to me 'Start at the bottom and go up.' While fixating this point, QIW finally came in in vocimotor imagery, but there was no visual imagery."

C, A. Delayed Recall. "Before I recalled KITE and SOFA, I had a visual blank in which there was room for 2 words; then vocimotor-auditory imagery, 'Two words associated together;' then both words appeared in visual imagery, localized on this visual schema, one over the other."

*Fi, A.* "There was a hesitation in which no words came; great tensions in the body; there had been gradually developing a visual schema in which I saw the series in a grayish outline extending toward the south-west from the floor."

XXI. If the word is recalled in imagery of the modality corresponding to *O*'s type and is not clear, it is often clarified by a coming in of imagery of a modality corresponding to the mode of presentation.

*T, VA.* Delayed Recall. "DEJ appeared in vocimotor-auditory imagery, followed by a visual image, localized to the left of the aperture; the *d* was especially clear."

*C, A.* Delayed Recall. "In recalling DEAD, DEA appeared first in visual imagery, and this was completed by an auditory image forming the complete word DEAD."

*W, Am.* Delayed Recall. "CARD came in in visual imagery, localized at the top of the visual schema; not more than the *AR* and a very faint *d* were present. Immediately I had auditory imagery of the whole word, with emphasis upon the *c*; I repeated the whole word to myself in vocimotor-auditory terms several times."

*S, VAMm.* Delayed Recall. "I had a faint vocimotor-auditory image of TOLA. This was followed by a very clear visual image of it in print."

XXII. The recalled word may appear first in the imagery corresponding to the mode of presentation and may be completed or clarified by the coming in of imagery corresponding to *O*'s imaginal type.

*T, AM.* "After a long pause I had a clear visual image of the letter *a*; then a vocimotor image of FAZ; then I vocalized it."

*C, AM.* Delayed Recall. "Very often I had a visual image of the first part of the word which would be completed by a very clear distinct visual image of the whole word."

*W, A.* "XUT appeared first in indistinct auditory imagery, I think of your voice; this was completed by a visual image of the word on a sheet of paper in front of me; the word appeared in type."

*Fi, Vm.* Delayed Recall. "All the words came in. There was perhaps a very vague visual image first, in printed type, accompanied by a distinct vocimotor-auditory image."

*S, VA.* "Most of the syllables were usually completed or filled out by a vocimotor image, although the syllable first appeared in a visual image."

XXIII. Visual imagery is not suited for a rapid anticipation or recall. If the *O* recalls very rapidly, it is found that the visual imagery does not develop quickly enough, and that for this reason the *O* often has recourse to vocimotor or auditory imagery or to both.

*C, VAM.* "I began anticipating the second presentation in auditory imagery, then in visual imagery. About the middle of the presentation I started rapid anticipation and this was done in vocimotor-auditory imagery, the visual imagery not coming in at all; I anticipated so rapidly that it seemed there was not time for it to develop."

*W*, VMm. "In the immediate recall I was surprised to find myself repeating the first 5 words in vocimotor imagery with no visual; I gave them very rapidly from the vocimotor image and only one vague visual image (of the word WAGE) came in."

*Fi*, V. "I then attempted to visualize the words, but the attempt always failed me and I abandoned it. The auditory-vocimotor anticipation was much more rapid than the visual."

XXIV. The mode of presentation does not determine the modality of the imagery which the learner will employ in learning a given material.

*P*, A. Delayed Recall. "The first pair of words that appeared was ERGO-VAMP; they appeared in vocimotor imagery while pressing the fourth finger."

*T*, V. "The immediate recall of this series was mostly in actual speech, many of the words being preceded by vocimotor-auditory imagery."

*C*, AM. "Most all the words appeared in visual imagery, followed very often by vocimotor-auditory imagery; the words were localized on my visual schema."

*Fe*, V. "CALF, SOFT, HUMP, URNS and BARK all came, one at a time, in vocimotor-auditory imagery, most of the auditory being of my own voice, but the vocimotor image seemed to be more intensive and clear."

*W*, AMm. Delayed Recall. "The first 7 words came in visual imagery; no vocimotor or auditory imagery was present."

*Fi*, V. "The immediate recall came in vocimotor imagery; no visual imagery."

*S*, A. Delayed Recall. "This recall was made from a visual image of the list about the size used in the presentation; I started at the bottom of the list and went up. HASH came in vocimotor imagery; then in visual imagery. MILT-CUBE came in visual and vocimotor imagery. Which came first I can not say."

XXV. If the *O* fails in his attempt to anticipate a forthcoming word, he sometimes attends to the preceding words which he had just anticipated, and then he waits for the desired word to come into consciousness.

*P*, VM. "After a few presentations I was able to anticipate the first pair and also the last 5 pairs. After this I attended wholly to the words which I was not able to anticipate. As soon as I perceived them I repeated them over and over until the next word was presented. . . . During this time I was neglecting the last 5 pairs which I had anticipated early in the learning. Later on, when I perceived these words focally as they were being presented, they appeared as new words."

*T*, VAM. "After I was able to anticipate the syllables I would hardly look at them . . . as if I were anxious to get to the place where I could not anticipate."

*C*, VMm. "In the third stage of the learning I attended to the drum only when I was not able to anticipate a syllable or when I was not sure when the word which I had anticipated was correct."



*Fe, V.* "Toward the end of the learning I had visual perception only of those words which I was unable to anticipate."

*W, A.* "Toward the end of the learning process I did not attend to your presentation of the words until I was able to anticipate. In the last presentation I anticipated all the syllables."

*Fi, VAM.* "The syllables were anticipated mostly in vocimotor-auditory imagery; next I would look at the drum and, if I had anticipated correctly, there would be a pronunciation of the syllable and then a turning away of my visual line of regard from the drum; then I would anticipate the next word."

*S, AM.* "In the third presentation I actually anticipated every syllable in the series; this anticipation was made with but little attention to you; I attended only to my own anticipatory processes."

XXVI. If an *O* is unable to anticipate a word he often repeats the preceding words until the desired word appears.

*P, VA.* "All the words came easily up to the seventh pair; then a blank; that is, no imagery came; then I had imagery of the next pair, so I gave it; I then went back to the sixth pair and repeated it in vocimotor-auditory terms; immediately the second pair followed right on."

*T, VAM.* Delayed Recall. "PIW was repeated several times, mostly in auditory imagery. Immediately CUG-QAR came in vocimotor imagery, no schema being present."

*C, VAM.* Delayed Recall. "The first 8 words appeared first as very definite and intensive auditory imagery, followed by vocimotor imagery; then I had a visual image of a blank, to which I attended. Finally NEXT appeared in vocimotor imagery."

*Fe, AMm.* Delayed Recall. "'Crop' came very easily in vocimotor-auditory imagery; auditory imagery of my own voice; then no imagery came but there was great unpleasantness and strains. 'CROP, —un, un' was repeated several times in vocimotor imagery; finally a vocimotor, 'Gee, don't know these.'"

*W, VM.* "When the words did not appear promptly in the immediate recall there was a period during which there was no imaginal content in consciousness; then my eye moved up and down that part of the visual schema to which the desired word belonged; usually visual imagery of the words preceding and following the desired words would come in; then suddenly these words would appear in visual imagery in their correct place."

*Fi, A.* Delayed Recall. "I had a visual schema in which was a blank space for about 2 words; I attended to the schema for awhile, conscious of strains in the whole body; then the syllable NAF came in vocimotor-auditory imagery and the remaining words of the series followed."

*S, VAM.* "I had a visual image of my schema with a visual image of IDOL at the top of the list; then blank spaces for about 3 words below which meant to me that there were words left out; then vocimotor-auditory *Aufgabe*, 'Try your vocimotor; you can get it that way;' then I had vocimotor-auditory imagery of IDOL several times and the remaining words came in finally."

XXVII. If an *O* comes to a part of the series which he is unable to anticipate, he very often stops his attempted anticipation until the word desired is presented to him in the ordinary course of the presentation of the series; he perceives this word, if the presentation is visual, or calls up imagery of it, if the presentation is auditory, until the next word is presented.

*C, VMm.* "In the next presentation I started to anticipate; in the middle of the series I had great difficulty; when they were presented I looked at them very hard and wrote them down, and looked at the word I had written for a long time."

*W, V.* "In the last presentation I adopted the same procedure as formerly, anticipating ahead of the actual presentation. When I could not anticipate I had recourse to the retention method; that is, as soon as the desired word was presented it was held in consciousness for a long time."

XXVIII. When an *O* could not recall a word, he sometimes set up the *Aufgabe* to go through the alphabet in an attempt to get the word desired; *i.e.*, commencing with *a*, then *b*, *etc.*, he would pronounce each letter or call up a visual image of it, excepting that, when he came to the letter which was the initial letter of the desired word, the word itself would come to consciousness.

*T, VAMm.* "After I had given CEJ there was a blank; visual schema came in and the last 3 syllables stood out focally and I gave them to you; the fourth last space became focal but no syllable appeared; then I set up the vocimotor-auditory *Aufgabe* to go through the alphabet; when I came to M, MUN came in vocimotor-auditory imagery; with this there was also a visual image of MUV, with the V much more clear than the MU."

*C, Am.* Delayed Recall. "JOQ-HAJ was recalled in a sort of a logical procedure. A vocimotor-auditory *Aufgabe*, 'Go through the alphabet.' . . . When I came to *j* I had vocimotor-auditory imagery, 'Some syllable had a *j* in it;' then a visual image of a *j*, accompanied by pleasant affective toning, and HOJ came in in visual imagery.

XXIX. In the learning, some of the words formed 'corner stones' on which the remainder of the series was learned.

*W, VA.* "My procedure was to retain in visual imagery the first and last of each group of 5, and then to add one word each time in each presentation."

*W, Vm.* "I spent the rest of this presentation in attending to the first and last word of each group; that is, looking at them more attentively and keeping them longer in visual imagery than I did the rest of the group. In the next presentation these words so retained were always recognized as the first and last word of a group. . . . Later I commenced to attend more closely to the middle of each group. Then my procedure changed to one of anticipation; I could anticipate the first and last of each 5, then the middle. The rest of the procedure consisted in anticipating the remaining words of each group."

*The Process of Learning*

The process of learning was found to consist of three distinct stages; and these three stages recurred throughout the experiments, whatever the mode of presentation, or the nature of the materials to be learned, or the ideational type (or learning-type) of the learner.<sup>20</sup>

I. *The Orienting Stage.* This initial stage of the process of learning extends over only the first few presentations of any given series to be learned. Whether it is confined to the first presentation alone, or whether it extends over several presentations, depends less upon the ideational type of the individual than upon the nature of the material itself (*i.e.*, whether meaningful words or nonsense-syllables) and the nature of the series (*i.e.*, whether difficult or easy for the particular individual).

During the presentation of the material in this orienting stage, the attitude of the learner is one of passive receptivity. He makes no attempt either to group or to anticipate the words which are being presented; he merely perceives them. There are rare exceptions. Occasionally an *O* manifested an incipient tendency during this initial stage to group the materials into larger units, a tendency apparently consequent upon his having set up for himself during the foreperiod an *Aufgabe* to divide the list of material into groups of definite size. *W* sought groups of five and *Fe* groups of four.

If the mode of presentation is a combined visual-auditory one, the learner in most cases attends focally to either the auditory or the visual stimulus alone, and very seldom to both equally. A feeling of familiarity for the series tends to develop during this initial stage, and marks the progress of the learner's orientation in his task.

It appears that the perception of the words, no matter how they may be presented, is invariably followed, at least in the first few presentations, by a reflex reproduction of them by the learner. This reproduction occurs in vocimotor or in vocimotor-auditory terms. Even the instruction to inhibit vocimotor imagery fails to prevent the vocimotor reproductions, at least during the first few presentations of the list.<sup>21</sup>

<sup>20</sup> Meumann, *Vorlesungen*, II, divides the learning process into four stages: (1) the orientation or adaptation stage; (2) the stage of passive receptivity; (3) the stage in which the material is tentatively recited or checked by the learner; (4) the stage in which the learner finally fixes the uncertain parts of the series. The first and second stages of learning as given by Meumann differ but little, if at all, and therefore can easily be combined into one stage. If this is done our classification agrees exactly with that of Meumann.

<sup>21</sup> Secor, W. B. (*Visual Reading, A study in mental imagery, Amer. J. Psychol.*, 11, 1900, 225-236), in his experiments on reading, reported that vocimotor movements could be inhibited. Curtis, H. S. (*Automatic movements of the larynx, ibid.*, 11, 1900, 237-239), using a different type of laryngograph, obtained graphic records of vocimotor movements when his *O*'s were mentally reciting a poem or a selection of prose. If Curtis' results are to be taken to mean that vocimotor movement was present in all cases, it is probable that Secor's learners employed vocimotor imagery, if not the actual vocimotor innervation. Abbott (*On the analysis of memory consciousness in orthography,*

When a learner of the visual type is fairly successful in inhibiting vocimotor processes, his visual imagery is usually less clear and definite than when the vocimotor processes are allowed to function in natural fashion. When the learner of the motor type attempts to inhibit the vocimotor processes, auditory imagery frequently makes its appearance and plays a more important rôle than when the vocimotor processes are not interfered with. Auditory imagery may thus be enhanced even when the learner does not succeed in completely inhibiting his vocimotor processes.<sup>22</sup>

In rare instances learners succeeded in almost wholly eliminating the vocimotor processes from the very start of the series; but in every such case they found that it was impossible completely to memorize the materials presented.<sup>23</sup> Even though the list were presented a great many times (in one instance 39 times), the process of memorizing still remained far from complete, and the learner eventually always gave up his attempt to memorize the material. A subsequent attempt to recall the list would show that not more than 5 or 6 words out of a list of 20 had been memorized, and that these words the *O* recalled with but a slight degree of subjective assurance and with no definite consciousness as to their exact position in the list. Every attempt to complete the act of memorizing without the participation of the vocimotor processes thus ended in failure and the abandonment of the effort to learn on account of fatigue or lack of time. Learners of the motor type were especially unsuccessful.

With the *O* of visual type, the vocimotor image, though essential at first, tends to disappear very early in the learning process. It is seldom present after the fifth or sixth presentation of the series. This rule holds even when the learner is not instructed to inhibit vocimotor imagery. We hold, consequently, that, whatever the imaginal type of the learner may be, vocimotor imagery or vocimotor innervation is absolutely necessary for an individual to begin to learn a series

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*Psychol. Rev. Mon. Sup.*, 11, 1909, 127-158) found that vocimotor processes were always an aid, and Smedley (*op. cit.*), concluded that it was impossible to test a single sense-modality because vocimotor imagery could not be repressed. The results obtained by Mould, Treadwell and Washburn (The influence of suppressing articulation on the favorable effects of distributing repetitions, *Amer. J. Psychol.*, 26, 1915, 286-288) show that the recall is twice as efficient when the *O* is allowed to use vocimotor imagery in the learning as when he is told not to use it, and accordingly attempts to inhibit it. The statistical data of these investigations indicate that vocimotor imagery was never wholly eliminated, and that the repression of vocimotor imagery was always a great distraction to the learners.

<sup>22</sup> This phenomenon has also been reported by Abbott and Secor, *op. cit.*

<sup>23</sup> Kline, L. W. (A study in the psychology of spelling, *J. Educ. Psychol.*, 3, 1912, 381-400) found that any interference with the dominant receptor mechanism results in a greater impairment of the learning process than does an interference with the preferred form of expression. Müller and Schumann (Experimentelle Beiträge zur Untersuchung des Gedächtnisses, *Zsch. f. Psychol.*, 6, 1893, 81-190, 175-339) found that the repression of rhythmic vocalization renders learning almost impossible for some *O*'s. Cohn (*op. cit.*) also found that vocimotor processes were important to the learning and that learning was less efficient when the learner attempted to inhibit vocimotor imagery.

of words or nonsense-syllables. In these early stages it can rarely be eliminated by instruction, and its elimination, when it does occur, prevents learning.

When the *O* is given the *Aufgabe* to inhibit vocimotor imagery, he reacts in either of two ways. (1) He may accept the *Aufgabe* and actively attempt to inhibit it; if he is successful to a great degree, very little learning, if any, takes place. (2) He may comply with the instructions by setting up for himself a new *Aufgabe*, usually in vocimotor terms, to use imagery of another modality; e.g., 'use visual imagery.' This latter procedure is more efficient than the first, but is effective only for *O*'s of the visual type and after the first few presentations.

When the *Aufgabe* required that the *O* pronounce the material aloud, vocalization often proved a hindrance to the learning. The chief fault of vocalization lies in the fact that it fills up so much of the time-interval (3 secs.) between the presentation of successive syllables that little time is allowed for the learner to anticipate the next syllable, and such anticipation is the learner's method of testing his knowledge of the series. As a matter of fact vocalization of the material, when required, becomes less intensive in the later stages of the learning.

II. *The Stage of Attempted Anticipation.* In the second stage of the learning process the *O* is very active in his attempts to anticipate the forthcoming members of the series. The power to anticipate the series becomes in every case the *O*'s criterion that he has learned the material.

The anticipation takes place either in visual or vocimotor (auditory) terms, depending upon the learner's type. In this stage the learner actually succeeds, however, in anticipating only a very few words, for he is concerned chiefly in obtaining a clear perception of each word during presentation and in attempting to combine the word at hand with the preceding and subsequent words.

In rapid anticipation the learner of visual type often makes use of vocimotor-auditory imagery, reporting that visual imagery does not develop quickly enough and that he therefore finds himself using vocimotor imagery.<sup>24</sup>

The first two or three and the last two or three words of a series are usually the first to be anticipated. There is no definite order in which the remaining words begin to be anticipated. Only one of our 7 *O*'s (*S*) did not invariably resort to grouping of the words, and even he occasionally used this expedient, although by no means so frequently as the other *O*'s who always grouped the words.

The number of words or syllables which constitute a group is determined in one of five ways. (1) *The time intervening between the presentation of two successive words.* As soon as a word was presented, the learner would repeat it, and then repeat as many of the preceding words as possible before the following word was presented. The maximum number of words that he was able to repeat

<sup>24</sup> Binet and Henri (La mémoire des mots, *Année psychol.*, 1, 1894, 1-23) report material recalled in vocimotor-auditory terms, because recall was so rapid that a visual image did not have time to develop. Von Sybel (*op. cit.*) found that when an *O* of visual type became fatigued he had recourse to vocimotor imagery. Von Sybel also found that the visual learner again employed vocimotor imagery when the presentation of the material was very rapid. Pohlmann (*op. cit.*) observed that an *O* of visual type is hampered in his learning by a too rapid auditory presentation.

in this time would constitute a group. (2) *The immediate memory-span of the O*. As many words as an *O* was able to repeat to himself from immediate memory without confusing their order or forgetting a word would constitute a group. If he attempted to add another word to such a group, he would be unable to recall one or more of the words, and this failure would mean to him that he had exceeded his immediate memory-span. (3) *A meaningful association*. If a certain number of words form a meaningful association, then this number of words may form a group. (4) *The Aufgabe*. In the fore-period, or during the learning, the *O* may set up an *Aufgabe* to group in fours or fives, thus forming a purely arbitrary group. The size of the groups chosen is frequently determined by the *O*'s experience, either during the experiment or in previous experiments, by which he knows what size of group is the most efficient for him to work with in learning a series of words. (5) *Difficult words*. A difficult word often marked the beginning of a group; if a learner had especial difficulty either in perceiving a word or in anticipating it, this difficult word would become the initial member of a group. The next difficult word would be the first word of the next group; thus the number of words which would constitute such a group varied.

A group formed through the medium of a meaningful association is least apt to be forgotten in the recall. An entire group thus formed may fail to appear to consciousness in the recall; but, if the first word of the group can be recalled by the *O*, the others follow very quickly.

Meaningful associations are present in the first few presentations only and then drop out, seldom to reappear in the learning. This rule holds no matter in what modality of imagery the association appears. The effect of such association is manifest in anticipation and recall, for the meaningfully associated words come into consciousness more quickly, one after the other, than the other words.

The temporal relations between the appearance of the words of the series and their meaningful associations are as follows. (1) The words to be recalled come into consciousness quickly and clearly in the imagery of the *O*'s type; the meaning is present in the words themselves and in the fact that they come together. The *O* was unable to find any other introspective evidence to explain the meaning. (2) The meaningful content comes into consciousness in imagery of any modality; the words of the series come later and very quickly, one after the other, in the imagery of the *O*'s type. If the association is present in a visual-concrete or an auditory-concrete image, it is followed by verbal imagery of the desired word in the imagery of the *O*'s type. (3) The words themselves come first in the imagery of the *O*'s type, and the meaningful content comes later, either in verbal or concrete imagery of any modality. (4) If a meaning was attached to a syllable by adding one or two syllables to the presented syllable, thereby making it a meaningful word, the *O* 'knows' what part of the made-word is the syllable desired by the fact that the desired syllable is more clear and definite, if a visual image, and more intensive and distinct, if the image is motor or auditory or auditory-motor, than the added or associated part.

III. *Anticipatory Stage*. In this final stage of the process of learning, the *O* is concerned chiefly in anticipating the syllables. He may anticipate as rapidly as he is able with no reference to the words which are being presented, or he may anticipate one word at a time just before it is presented to him. As soon as the word is presented he

perceives it focally, and again anticipates the next word just before it is presented to him. Vocimotor imagery may or may not be present if the *O* is of visual type; if he is of motor type he repeats this stimulus-word several times and then links it with the preceding or subsequent words, or with both.

In the case of an *O* whose anticipation of words or syllables is far in advance of their actual presentation, an interesting phenomenon is seen when the *O* comes to a point in the series where anticipation is impossible. Then the process of anticipating ceases until, in the actual presentation, that word is reached which he failed to anticipate.

This procedure of anticipating and linking up the words which he can not anticipate, a learner continues until all the words have been anticipated at least once. In many instances, after correctly anticipating the series once, he will set up the *Aufgabe*, 'Go through and anticipate the series once more, to make certain;' and then, having again anticipated successfully, he will signify that he has learned the series.

When the material is presented to the learner in a purely auditory fashion, he very often finds it difficult to obtain a definite percept of words or syllables containing such letters as *c*, *k*, *d*, *q*, and *t* occurring either as initial or final letters, and *w* and *h* occurring as final letters in a syllable.<sup>25</sup>

Some *O*'s, as soon as they perceive the auditory stimulus, decide upon a definite spelling of the word, especially in the latter part of the investigation. In this way the uncertainty as to the correct spelling of the word, if it enters at all, is very slight. In most instances such words are not spelled by the *O*'s in the form in which *E* had them in his lists.

Greater attention, it appears, may be secured by material presented in auditory fashion than by material presented visually. This difference is due to the nature of the auditory presentation itself. Individuals find it more difficult to obtain a definite auditory perception

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<sup>25</sup> Henmon, V. A. C. (The relation between mode of presentation and retention, *Psychol. Rev.*, 19, 1912, 79-96) found that material was learned more efficiently when the words were presented in purely auditory fashion, but he excluded all syllables ending in *c*, *q* and *h*, and all syllables beginning with *x*. The excluding of words containing these letters from his material did away with the main difficulty connected with the auditory mode of presentation. Henmon claims he was investigating the relative efficiency of the different modes of presentation, but by omitting words containing such letters as *c*, *q*, *k*, he eliminated one of the difficulties necessarily connected with the auditory mode of presentation. The auditory mode of presentation, therefore, was given an advantage which was not given to the other modes of presentation, since many letters like *e*, *a*, *b*, *l*, look alike in the visual presentation, and may give rise to an indefinite visual perception.

Pohlmann (*op. cit.*) found that auditory presentation is better than visual for young children. This result can be explained by the fact that children are more familiar with spoken language than with written language. Pohlmann also found that auditory presentation is not efficient for the learning of nonsense-syllables because the learner is often uncertain as to what the exact sound is.

Abbott (*op. cit.*) also confirms our findings, for her *O*'s recognized only about one-half of the words when they were pronounced to them.

than a definite visual perception, especially with nonsense material, hence greater attention is required when the material is presented in auditory fashion. Nevertheless in spite of increased attention auditory presentation does not increase the efficiency of learning. To a large extent this heightened attention is aroused by the inherent indistinctness of the auditory percept, and the *O*'s alertness is expended in decisions about the material and not in further impression of the material.

In both the immediate and delayed recalls the material is recalled always as individual words, though the words may have been grouped in the learning. Words which were grouped in the learning came to mind more quickly in the recall one after the other and with a slightly longer pause after the last one, than do words which were not grouped. Those *O*'s who employ a visual schema often in grouping visualize a part of this schema, equal to that which the number of words in the group would require if they were printed in the same fashion as the material used in the visual presentation. The words themselves then come to consciousness, one at a time, usually in visual imagery. Words not grouped in the learning come to consciousness in the recalls, one at a time, but much more slowly than the grouped words.

In many cases an *O* is subjectively certain that the recalled material is correct, but the structure of this subjective assurance is not the same for all *O*'s.<sup>26</sup> The following items, arranged in order of importance, may contribute to this state of consciousness, although not more than two or three of them need be present at any one time. (1) The *O* after recalling a word was able to attempt the recall of the subsequent word without the first word reappearing during the attempted recall of the second word; (2) the imagery of recall comes rapidly to consciousness; (3) the recalled words are pronounced with positiveness; (4) the affective tone is pleasant.

When the words do not come to consciousness quickly either in the anticipating or in the recall, all *O*'s, regardless of their imaginal type, usually recall the words in vocimotor imagery.<sup>27</sup>

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<sup>26</sup> Finzi (*op. cit.*) noted that subjective assurance depends upon the distinctness of the memory image; the more distinct the image the more convinced is one of its fidelity. He also found that certain organic sensations are present when the learner is subjectively certain that his recall is correct. Frankfurter and Thiele (*op. cit.*) pointed out that an important requisite for this state is the presence of a spatial schema for localizing the material. Kühn, A. (Ueber Einprägung durch Lesen und durch Rezitieren, *Zsch. f. Psychol.*, 68, 1914, 396-482) noted the following factors as making up the consciousness of subjective assurance: (1) clearness of the visual image, (2) number of helps, and (3) smoothness of recall. Meyer (Bereitschaft und Wiedererkennen, *Zsch. f. Psychol.*, 70, 1914, 161-211) emphasized two factors: (1) quickness of reaction time and (2) definiteness of localization. Pederson (Experimentelle Untersuchung der visuellen und akustischen Erinnerungsbilder, angestellt an Schulkindern, *Arch. f. d. ges. Psychol.*, 4, 1905, 520-534) held that (1) a good perception of the material and (2) a highly concentrated attention were the requisites for a consciousness of subjective assurance.

<sup>27</sup> Von Sybel (*op. cit.*) also found this to be the case. He reported that his learners used more vocimotor imagery and less visual imagery when the series was difficult to acquire.



A schema of localization is usually employed by *O*'s in the recall, especially when the material to be recalled does not come to consciousness quickly. There are three types of schemata: (1) a visual schema; (2) a kinaesthetic schema; (3) a rhythmic schema.

(1) *Visual Schema*. This schema is employed mostly by *O*'s of the visual type,<sup>28</sup> and to a less extent by some *O*'s of the motor type. It consists of a visual image of a sheet of paper with words printed on it. It is usually localized directly in front of the *O* with the words appearing in a vertical column, the first word at the top. In one instance this schema appeared in a horizontal plane with the words running from left to right. When a word does not come to consciousness quickly, the schema appears first. The part of the schema to which the word belongs is most focal, and the rest of the schema is present in a very indefinite non-focal fashion. The word desired then appears in consciousness in visual imagery, usually localized in its proper place in the schema. Some *O*'s are conscious of eye-movement up and down the series localizing the words in the visual schema.

(2) *Kinaesthetic Schema*. This schema is used by the *O*'s of the motor type who employ very little visual imagery. It consists of a kinaesthetic movement or imagery of movement of the hand or head pointing to that part of the series to which the particular word belongs. The extreme left of the *O* represents the first word of the series and the extreme right the last of the series. No visual imagery is present, although there is the kinaesthesia of eye-movement accompanying the manumotor or arm-motor imagery of pointing.

(3) *Rhythmic Schema*. This schema is used by *O*'s of all types, and consists of a vocimotor consciousness of rhythmic sounds. In some instances no definite words or syllables are present.<sup>29</sup> The rhythm, up to the point where the word fails to appear, is repeated by the *O* until the required word is obtained or until the learner gives up his attempt to recall the word.

When the words do not appear in consciousness some *O*'s often set up an *Aufgabe*, usually in vocimotor-auditory terms, to go through the alphabet; i.e., start with *a* and pronounce each letter, expecting that when the correct initial letter is pronounced the word itself will come to consciousness.

The clearness and definiteness with which any schema appears in consciousness is in direct relationship to the difficulty with which the words appeared. If the words come to consciousness after a short pause, the schema, if it appears at all, is non-focal; if the word or group does not appear until a relatively long time has elapsed, the schema is focal and definite in consciousness. Since the schema is more focally present when the recall of words is more difficult, it is therefore more focal in delayed recall than in immediate recall.

<sup>28</sup> Kuhlmann, F. (On the analysis of the memory consciousness, *Psychol. Rev.*, 13, 1906, 316-348) reports that the schema of localization generally precedes the recalling of the material.

<sup>29</sup> Müller (*Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes*, *Zsch. f. Psych.*, Ergbd. V., 1911, xiv+403) emphasized the importance of rhythm, especially in the first stages of the learning. Müller and Schumann (*op. cit.*) also found that rhythm was a very important factor in learning inasmuch as the syllables which had once formed a part of a metrical foot tended to be associated more closely than syllables not bound together in this way.

The *O* is apt to be uncertain in recall when a word is recalled with difficulty.<sup>30</sup> Two or more of the following factors, listed in order of their importance, usually constitute this consciousness of uncertainty. (1) The first syllable in an associated pair keeps repeating itself; even after the recall of the second syllable the first continues to recur in consciousness. (2) Images of the two syllables alternate or rival in consciousness. (3) A word fluctuates in its position in the schema of localization. There is (4) hesitancy in vocalization, (5) a questioning intonation in vocalization, (6) an unpleasant affective tone.

If in the learning an *O* forms a group which is recalled in motor terms, a motor trend sometimes appears as an aid in recall: as soon as a learner vocalizes one word of a group he 'finds' his vocal apparatus automatically set to say the next word. The group thus becomes a 'motor unit' which runs its course automatically once it is initiated.

In anticipating and recalling the words of a series, the visual imagery of a word may appear (1) typewritten, (2) in the *O*'s own handwriting, or (3) in a form that can not be recognized as any specific writing or printing. There is no conclusive evidence that explains the occurrence of one of these forms rather than another. Most of the visual imagery is of the typewritten form and is derived doubtless from the presented material. It is when the *O* is required to write the words in the learning or in the recall that he has many visual images of his own handwriting. Especially does he seem to visualize his handwriting if he has a characteristic way of forming certain letters.

The *O* of visual type, when presented with material in either auditory or visual fashion, always recalls in visual imagery.<sup>31</sup> The *O* of motor type, when presented with material in visual or auditory fashion, almost always recalls in vocimotor imagery. It appears, therefore, that, regardless of mode of presentation, an *O* recalls material predominantly in imagery of his own type, although supplemented at times by the imagery corresponding to the mode of presentation. Certainly the mode of presentation is in no way indicative of the modality of imagery that an *O* will employ in recalling that material.

When material is recalled with difficulty, the imagery may first appear in the *O*'s own type, and then be completed by imagery corresponding to the imagery of the mode of presentation; or the difficult word may first appear incomplete and unclear in the imagery of the mode of presentation, and then be completed by the imagery of the learner's type. Observers of all types in recalling in auditory terms a material presented auditorily by *E* usually have imagery of their own

<sup>30</sup> Kuhlmann (*op. cit.*) and von Wartensleben (Ueber den Einfluss der Zwischenzeit auf die Reproduktion gelesener Buchstaben, *Zsch. f. Psychol.*, 64, 1913, 321-385) found subjective uncertainty when there was rivalry between two images for the center of consciousness. Meyer (*op. cit.*) found that the greater the lack of subjective assurance the longer the reaction-time, and that indefinite localization conditioned subjective uncertainty.

<sup>31</sup> Abbott (*op. cit.*) points out that a visual image is invariably substituted at once for the heard letters. Frankfurter and Thiele, Meumann and many other investigators have shown that the image of the reproduced word is primarily determined in the ideational type of the learner, and is influenced only secondarily by the mode of presentation.

voices rather than of *E*'s. Occasionally, however, if *E* pronounces a word in a manner which seems odd to the *O*, the recall appears in auditory imagery of *E*'s voice.

In no instance, either in learning or in recall, did any *O* report the presence of a manumotor image.<sup>32</sup> It has been assumed that learning is more efficient if the material to be acquired is written during the act of learning, especially when the material is dictated to the learner as it may be in learning to spell. In the light of our data it appears that the writing-movement, the motor sensations *per se*, do not help at all in the learning.<sup>33</sup> The help comes rather from the *O*'s seeing what he has written, and it is this visual percept only that helps the learner. The act of writing is important and necessary because it makes possible this visual percept and because attention is thus retained longer upon the word than is the case when the word is written by another person.

If the series is difficult to learn and the *O* requires a great number of presentations to learn it, the delayed recall is apt to be relatively poor. This situation arises because successive presentations yield diminishing returns. In most of the later presentations the *O* passes over the words which he has already anticipated; he assumes that they are learned and tries neither to perceive them clearly nor to anticipate them. Thus the later presentations do little to strengthen the associations of many of the words, which after a time pass below the associative threshold as readily as if the final presentations had not been made.

Meumann's rule is that the greater the number of presentations, the greater the strength of the association, everything else being equal. But in no series unfortunately are all things equal. Even nonsense syllables are of unequal difficulty, and the various positions within the presented series are variously favorable. Hence in learning a series it is inevitably true that some parts are learned first and that the final presentations are of greatly diminished value in the further impression of these parts.

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<sup>32</sup> One observer, *T*, Am, reported with great uncertainty what he thought was a manumotor image, but at no other time was a manumotor image reported by any *O*.

<sup>33</sup> Smith, T. L. (On muscular memory, *Amer. J. Psychol.*, 7, 1896, 453-490) found that errors in recall were reduced 16% by allowing the learner to write the letters; but his subjects were deaf mutes and employed the deaf-mute alphabet. The nature of this material lends itself more readily to motor reproduction than does printed or spoken language. Lay (*op. cit.*) concluded that the writing *per se* is an aid to learning; Fuchs and Hagenmüller and Itschner (*opp. citt.*), who obtained results similar to Lay's, explained their findings differently. Fuchs and Hagenmüller pointed out that the material is seen twice when it is written, once when it is presented and a second time after being written. Itschner calls attention to the fact that the presentation-time is longer for the series when the *O*'s write the words and that writing the words destroys an illusion that the material is learned, which occurs prematurely in visual presentation.

R. Dodge (*Die motorischen Wortvorstellungen*, 1896, 78 pp.), although of extreme motor type, never had a manumotor image.

*Objective Data*

In securing the objective data we arbitrarily determined to make the following deductions for each of the possible errors in recall. The deductions are in arbitrary units based on the assumption that perfect recall involves 1,440 units.

	Three-letter syllables	Four-letter words
For a wrong letter.....	32	24
For an omitted letter.....	24	18
For a misplaced letter.....	16	12
For each letter of an unplaced word.....	8	6
For each letter of an interchanged word.	4	3
For an interchanged letter.....	4	3

The deductions were determined in the following manner. The correct recall of a single letter was assumed to count 6 points, and its omission in recall to necessitate a deduction of 6 points from the maximal score. For giving a wrong letter 8 points were deducted, since it is a greater error to give a wrong letter than to give none at all; in this case not only is the correct letter forgotten, but the *lacuna* is also filled in by false data. Since, when a wrong letter is given, more than the total value of a letter is deducted (8/6), it is theoretically possible to obtain a negative score if more than three-fourths (6/8) is positively wrong in recall. Such a situation, however, if it occurred, would indicate a positive tendency for mislearning and not merely a failure to learn, and should properly be represented by a negative value. For each letter of a misplaced word or syllable, 4 points were to be deducted; for each letter of an unplaced (unlocalized within the series) word or syllable, 2 points; for each letter of interchanged words, 2 points. In the foregoing table of deductions these points have been multiplied by 4 for three-letter nonsense-syllables and by 3 for the four-letter meaningful words, in order that the total values of the two materials might be the same. Thus the score-value of 60 three-letter syllables is  $60 \times 3 \times 4 = 1440$ ; and the score-value of 60 four-letter words is  $60 \times 4 \times 3 = 1440$ . The 1440 units represent perfect recall; deductions are made from 1440 in accordance with the foregoing table, and the remainder is expressed as a percentage of perfect recall (1440 points).

TABLE I

K ORDER OF EFFICIENCY FOR EACH MODE OF PRESENTATION. V = VISUAL, A = AUDITORY, M = VOCIMOTOR, m = MANUMOTOR. MODES OF SAME RANK ARE CONNECTED BY SIGN OF EQUALITY

RANK-ORDER

Obs.	Material:	1	2	3	4	5	6	7	8	9	10	11	12
		Most Efficient								Least Efficient			
C	Meaningful Nonsense	AMm V	Vm VMm	Vm Am	A = VAMm	Am VA	VMm = VM	V AM	VAm AMfm	Vm VAM	Vm A	AM Vm	VM AMm
Fe	Meaningful Nonsense	VM = VA VM	VA = AMm	VAM VAMm = A	VAm A	Am VMm	V Am	A AM	VAMm VA	Vm Vm	Vm V	AM VAM	AMm AMm
S	Meaningful Nonsense	VM AM VM = AMm	Vm VMm	Vm VMm	A AM	VA V	VAMm VA	VAM Am	Am Vm	AMm A	V VAM	VAm VAM	VMm VMm
	Meaningful Nonsense	VM V VAM Vm = AM	A AM	Vm VA =	Vm VA =	VAMm = V	Am A	AMm VAMm	VAM VMm	VMm VM	AM AMm	VAm Am	VA AMm
Fi	Nonsense	VM VAM = AM	VAM = AM	Vm VA =	VMm VA	VA	A	Vm	V =	Am =	AMm	VAMm	VAMm
P	Meaningful	VM AM	VAMm	Vm VAMm	Vm VA	V	VAm	Am	VMm	VAM	AMm	VA	A
T	Nonsense	VAM VM	VMm	VAMm	AMm VA	VA	V	AM	Vm	VAMm	A	Am	AMm
All	Meaningful Nonsense	VM Vm VM VMm	VAMm = V VAMm = AMm	VAMm = V VAMm = AMm	V = AMm	Am VA	A V	VAM AM	AM VAM	Vm VAM	VAm Am	AMm Am	VA A

Table I shows that there is no one mode of presentation which is the best for all *O*'s. Visual-vocimotor presentation, VM, is the most efficient in 7 cases: it is second in efficiency once, fifth once, ninth once, and last once. Nor is the same mode of presentation best for the same *O* with different materials. *W*, for example, finds visual-vocimotor presentation, VM, the most efficient mode in learning meaningful words, whereas it is only eighth best for him in the learning of non-sense material.

TABLE II

AVERAGE EFFICIENCY FOR EACH MODE OF PRESENTATION AS MEASURED BY AVERAGE NUMBER OF PRESENTATIONS REQUIRED FOR LEARNING; ALL OBSERVERS. V = VISUAL, A = AUDITORY, M = VOCIMOTOR, m = MANUMOTOR. LAST COLUMN ARRANGED IN ORDER OF EFFICIENCY WITH LEAST EFFICIENT MODE AT THE TOP

Order of Presentation	Mode Presentation	Meaningful Words	Nonsense Syllables	Average Two Materials
7	Am	5.90	7.83	6.87
3	VA	8.10	5.58	6.84
10	AMm	7.80	5.92	6.86
2	A	6.00	7.33	6.67
11	VMm	9.10	4.17	6.64
8	VAM	7.00	5.83	6.42
5	Vm	4.80	7.58	6.19
6	AM	7.20	5.00	6.10
12	VAMm	4.00	6.90	5.85
1	V	5.90	5.25	5.58
4	VM	3.40	3.42	3.41
9	VAm	8.00	....	....

Table II again shows that the combined visual-vocimotor mode of presentation is by far the most efficient. The amount of variation between the other modes of presentation is so slight that no significant differences are apparent.

These objective data do not properly afford an answer to the problem of the most efficient mode of learning, because in the first place the determinations are too few to allow of a significant statistical treatment, and because the general averages fail to take account of the imaginal type of the *O*'s. If statistics are to tell the true story, an average must represent not a single mode of presentation but a single mode of learning. The learning-process must be introspectively controlled or at least viewed in the light of the previously determined type of the learner, and averages must be found for similar modes of learning, even though they occur with dissimilar modes of presentation.

## SUMMARY AND CONCLUSIONS

1. The process of learning consists of three distinct stages: (a) the orienting stage (pp. 269 ff.); (b) the stage of attempted anticipation (pp. 271 f.); and (c) the anticipatory stage (pp. 272 ff.).

2. All of our *O*'s found it necessary to employ vocimotor imagery in learning a series of meaningful words or nonsense-syllables; no *O* was able to learn a series of words or nonsense-syllables if he succeeded under instruction in inhibiting vocimotor imagery from the start. The *O*'s of visual type in most cases did not employ vocimotor imagery after the first few presentations of the material in the learning, but the vocimotor imagery was present during the initial presentations and did not lapse until the visual imagery had become clear and definite. The *O*'s of the motor type are never able to inhibit vocimotor imagery and yet learn the material.

3. If the *O* is instructed not to use vocimotor imagery during learning he responds (a) by attempting actively to inhibit vocimotor imagery, thus interfering with or preventing learning, or (b) by setting up for himself a new *Aufgabe* to use imagery of another modality (e.g., visual imagery).

4. The *O* in learning usually groups the words or syllables; and the number of words or syllables which constitute a group depends upon (a) the time intervening between the presentation of two successive words, (b) the immediate memory-span of the *O*, (c) the meaningful associations between the words or syllables, (d) the presence of an *Aufgabe* for grouping that the learner himself may set up, and (e) the position of difficult words within the series.

5. Manumotor imagery does not aid either the learning or the recall. When the material to be learned is presented to the *O* in auditory fashion, the learning is in most cases more efficient if the *O* is required to write the material than if he does not write it; and the increased efficiency occurs especially when the materials are isolated words or syllables or when auditory perception is less definite than visual perception. In these cases the *O* must decide upon a definite spelling in order to write the word pronounced to him, and the writing thus definitizes the perception. The advantage of writing, therefore, comes not from manumotor processes but from the visual percept of the written word.

6. The mode of presentation is in no way indicative of the modality of imagery that an *O* will employ in learning or

recalling a series of words or syllables. The modality of the imagery which a learner employs is determined primarily by his ideational type and only secondarily by the mode of presentation.

7. All *O*'s find it difficult to obtain a definite auditory perception of some syllables, especially those syllables containing the letters *c, q, k; d, t; etc.*

8. The recall of difficult words or syllables is in most cases preceded by the appearance in consciousness of a schema in one of three types: (a) visual schema (p. 275), (b) kinaesthetic schema (p. 275), (c) rhythmic schema (pp. 263, 275).

9. In addition to the words themselves and their associations there may occur as an aid a 'motor trend.' This 'motor trend' is present in the acts of anticipation but more frequently in the recalls.

10. Extraneous associations with the words to be learned are formed by all the *O*'s. There seems to be no well-defined chronological order in which the words and these associations appear in recall. The word appears sometimes in the imagery corresponding to the learner's ideational type and sometimes in the imagery corresponding to the mode of presentation; and the association similarly may come either in the imagery of the learner's ideational type or of the mode of presentation.

11. Words which have these extraneous associations are in most instances retained better than words not thus associated.

12. The first two or three and the last two or three words of a series are the first words of the series to be learned.

13. Visual imagery is not efficient for a rapid anticipation and usually gives way to vocimotor imagery when rapid anticipation is acquired.

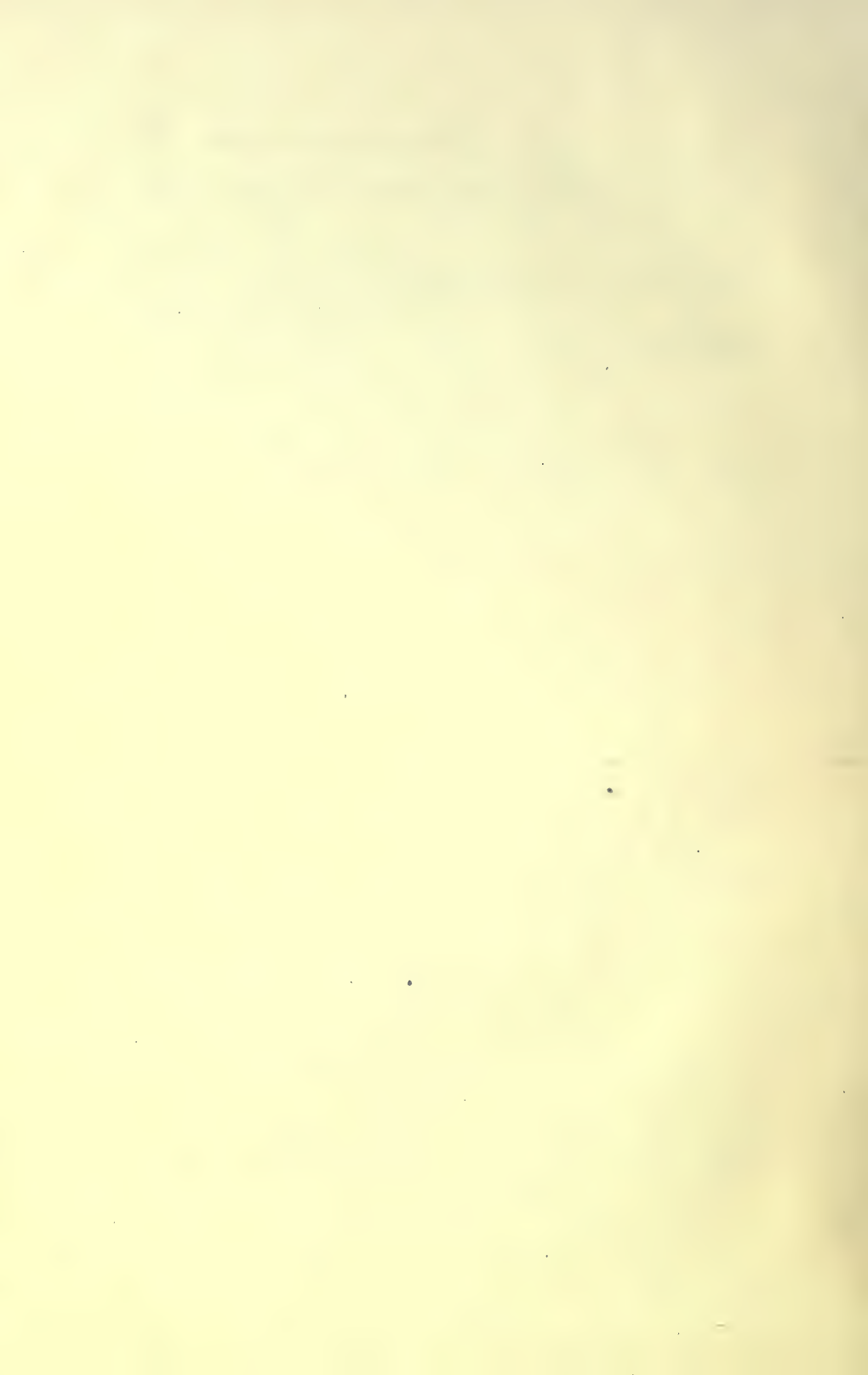
14. In visual-auditory presentation the learner seldom attends equally to both the auditory and the visual aspects of the presentation. He attends usually almost wholly to the one or to the other according to his ideational type.

15. The recall of a series is sometimes accompanied by subjective assurance and sometimes by subjective non-assurance.

16. The statistical data obtained in this study are significant in scarcely a single instance for the reason that, although the objective conditions were kept constant in accordance with the rules for such investigations, the subjective factors could



not be brought under control. At best mere objective data will do little more than indicate the most efficient mode of presentation for a particular *O*, until account is taken of the ideational type of the *O*'s, the attentive selection that they exercise among the various presentative aspects of a material, and the manner in which one sensory mode is subject to translation into another. Some introspective procedure is a necessity.











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