AN ANALYTIC STUDY OF THE MEMORY IMAGE AND THE PROCESS OF JUDGMENT IN THE DISCRIMINATION OF CLANGS AND TONES. (Concluded.)[1]

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EXPERIMENTAL. CHAPTER II. (*Continued.*)

PART III.

The problems previously considered, viz., the nature and course of the tonal memory image and the nature of the judgment consciousness, are in Part 3 examined by the aid of what may be termed the method of continuous change or the method of reaction. The second tone, V, starts from above or below the standard, N, and moves uniformly toward N until arrested by the observer when subjective equality is reached. The method thus differs from that employed in Parts 1 and 2 for (1) a moving tone is used for V in place of the discrete stimulus of the method right and wrong cases, while (2) the judgment is always that of 'equal' and (3) a movement of reaction is required on the part of the observer.

The method is most similar to that of equivalents[2] with the introduction of a time-interval between N and V. It yields two values, V_o ||| N and V_u ||| N, these being the averages of the determinations of subjective equality made in a certain number (in Table VII, six) of movements of V from above and from below N respectively. The mean of these two values, taken algebraically, indicates, by its size and sign, the amount and nature of any tendency on the part of the observer to err in a greater degree upon one side or the other of N. This value

[1] For the first article, see this *Journal*, XII, 1901, 409-457.

[2] Külpe: *Outlines of Psychology*, 1895, 56 f. It may be likened also in some respects to the reaction method as described by Stern (*Psych. d. Veränderungsauffassung*, 108 ff.), who says, "das Characteristische des Reactionsverfahrens besteht darin, dass die Veränderung solange währt, bis die Versuchsperson selbst ihr durch eine Reactionsbewegung ein Ziel setzt." It is hardly necessary to point out that Stern's application of the method was made with a different purpose (the perception of change itself), so that the variable moved more slowly, and not, as in our tests, from a given D toward equality. These points of difference preclude extended comparison of results.

corresponds to the 'true subjective equality' of the method of equivalents proper, but we have chosen to term it the 'estimation value of N.' Finally, the mean of these two values, arithmetically taken, indicates the average distance from N of the upper and lower boundaries of the 'zone of equality.' In a few cases, as the tables show, the signs of the two values of V ||| N are alike; then obviously, the 'average limit of error' coincides with the 'estimation value of N,' and simply determines the center of the 'zone of equality.'

In his use of the reaction method Stern[1] saw fit to subtract a constant value, 0.5 sec., assumed to represent the reaction-time. We have not carried out any subtraction in the present Tables for several reasons.

1. Though the value of the reaction-time is, according to Stern, higher for continuously changing than for discrete stimuli, it decreases as the rate of the variation increases.[2] Since our rate is much faster than any of those employed by Stern, the value in question would be much nearer the simple reaction-time to discrete stimuli than 0.5 second.

2. Stern also includes in the subtracted interval a period known as the 'decision-time.' This is due to an inhibition of reaction, set up by the attempt to secure greater certainty. "Man lässt das Urteil erst eine gewisse Sicherheit gewinnen, ehe man sich zur Bewegung entschliesst; die Anregung zur motorischen Aktion ist bei allmählichen Veränderungen eine sehr geringe." Under the conditions of our own tests, we very much doubt whether this influence is to be reckoned with at all. To be sure we find everywhere evidences of a tendency to premature reaction which is being met by obvious conscious attempts to inhibit it, and this process might seem, on first thought, to be identical with the above-mentioned retardation of the decision. But these are two distinct phenomena. Stern says that the decision-time is "eine, wenn auch *kurze*, so doch nicht ganz zu vernachlässigende Zeit." Under our conditions several tendencies to react may appear and be inhibited before the actual movement, while the interval between each one may be of perhaps one second's duration. It would be manifestly absurd to add these relatively long periods to the observer's reaction-time proper for the purpose of subtraction.

If, however, there should be present a retardation of the reaction of very short duration such as Stern mentions, it seems quite appropriate that this time should be rather included than excluded from the results, for the delay is made for the sake of subjective certainty, and the recorded values will therefore in-

[1] *Zeits. f. Psych.* vii, 1894, 270; xi, 1896, 21; *Veränderungsauffassung*, 109 f.

[2] *Veränderungsauffassung*, 109-110.

dicate simply the point of assured equality rather than the point at which the first intimation of equality appeared.

3. Both the tables and the introspection, as will be more fully shown later, indicate the presence of an uncommonly large error of expectation. This means that the movement of reaction takes place before subjective equality is reached. The method itself offers no satisfactory procedure for counteracting or adequately estimating the force of this error as do those methods in which it is possible to reverse the direction of the steps or movement of V in half the tests. It seems, therefore, unwise to accentuate this error, already so plainly present, by an increment whose amount can be only arbitrarily established.

4. Neglect to discount a value for the reaction-time would affect merely the absolute values of our Tables; the relative values would be practically what they are now; the 'estimation value of N' would be unchanged, save in a few instances.

5. We are not primarily concerned with the quantitative results.

We have, therefore, chosen to present values computed upon the basis of the actual moment of the reaction rather than to manipulate these values by the subtraction of a value whose amount is exceedingly difficult to estimate, and whose influence is perhaps to be questioned in the face of the strong expectation error.

Instrument. For convenient work by this method the following changes in the blown bottle apparatus are advisable if not absolutely requisite.

1. The large air storing tank is replaced by a simple device consisting of two galvanized iron cylinders approximately 75 cm. deep and 30 cm. in diameter. The lower cylinder is filled with water, and provided with a pipe projecting above the water within and connected with the bottle system without; the upper cylinder is inverted and arranged to slide within the lower. A weight of 3.7 kg. on the upper cylinder yields adequate pressure and produces a smoother, less hissing tone than the air stored under greater pressure in the large tank.

After 6 or 8 tests, a counterweight of 9 kg. speedily raises the exhausted cylinder, and the experiments can thus proceed with almost no interruption and with far greater economy of energy; indeed, without steam or other mechanically driven pumps, it is very difficult to store enough air for an hour's work by the continuous change method.

2. The smaller crank of the Stern machine is entirely removed. The axle of the larger crank is extended to a length of 130 cm. from the cog wheel, and supported in a rigid journal. The crank itself is replaced by a brass arm 135 cm. long, supplied with a knob-shaped wooden handle. This long crank arm is a necessary help in producing an even revolution of the gearing; the extension of the axle is necessary to permit the lengthened crank to clear the projecting rod of the mercury piston.

3. The armature of a Petzold time-marker is fitted with a light projecting arm of steel, 17 cm. long, carrying two teeth. These parts

are so adjusted that when the observer closes a circuit key, the teeth instantly engage the cogs of the gear wheels so firmly as immediately to stop the movement of the crank by the operator. The advantage of this device over the stop-watch[1] is obvious.

Method of Procedure. One of three standard tones, *a*, *b*, or *c* (corresponding to settings 5, 15, and 25 of the apparatus, and to the pitches 242, 270, and 298 vibs. respectively) is given with a duration of one second, beginning two seconds after the usual 'now.' After an interval (10 or 40 seconds), a second tone, V, is given, which begins 3, 4, or 5 turns of the crank in either direction from the standard setting (*i. e.*, at 8.4, 12.2 or 14.0 vibs. above or below N), and moves uniformly toward the standard, always at the rate of one-half revolution of the crank (1.4 vibs.) per second. When the observer[2] thinks that V is equal to N, he presses the key which, as was above explained, stops the movement of N. The observer dictates his introspection and the operator records the setting of the apparatus in terms of revolutions and hundredths of a revolution, thus giving readings within 0.028 vib. The observer's error is later computed in terms of vibration rate. The observers are *M*, *B*, *S* and *Wh*.[3]

The experiments of Part III are subdivided into four Series, whose conditions are varied in three respects, (1) by using a time interval of 10 or of 40 seconds (2) by procedure with or without *specific* knowledge, and (3) by active attention to, or active inhibition of, the image (artificial distraction).

Series 1.

Series 1 consists of three sets of 18 tests each for each observer at 10 seconds interval. The first set is not figured in the quantitative results because of the rapid growth of special practice which took place at the outset. The third set is taken late in the course of Part III (directly after a series in which the procedure is with knowledge), but is treated in connection with the second, so that Series I, as represented, practically consists of 36 tests for each observer.

In order to make these tests more comparable with those by right and wrong cases, and to avoid the error of expectation so far as possible, the procedure is without knowledge. But this phrase must be used with qualifications. By it is meant that there is no knowledge of the *standard* to be used, of the *amount* of the difference, D, of the *absolute rate* or of the *direction*, of the

[1] Employed by Stern for a similar purpose: *Zeits. f. Psych.*, xi, 1896, 20; xxii, 1899, 2.

[2] In this procedure, naturally, but one observer is tested at a sitting.

[3] Dr. W. C. Bagley kindly served as operator for *Wh* in Part 3.

movement.[1] Any test in which the direction of the movement of V is unrecognized is discarded and a new trial given. The direction of V may be known in two different ways: 1st, by an immediate awareness of its pitch relation to N, 2nd, by observation of V itself as it moves. The second is obviously a slower process, and it is correlated with less accurate judgments. This is to be expected since the slower process implies a loss of the position (tonal or otherwise) of N, and since the very effort of observation entails a distraction of the attention from the real object of the test.

TABLE VII.

All Values in Vibrations.

Obs.	D	V_o III N	m. v.	V_u III N	m. v.	Aver. Limit of Error.	Estimation Value of N.
M	8.4	0.39	1.23	—1.07	1.51	0.73	—0.34
	11.2	2.74	2.76	—3.38	1.46	3.06	—0.32
	14.0	3.00	2.40	—3.20	2.21	3.10	—0.10
B	8.4	2.26	1.18	—1.68	1.46	1.97	0.29
	11.2	4.45	1.82	—4.26	1.04	4.38	0.10
	14.0	6.83	1.99	—4.93	2.16	5.88	0.95
S	8.4	1.09	2.09	—1.88	2.09	1.49	1.49
	11.2	2.29	2.80	—1.29	1.79	1.79	0.50
	14.0	3.78	0.98	—1.51	1.62	2.65	1.14
Wh	8.4	—1.34	1.37	—1.09	1.09	1.22	—1.22
	11.2	0.90	1.82	—1.54	1.93	1.22	—0.32
	14.0	0.05	0.92	—4.09	1.60	2.06	—2.02

Quantitative Results.

Table VII shows the quantitative results of Series 1. From it the following results are apparent:

1. With two exceptions, every value indicates an error of expectation.

2. For all observers, the expectation error increases with the increase of D:[2] this is shown by the progression in the col-

[1] It may be noted that *Wh* was, at least at first, at a slight advantage. He knew that there were three standards, three D's, and that the rate of change was uniform; yet the observers were soon put upon nearly equal footing because (1) the knowledge of the number of standards was of no practical value, (2) the other observers soon came to the conclusion that three (or four) different D's were in use, and (3) they were told early in the first set that the rate was uniform, and that V never started at equality with N.

[2] To anticipate the qualitative discussion somewhat, it may be noted that the two exceptions just mentioned both occur with the smallest D, *i. e.*, under conditions such that a momentary cautiousness or a slight effort to combat expectation will suspend reaction too long and

umn of the average limit of error.

3. The mean variations are large.

4. *M* and *Wh* constantly underestimate, *B* and *S* constantly overestimate N. This feature is of itself indicative of some individual differences in the manner of judging, so that we are led to examine the judgment consciousness as it is revealed by the introspection.

Qualitative Results.

A. Features common to all observers.

The introspection throws light upon several minor features; *e. g.*, the manner in which the position of V is first known, the nature of its movement, the existence of a curious 'after-tone,' etc., besides yielding, what is more to our point, a satisfactory analysis of the judgment-consciousness. The chief matters of interest in this analysis are the direction of the attention, the ultimate basis of the judgment, the influence of expectation, the feeling of assurance, and the nature of the reaction movement. These factors must, for the most part, be discussed in the light of the reports of each observer separately. But in five respects, viz., the knowledge of the position of V, the nature of the movement of V, the nature and influence of expectation, the 'after-tone,' and the assurance, the reports of the observers exhibit such community that these topics may be profitably discussed at the outset.

Knowledge of the position of V. Observers *M*, *B* and *Wh* as a rule knew N as soon as it sounded; *S*, as might be expected from her poor sensible discrimination, had more difficulty and frequently relied upon her observation of the direction of the movement to gain her knowledge of the position of the starting point. However, the wider D's offered little difficulty. It is of interest to note that large D's produce in an exaggerated manner the organic shifts which have already been reported as characteristic of the 'higher' and 'lower' feels of compared tones. For example, the slight feeling of relaxation which was noted by several observers in the tests with discrete tones (D = 8 vibs.) became exaggerated into a very distinct slump or depression when V differed from N by 14 vibs. "V caused a sudden feeling of drop, very like the feeling you get when you wake up suddenly thinking you are falling" (*B*). "The recognition of the place of V above or below the image is nearly always immediate, and similar to that in

equality will be passed. Both the observers in question, *S* and *Wh*, note this explicitly; *e. g.*, "Feeling the error of anticipation, I now have a tendency to restrain the reaction. With a small D, therefore, the time to equality is so short that I overdo this and react too slowly."

the discrete experiments, except that it always seems to come as a shock or blow, a change of bodily attitude of some sort" (*Wh*).

The movement of V. The variable tone seems practically never to progress steadily towards N, but to move by stages which may be regular or irregular. *S*, who uniformly experienced a lively visualization of the progress of the tones, was able to illustrate this movement graphically. The following reports will indicate more clearly what is experienced: "V moved slowly toward my image which I kept clearly in mind. When yet a short way off, it jumped to it by a wide step and fused with it." "Jumped to equality on the second slur. I had to react, though I suppose it was too soon." "V came down by a series of swoops. Finally one was almost at equality, but I said to myself: 'wait till the next.' At the start of the next plunge I saw suddenly that it had passed, and I reacted as quickly as possible, but with disappointment at the failure" (*Wh.*) The number of stages depends largely upon the amount of D; when D is 8.4 vibs. the tone usually makes 3 or 4 steps; when D is 14.0 vibs. there are 7 or 8 steps to equality. It will readily be seen that the existence of these stages plays an exceedingly important part in the mechanism of the judgment.

Expectation. The existence of a large expectation error is one of the most striking results of the continuous change method. It is very apparent in the quantitative results of Table VII where, with but two exceptions in 24 cases, V_o ||| N is represented by a positive, and V_u ||| N by a negative sign. This table also shows very clearly that the amount of expectation is largely increased by increase of D. The existence of expectation is also very apparent in the qualitative reports. One of the most regularly recurring features is a tendency to premature reaction. It is scarcely too much to say that in *every* test, the observer experiences from one to more impulses to react before actual movement is carried out. The introspection shows, however, that this expectation tendency is not always due to a single motive. We may distinguish several contributory causes. First, in the case of a large D, expectation may result from the very fatigue of waiting for equality. The pitch interval of 14 vibs. demands, at the rate we have employed, ten seconds for its transition. This is a long period for active attention to the variable tone when the observer has already been taxed with the effort to retain the image, or whatever stands for the position, of N during an empty time-interval of 10 seconds before the variable stimulus appears at all, and when he is still further taxed with the effort to maintain the position of N through the ten seconds dur-

ing which V is sounding. It is small wonder, then, that despite the precautionary check to hasty reaction which the wide D itself affords, the observer should yield to the temptation to "have it over with." This occurrence is frequently reported thus: "With a wide D, I get tired of waiting." "D was wide and the strain on the attention so great that I reacted even with the thought that it was not yet quite equal; but still I felt that I must get through with it." "When D is wide, I now make a distinct effort not to hurry, but still I react too soon" (*B*). Again the expectation may be set and released at a definite point, this point being determined by an estimate of the amount of the D.[1] In these cases, obviously, the judgment is determined by the lapse of that amount of time, which, it is inferred, should bring V to the point of equality. Here, however, we may regard this process as one phase of the expectation tendency. This influence may determine the judgment quite by itself, or it may modify the natural course of the reaction which would otherwise ensue, *i. e.*, frequently an observer says he felt that V must have reached N, although equality had not yet been attained on the basis of auditory recognition. Illustrations are: "Felt it must be time to react though V was not quite back to what I wished" (*Wh*). "Was n't quite there, but felt it ought to be, probably from my previous estimation of D" (*B*).

Finally, there is a simple sort of expectation which is a very potent factor in the judgment consciousness, but which cannot be more accurately defined than a dread of getting past equality. Apparently the feeling is that, once equality be past, one would be helpless, for the moving tone would then be constantly getting *away* from the desired point. Perhaps this interpretation is too much logical, and too little psychological, but, whether or no this much is in the observer's mind, the action of some such motive is very evident from the following examples: "Scared stiff for fear of passing equality." "There is still almost as much excitement now as at first. I can't look at the matter calmly" (*M*). "I get worried when V approaches N for fear it will get away from me" (*S*). The experimenter can attest that this expectant attitude is clearly visible by all the usual outward tokens of the keenest sort of attention, which culminates, at least, during the earlier tests, in distinct agitation at the crucial point. Now it would seem very probable that so vivid an expectation would be noted by the observers, and that deliberate attempts would be made to counteract its influence. We have already quoted extracts which show that

[1] This point will be further discussed below when the basis of judgment is mentioned.

such is actually the case. What is most remarkable is that, save in exceptional individual tests, this deliberate inhibition of the tendency to premature reaction is never adequate. When the observer is making a conscious effort to retard his judgment, and when this effort seems to him to have been adequate, or more than adequate (so that he complains that he has passed equality, has waited too long), even then the subconscious tendencies prevail, and an expectation error appears. "With wide D's, I now make a distinct effort to wait" (*B*). "I think I now generally wait a little after V seems at equality to make fully sure of it." "There is an area of equality. If I am excited, I react as soon as I get to it; if cool or confident, I wait till I am well within this area" (*Wh*). Often the natural influence of the wide D to heighten expectation is combated with varying success by the time inference; *i. e.*, that since D is wide, it will take more time to reach equality. The resultant reactions are thus subject to noticeable variations. This is one of the influences which produce such large mean variations. A single case will illustrate. "A very big D going down. . . . . I passed through a period of seeming equality, felt it time to react, but hesitated (probably because D was wide and the time then elapsed but short); then, after a tonal *difference*, entered *another* period of equality and reacted" (*Wh*). [Result, still 0.6 vibs. too high.]

The after-tone. It will be remembered that the moving tone was arrested by the direct action of the armature of an electromagnet upon the gear wheels: the actual movement was very short, and its inertia was reduced to the lowest point by proper adjustment of the springs controlling the armature; nevertheless, all four observers quite independently noted that after the key had been pressed there was a distinct additional movement of the tone. By listening to this 'after-tone,' observers *B* and *S* quite frequently, *M* less often, decided whether the reaction had been made too soon or too late, and in this manner they evolved a sort of control over their natural expectation error.[1] Typical reports are: "After judgment is made and the key pressed, V has moved some since my decision (*S*). "After reaction, noted after-tone and thought 'I should have waited longer; that tone was nearer the right one'" (*M*). "At the moment I press the key, the tones seem equal; then immediately afterwards I listen to V and see that I did not wait long enough" (*B*). "At judgment, thought 'too low,' but after-tone seemed about right" (*B*). To obviate this peculiar influence, it became necessary finally to put in the reaction circuit

[1] *Wh* noted the tone, but did not use it as a corrective of his judgments.

a rather loud 'buzzer;' which sounded whenever the key was pressed, *i. e.*, simultaneously with the action of the armature clutch. The intensity was sufficient to drown the bottle-tone. The introduction of this noise, however, did not, curiously enough, accomplish the purpose for which it was intended, for despite the sound of the 'buzzer,' *B* and *S* occasionally reported the after-tone. More careful observation then brought out the real nature of the phenomenon. The so-called 'after-tone' is in reality due to a subjective process,—the formulation and execution of the judgment withdraws the attention for a very short time from the stimulus. The observer then hears that portion of the moving tone which sounds after his impulse to react and before the action of the clutch and the noise buzzer stop both the movement and, so far as the observer is concerned, the sound of the variable tone. This explanation will be clearer when the nature of the apparent movement of the variable tone and the influence of expectation are recalled. The movement of V takes place not uniformly, but by a series of slumps or slurs. One of these sudden changes may take place just after an impulse to react matures. The general effect of expectation is, we think, to cause the incoming variable stimulus to seem nearer the standard than it actually is. When the test is completed by the decision, the influence of expectation is suddenly thrown off and the observer hears the tone quite distinctly different in pitch from the tone noted a moment before when the key was pressed.

Assurance. From the very nature of the continuous change tests, one cannot expect the observers to exhibit that degree of certainty which is obtainable in the tests with discrete stimuli. There the answer was definitely right or wrong. Here only a very happy chance can bring the reaction movement at precisely the fraction of a second when V is passing the point of equality. The influence of expectation and of the attempts to counteract it also plays some part in lessening the observer's assurance.

We prefer to speak rather of the observer's assurance than of his certainty, and to retain the latter term for the method of judgment, for, in the present case, no observer can say definitely that his reaction was made at precisely the proper moment; he can only feel an assurance that it is "pretty good," "somewhere near," or "the best I could do." As *Wh* expressed it, there is not a point, but an area, of subjective equality, and that reaction is felt to be satisfactory which is within this area. Even so, the assurance of the observers is never very great. It is often affected either favorably or unfavorably by the after-tone. The following are typical reports: "V not like my image, but the nearest thing that had come."

"Judgment rather uncertain. Thought it too slow at first, then, hearing the after-tone, decided not." "After reaction thought I had only reached the *edge*" (*M*). "I never get any definite recognition, but I stop the tone when it is near it. Don't usually know the direction of error" (*S*). "Not just right, but don't know which way the error is" (*B*). "Decision fair, but not a 'dead-sure' feeling" (*Wh*).

B. Features peculiar to individual observers.

We have just discussed certain features of the qualitative results of the continuous change method which were common to the reports of all the observers. This discussion revealed the existence of a peculiar after-tone, largely subjective in nature, which was used to control decisions, and of a strong expectation tendency which was fostered by several contributory motives, but counteracted by conscious attempts at restraint. Furthermore, it was shown that the perception of the starting-point of V, and that of its movement, involved practically similar experiences for all observers. The degree of assurance was quite similar for all. One might, therefore, suppose that there would be little room for individual variation in the reaction-consciousness. But such a supposition is too hasty; it neglects the fact that the passing of a single decision is the result of the operation of a very complex tangle of mental processes, of the function of a fairly large number of factors, each of which has its own special influence upon the outcome. Indeed, it seems, in many instances, impossible for the best trained observer to unravel the tangle, and to designate the amount of the influence which is to be ascribed to each of the factors in operation. We must be content if the observer can indicate the striking mental structures in every particular test, and if he can, in the course of a large number of introspective reports, indicate, from time to time, the less obvious structures which are to be found in his typical experiences. In this way, we can hope to obtain, in the first place, a tolerably accurate knowledge of the general process of judgment for each observer, and, in the second place, an account of the one or more particular features which have been prominent in each single decision.[1]

[1] One of the most interesting things which appeared in our reports was the tendency of the observers to specialize upon some particular introspective feature during each sitting. Thus, to take a single example, *S* gives her attention on one day quite exclusively to visualization, on another to temperature associations, on a third to the nature of the familiarity feel. This tendency reminds us of the readiness with which the observers pick up suggestions as to the probable content of the judgment consciousness (first article, 424). This emphasis upon certain phases during certain groups of tests must be fully

Perhaps we may simplify the consideration of the reaction-consciousness, if, while recognizing the truly unlooked for complexity of its structure, we attempt to outline some of the main directions in which individual variations may be expected.

I. As we have already pointed out, the attempt to restrain the expectation error may be successful or unsuccessful, nor can we predict, even in the case of a single observer, kept under constant objective conditions, that the outcome will be uniformly in favor of either tendency.

II. Some observers have a distinct emotional preference in regard to the direction of V, *i. e.*, they prefer to listen to a rising, or to a falling, variable stimulus.

III. The attention may be directed (*a*) uniformly upon the image of N, (*b*) uniformly towards V, either (1) directly upon V itself, or (2) indirectly upon V by the use of an anticipatory, changing image,[1] (*c*) alternately upon the image and upon V, either (1) by a series of rapid alterations, or (2) by a single shift to V near equality.

IV. The basis of the decision may be (*a*) tonal, in terms of (1) equality, (2) familiarity, (3) some change in V, (*b*) visual or visual-motor, (*c*) an inference in terms of the elapsed time.

V. The reaction movement may be (*a*) entirely automatic, or (*b*) an occasional source of distraction.

VI. There may be possible contrasts with preceding tests.

If, to these possible variations, we add the existing variations in the individual capacity to attend to the stimulus and to retain the memory image which our preceding tests have brought to light, as well as the variations in the sensible discrimination of our observers, we shall be prepared to find large mean variations in the numerical results and noticeable points of difference in the introspective verdicts.

Observer M.

M prefers to have V 'settle.' Once there was a curious illogical experience. V rose and went past equality without at any time passing through equality. The reaction was too soon; apparently expectation was excessively strong.

The usual *method of decision* is to hold the image as long as possible, then to turn the attention to V (which is, by this

realized in the interpretation of the introspection, and not too carelessly ascribed to the objective conditions of the series in use at the time. Moreover, we think it likely that this sort of 'auto-suggestion,' if that term may be used, may lead the observer to occasional bits of faulty introspection. Thus, during one of her 'temperature days,' *S* gave the following rather doubtful case: "Image not very good. The electric lights went on just before the test: seems as if they made me feel warmer, and therefore sharped my image."

[1] See under observer *Wh*, pp. 237-8.

time, near equality). The reaction occurs when V, by becoming (subjectively) more intense and "bigger," signalizes the matching-point, or when, as a result of rapid comparisons, there is an auditory or a visual 'match.' As in the tests of Parts I and II, *M*'s experience is suffused with lively visual and visual-motor imagery which is often of assistance in the decision.

The *movement of reaction* is apt to demand conscious attention.

These points are illustrated by the following introspective evidence: "Followed V down with my eyes in my imagination. Compared V with N twice at intervals, then two very quick ones when it got near." "Held image till V got near, then made two comparisons." "The series of auditory comparisons is pronounced in the form of a series of verbal judgments,—'too high,' 'too high,' 'high,' 'there.'" "V seems to swell out and get more intense at the point of equality, and this helps the judgment This is very comforting; reminds me of the apparent spread of the æsthesiometric compass when it comes to a more sensitive area." "N on a plane by my eyes. V moved up vertically till it coincided." "N was like a caterpillar, fuzzy, yet too small in the middle, a thin thing, and very hard to remember. When V got fuzzy and thin and removed the image, I reacted." "Lost the image finally, so attended to V which recalled N at the time of the reaction." "Hate the bell; it laughs at you when you are wrong." "Frequently have to think of the button at the reaction, and this is felt to be a confusion and a bother."

Observer B.

B prefers to have V move down; it is easier to react then than when V moves up. In the latter case, there is more strain and nervousness, greater expectation, and a change from the usual method of judgment, much attention being given to the image.

The usual *method of decision* is to give full attention to V, the image being present, if at all, only feebly in the background. "I attend only to V, not comparing it at all with N. The image is hardly ever present in the reaction consciousness, and not usually present at all after V sounds." There may be, as we saw in Part I, an attempt to use the image in unusually difficult cases. "I react by attending to V and watching for a feeling or coloring of the tone which means equality. If this seems too difficult, I pull up the image for comparison, but it is very confusing to try to hold the image and attend to V at the same time."

The amount of D at which V starts exercises a strong influ-

ence upon the reaction consciousness of *B*. Very frequently the actual movement of reaction is entirely determined by this means, in other cases its approximate time only. Thus if D is large, expectation may be increased or a sudden caution be born. "Was n't quite there, but felt it ought to be, perhaps from a previous estimate of D, so I reacted." "At wide D's, I often now make a distinct effort to wait." "As soon as V sounds, I determine about how long it will take to get back." "Not much D, so I thought 'it won't take long to get there.'" "A wide D demands too much strain of the attention; sometimes, however, it makes me cautious and I go slower."

This observer, though very musical and generally recognizing the position of V at once, had several peculiar experiences with the *movement of V*. "Went up too fast at last; a sudden jump made V really too high at the decision." "V started at or near equality. At any rate, it never was equal to N at any time save possibly at the start." "V started right on N, I am positive." With one test (D = —11.2 vibs.) nine trials were necessary before *B* interpreted the conditions correctly; eight times it was reported that V began at N, or below N, and went lower yet. Finally *B* announced in despair "I 'm all mixed up; I believe you are playing tricks with me."

Expectation and the time factor. The persistence with which the expectation error appeared in the case of *B*, and the rather striking fact that this error increased as D increased by nearly the same amount, led to the suspicion that *B* was reacting almost entirely in terms of time; that, for some reason not clearly obvious, the movement of reaction took place at practically the same time after the sounding of V, notwithstanding the three very different values of D in use.[1]

A series of 'puzzle-tests' (*Vexirversuche*) was accordingly planned to discover whether *B* was influenced by some 'habitual-time' tendency, analogous to an 'optimal-time' influence. In these tests variations were tried in the amount of D (using 0, 5.9, 9.8, 15.4 and 19.6 vibs. in place of the usual values), and in the direction of V, which was kept at zero, or moved away from N, etc., etc. The regular time-interval, 10 seconds, was employed. Not until *eight* such tests had been given did *B* suspect anything unusual. She then exclaimed: "that tone went the wrong way, though I first thought it was moving up. I 'm afraid you are trying to trick me." This is a very forcible illustration of the confidence which the routine of a long continued experiment will inspire.

[1] The alternative explanation is that the expectation error increases uniformly with increase of D.

So habituated was *B* to the method of procedure that eight puzzle-tests were required to shake this confidence. In several of the tests the unusual conditions produced curious illusions; thus V was given = N: *B* reacted after 3.6 seconds, giving as her report,—"V higher, ran down. Reaction possibly too soon, but very good. I can always tell that (!)."[1] These tests were continued until 25 were given. After the eighth, *B* became more cautious; at the 17th she concluded that new *rates* of change were being used. There still remained a surprising amount of confusion as to the position, but more especially as to the direction of V. Thus, V was once started 11.2 vibs. below N and then *lowered* at the usual rate, after nearly 15 seconds, *B* reacted when V was 31.8 vibs. below N or 20.6 vibs. below the starting-point of V. According to the report, "V at first went up; then it seemed to get more piercing, and for a long time I could n't tell which way it went. Finally it got milder and nearly like N, but the judgment was probably a little low."

If we compute the length of time from the sounding of V to the movement of reaction, we find, for the three values of D used in the regular tests, *i. e.*, for 8.4, 11.2 and 14.0 vibs. respectively, the following periods in seconds,—[2] 2.46, 3.58 and 3.18. If now we compute the corresponding values for the new D's used in the puzzle-tests, we find for 5.6 and 9.8 vibs. the values 3.84 and 3.70 seconds respectively.[3] The average for these 5 D's is 3.35 ± .43 seconds. This result is confirmatory of our hypothesis of an 'habitual-time.' It may be worth while to recall here the test mentioned above in which *B* reacted to a V = N after 3.6 seconds. We conclude, from these indications, that *B* is influenced by a very strong tendency to react at about three and a half seconds after the sounding of V.[4] This

[1] *Cf.* Stern, *Veränderungsauffassung*, 94; Seashore, *Studies from the Yale Psych. Lab.*, III, 1895, 29 ff.

[2] These values do not correspond with those given in Table VII because they are the average for those tests only which were made before the puzzle-tests had made *B* more cautious.

[3] The remaining puzzle D's, 15.4 and 19.6 vibs., were so unusually large that it is too much to expect that the elapsed-time influence should make itself felt without restriction. Their values, 5.02 and 5.90 seconds, are accordingly omitted.

[4] Despite the differences in the conditions, it seems quite probable that this influence is akin, if not identical with, Stern's 'optimal-time.' At any rate his times (3.3, 3.9, 3.7 seconds) are curiously like those obtained by us, and the statement of the law (p. 236) might equally well apply to observer *B*: "Wenn jemand einen Veränderungsreiz stetig beobachtet und den Wahrnehmungsaugenblick selbst feststellen soll, so tritt um etwa vier Secunden herum eine kritische Zeit erster Ordnung ein. Die Aufmerksamkeit ist auf's höchste gesteigert, die Erwartung drängt zur Entladung, und das abschliessende Urteil wird, wenn irgend möglich, gefällt: hierbei ist dann die ob-

tendency makes itself felt almost entirely in tests in which D is plus.[1] Very likely this is correlated with the preference above mentioned for a descending variable because of the ease of judgment then. The 'ease,' we think, is due to the control exercised by this unconscious 'time-release' factor.

Observer S.

One of the most prominent features in *S*'s introspection is the *identification of N* by the use of several different categories. This seems to be partly a relic of the procedure with right and wrong cases[2] (each N being, as soon as heard, compared with the N of the preceding test), and partly a desire to gain a feeling of order and security in the work by arranging a schema of the standards in use. *S* thought at first that there were six or seven, later three or four standards. These appeal to her as differing from each other not only auditorily, but in temperature[3] and size, and occasionally in other respects, personal characteristics, etc. "N places itself in my scale auditorily, visually and in regard to its temperature, and remains placed there throughout the test. The warmest N is comfortably warm, more than lukewarm; the coldest is just like pleasantly cool water, this being the lowest tone used. Some tones are masculine, others (generally the higher ones) feminine." "Could not place this N in my series, and this bothered me as it gives me confidence to get N put readily into my scheme of identification."

Though, as might be expected, this process of identification was not always successful, the assignment was more often than not correct. There is no question but that the contribution supplied by the other sense departments is the essential basis of this process. *S* knows that a given N is a cool one before she knows that it is (relatively) low in pitch. Here we have a striking illustration of an unusual and unlooked-for means for the recognition of the impressions of one sense department in terms of another. It seems quite unreasonable, logically, but not, after all, so unreasonable psychologically, for, as we have already pointed out, *S* has a poor auditory discrimination, but a very strong affective reaction to tones. It is this affective supplement which catches the attention, therefore, and which gives individuality to the various standards.

The same prominence of *visual factors* which characterized *S*'s experiences previously appeared here again with even

jective Grösse, welche die Veränderung in jener Zeit erlangt hat, innerhalb weiter Grenzen irrelevant."

[1] The figures just given all refer to a descending variable tone.

[2] *Cf.* especially 439 (6) of the first article.

[3] *Cf.* first article, 420, 428, 437, 451.

greater distinctness than before. We have said that N seemed to have a certain visual size and place. V invariably evokes a still more pronounced visualization, usually described as "a smoky, gray round thing moving up or down and making a rope as it goes. "I watch the moving end or knob. N is a similar round stationary thing at the left of V. I seem to stay on the V side and look towards the image on the left. When V goes down it drops vertically, but when it goes up, it always moves obliquely out away from me at an angle of about 45 degrees." The visual phenomena thus described are not so active as determining agents in the reaction consciousness as those which serve to identify N. Here they are, as *S* puts it, rather the expression of the auditory relations between V and N.

The actual *decision* is usually either (1) the result of a series of auditory comparisons (the attention being for the most part on N, and jumping over to the image for a moment), or (2) the result of some modification of V. It is noticeable that the latter type of decision became more prominent as the work progressed, less and less importance being attached to the image. This is entirely in accordance with what we have already had occasion to mention so frequently,—that the process of image-comparison is used in cases of difficulty when the direct method is, for any reason, not available. The modification of V may be an auditory swelling, as in the case of the observer *M*, but oftener it takes the form of some organic or affective response. "Reaction based this time upon a certain individuality which appeared in one place in V,—something auditory perhaps." "When I reacted, V 'stood out,' was 'my tone.'" "At times, at the moment of reaction I see a whitish convex thing which appeals to me as something graspable; the rest of the tone is not thus graspable." (3) A third, somewhat less frequent, basis for the decision is the experience of a sudden *bodily glow or warmth.* We may suppose that this is a constituent of the organic reaction which forms the essence of the 'mood of familiarity' or 'quality of knowness' for this observer, but like many constituents which enter into rapid and complex mental processes, its presence is only distinctly made out in occasional introspections when the conditions favor analysis. It is credible, too, that *S*, who experiences strong affectively colored associations of temperature with tones, should, on that very account, be the observer to analyze out this particular feature of the familiarity feel most successfully. On the other hand, *S* herself says that the warmth which comes with recognition is quite distinct from that which is ascribed to tones. The former is experienced in other cases than in the recognition of tones; it comes, for example, when the point of an argument in a lecture becomes suddenly clear.

The similarity of this case to the recognitory consciousness in our tests is not very difficult to perceive.

There remains to be mentioned, in the case of *S*, a strong preference for a rising V. "It is pleasant to have V grow strong and big, depressing to feel it sink." One may accordingly explain the overestimation error as due to an unconscious prolongation of the pleasurable movement of rising variables, or to an unconscious premature checking of the depressing movement of descending variables.

It has already been mentioned that *S*, owing to a poor sensible discrimination, had, at times, difficulty in perceiving the *position of V* at once, especially with the smallest D. Frequently the actual movement of the tone supplied the desired knowledge. In nine out of 36 tests, however, *S* carried out the tests completely and then reported that V moved in the opposite direction to that actually executed. These tests were given again (being interspersed in a regular series) until correctly interpreted. A single repetition was sufficient in six cases, three or four in the others. In five cases, D was 8.4 vibs., in two cases, 11.2, in two cases, 14.0. These rather anomalous results raise an interesting point. How are we to interpret the quantitative value of *S*'s tests, especially her estimate of equality, when, to take one example, V was descending from 14.0 vibs., and *S* reported: "V went up, a good swelling tone; judgment of recognition?" A more hopeless confusion of the objective conditions could scarcely be imagined in view of the long practice *S* had had. We are still, however, ready to assert that the reaction might quite well have indicated a real recognition of the merging of a difference into an equality. The results of *B*'s puzzle-tests show how easily the direction of a movement of a continuously changing tone may be mistaken. It has, again, often been asserted, and our previous results have everywhere confirmed the assertion, that difference is more readily noted than the direction of the difference. Finally, we have shown how dependent *S* often is upon supplementary contributions from other modalities for her perception of tonal relations. The introspective evidence points clearly to the influence of these contributions in producing many of the confusions. If a tone seems to be 'swelling,' or is visualized in the wrong position, this is enough to override the direct perception of its auditory relations. *S* herself says: "I think I am too much influenced at times by my visualizations." We may conclude, then, that in the case of *S*, some one of a number of extraneous factors causes a misapprehension of the proper place of V; this influence is so strong that, coupled with the general difficulty of perceiving the direction, it overrides the objective conditions. However, *S* knows that V is different from N, and makes a satisfactory reaction when it reaches equality.

S noted occasionally a short but distinct interval between the formation of the decision and the pressing of the reaction key.

Observer Wh.

The method of decision in the case of *Wh*, although it changed as the tests progressed, was throughout much more exclusively auditory than that of the other observers. At first there was a series of auditory comparisons. But very soon comparison was given up, although the auditory image was still maintained by effort during the time-interval, and, as long as possible during the sounding of V.[1]

The common method pursued by *Wh* is thus that in which the judgment is auditory-motor (or auditory), the attention being held upon the image with all possible persistence, not alternating between the image and N, but merely waiting for coincidence. When, however, D is large, there are what *Wh* calls occcasional 'looks' at V (not comparisons or 'balancings,' but brief shifts of the attention).[2] "I image the ideal tone as soon as V sounds and keep this ideal in mind somehow, but toward the end my attention 'flops over' to V, and I come down with it to the place (*i. e.*, N) from which I had jumped to it. The 'flopping over' has a distinct motor feel about it." "Once I tried so hard to think the image that I did n't attend to V at all, so that the decision was very uncertain. Found no equality point at all." "I still hold to the image, but it seems a place in space to get to quite as much as an auditory quality, for the tonal image is not distinctly present."

The second chief method used by *Wh* is a peculiar one, for the attention is not directly upon either the image or V; in fact, there cannot be said to be any image in use, in so far as we mean by the image a representation of N. As V moves along by a series of slumps or slurs (descending or ascending V respectively), *Wh* at each stage imagines what the next stage is to be. Perhaps an introspective report will make this clearer. "I attend in a way to V, yet I am, so to speak, go-

[1] Naturally, as we have seen in the case of the other observers, when V gets so near N that it becomes a source of confusion to the image, the attention, compelled by the insistence of the sounding tone in contrast to the natural feebleness of the image, is very apt to go over to the variable and be held there until the reaction. As the tests continued, the spatial characteristics of the image became of more importance, and the image (we use the term for whatever is held in consciousness to represent N) lost much of its auditory nature.

[2] In distinction, for example, from the procedure of *M* in passing a series of verbal judgments.

ing ahead of it auditorily and coaxing it along; mentally hearing it take its course from difference to equality just in advance of the tone itself. When V has completed the path I thus made for it, I react."

Finally, *Wh* uses occasionally the method already mentioned of relying solely upon some change in the (subjective) nature of V or upon the appearance of some familiarity feel. This form of decision is not used by this observer save when other means fail. "Distinct swelling of V at the right place." "No image at V, so attended to V to see when it got familiar. At a certain area it aroused a 'familiarity tag' and the reaction. I 'm not at all sure of this sort, rather have some idea of the place of N in mind all the time." "When D is very large, I sometimes lose my image-place entirely and have to go by the familiarity feel."

The *amount of D* did not exercise over *Wh* so great an influence as upon the other observers (especially *B*). Occasionally, of course, a wide D increased the tendency to premature reaction: "Big D; had a strong expectation which made the rate of V surprisingly slow." More frequently quite the reverse effect appears: "Pleased with wide D, for then there is plenty of time. I can be calm and make the reaction coolly."

The influence of D as a determinant of the reaction by a computation of the time necessary (*i. e.*, quite apart from its influence upon expectation) seems not very strong with *Wh*. While cases appear like those of observer *B*, there are many others in which the estimate of the size of D, instead of determining the moment of the reaction, is itself revised by the influence of the other factors in the judgment consciousness. "I thought the D was small, but the tone was some time in reaching equality, so (as I know this means a wide D) concluded I was mistaken in my first thought."

The *movement of reaction* "seems now to be fixed, united with N, in such a way that whenever V reaches N, the reaction 'goes off,' usually quite automatically." "Just before V gets to equality, I put my finger on the key, my arm muscles set for the movement, and feel in general a very pleasant anticipation of making the reaction. It is a sort of 'hitting the nail on the head' feeling, or like chopping a running rope at some fixed point."

Series 2.

This series consists of 36 tests for each observer, identical with those of Series 1, save that the time-interval is 40 seconds.

The *quantitative results* are extremely irregular, so much so that it is useless to present them in tabular form for extended

comparison with those of the other series. It will suffice to point out, for example, that in five out of 24 cases the expectation error disappears, that there is, in the remaining cases, no sign of any relation between this error and the size of D, that the mean variations (except for *S*) are uniformly larger than before, that the estimation value of N is not constant in sign for any observer (save for *B* who underestimates with all three values of D).

The cause of this rather unsatisfactory outcome from the quantitative point of view is not far to seek. It is due to the fact that, to the natural difficulties of the continuous change method which we have just discussed in detail, there is added the difficulty of the long time-interval.

The *qualitative reports* are quite as irregular and quite as difficult to put into tabular form as the quantitative. To begin with, the observers differ very much in their use of the auditory image. Thus, in 36 tests, *M* reported 25 cases in which the image was present in the decision (in 22 of them after having persisted throughout the interval), three in which it was not present, and eight unclassified; *B*, on the contrary, reported only 10 cases with the image and 13 without it, while the remaining 13, in which this point was not explicitly settled, probably belong to the latter type. *S* makes use of her visual images quite frequently; *Wh* reacted with an auditory image 16 times, without any 13 times.

Despite these variations, the following general propositions may be laid down. (1) Owing to the long practice now attained, the auditory image can be held somewhat better than during Series 3 of Part 2. (2) The presence of the image (even if the auditory core is lacking) affords greater assurance in the reaction. (3) It is helpful to have the image persist in some form until V starts, even if it does not enter consciousness again; to have in mind a definite place for N when V begins, because recourse is thus had to a decision based on the amount of D. (4) It is, however, possible to make an objectively satisfactory reaction when the image has been permanently lost before V sounds. Such reactions are most frequent for observers *B* and *Wh*. *B* finds them subjectively satisfactory, *Wh* much less so. The actual basis of the decision of this type varies. If the recognition seems rather hopeless, the observer is apt to catch at the slightest indication of equality. "Image entirely gone, yet knew V started below. This time, however, I had neither a tone nor a place in mind for V to reach. So I watched V to get a familiarity, but reaction was really largely due to a feeling that V had gone on long enough" (*Wh*). "The familiarity feel seems to be something bodily which comes on gradually and finally engulfs me" (*Wh*). "Sometimes the visualized

note becomes a warmer gray at the moment of decision" (*S*). "V seems to 'splay' out or extend itself horizontally when it gets to the proper level" (*Wh*). "Just watched V and waited for myself to react, automatically, as it were" (*Wh*).

In Series 1, we saw that *S* and *B* had occasionally anomalous tests in which the *position and the direction of movement of V* were not correctly apprehended. The long time-interval of Series 2 magnifies this difficulty, so that we find five such cases accredited to *M*, nine to *B*, 27 to *S*,[1] and four to *Wh*. Now it is worth while to examine these cases in more detail. For the sake of simplicity, let us class them according to the apparent starting point of V. The resulting distribution is, then, as follows: started at equality and went up, 3; started at equality and went down, 2; started above, 2; started below, 17; miscellaneous movements[2] and totally unrecognized cases, 19. The pertinent feature of this distribution is the predominance of the cases in which V seems to start from below. Taken with the prevalence of comments by the observers upon the ease with which the position of V is recognized when it does start from below, we find confirmation of the principle upon which we insisted in Part I, viz.: that, for most observers, there is a tendency to sharp the image in the case of a long time interval.[3] Whether the auditory image is actually present when V

[1] One is, perhaps, warranted in saying that for *S*, discrimination by the continuous change method is practically impossible with this time-interval. *S* was tested roughly for S. D. by the aid of the piano, two notes being struck one second apart and the judgments 'equal,' 'higher' or 'lower' being required. The results for musical intervals from unison to the octave gave 94 per cent. right cases, the wrong cases being entirely confined to a single interval, the major second. Incidentally it appeared that *S* was liable to mistake a difference of intensity for a difference of pitch. This tendency was further investigated by special tests and the result confirmed; it was also found that a variation in the intensity of the stimuli would influence the estimation of the relative size of intervals, and that minor intervals were usually overestimated. These results simply bear out our general contention that *S* is very unmusical and that, in the more difficult series of our experiments, the task imposed was beyond *S*'s capacity for *sensible* discrimination.

[2] This class includes a variety of combinations of which the following are examples:—"V appeared equal. Don't know which way it moved."—"V seemed to start below and yet to *go down*. I was determined to have it go up, and tried to make it do so in vain." "Began slightly lower, surely, but didn't approach N. Stayed on same pitch or wabbled around it." [In this case D = + 14.0 vibs., really. A striking illustration of the influence of expectation with observer *B*. The erroneous preliminary estimate of the position of V sufficed to suppress completely the perception of the actual movement of the tone. Very likely the "wabble" was due to an actual alternation of attention between the expected and the given direction of movement.]

[3] See first article 422 (2 *b*), 426, note 1, 432 (5 *a*) and note 2.

starts or not, the fact that its pitch (and also, as a rule, the various organic sets and other associative supplementings) has been gradually raised in the endeavor to maintain it as vividly and clearly as possible, brings it about that the 'level' representing the place of the standard has been altered at V. Putting the matter in another way, the unconscious, gradual sharping of the image during, say, 30 seconds, will affect the identification of V at the 40th second, even if the auditory image has ceased to be consciously present. "Image absolutely gone, but V immediately aroused a verbal 'high,' and was felt to be *so* high. I knew at once approximately *where* the image must have been, though I didn't hear the image sound again" (*Wh*).

In connection with the gradual fading of the image and the difficulty of maintaining it in serviceable condition for the 40 seconds interval, there should be noted a very frequently reported phenomenon, that of the *arbitrary alteration or displacement of the auditory image*.[1] Apparently the auditory image is not always the determinative feature of the complex which stands for N during the interval. The observer sometimes controls the tonal image by reference to some other material as a basis. This scrutiny of the image is clearly illustrated in the ensuing quotations. "Two images during the interval. Knew the higher was the correct one." "Put this image too far down, misjudged it, so when it insisted on raising itself, I had to let it do so." "Lost image for awhile; then two came back, distinct from each other, auditorily and spatially. The real one was the upper one, but it had a tendency to fall down into the lower one, so that I had to keep pushing it up. It was a regular nightmare, like emptying lakes with a thimble" (*M*). "Changed my image during interval. Thought it too high and voluntarily put it down" (*B*).

Finally, there is to be mentioned the growing ability to *recognize and identify the three standards*. We see no reason to correlate this specifically with the use of the long time-interval; it may be attributed merely to the growth of special practice. *Wh*, possibly because his pre-knowledge of the actual conditions satisfied his curiosity on the point, did not develop any system of classification. *S* concluded that there were three standards or three groups of standards, perhaps two low, two high, and one in the middle. The lower standards were cold and colorless. *S* could frequently identify the standard by means of these associative tags, saying—"That's a cold one," "That's the warmest one," etc. This process made the test more easy of completion: "Not a good reaction because I

[1] Something of the sort was noted in Part I, *e. g.*, the double images of *F* and *Wh*, 430, 5*a*, 432, 5*a*.

did n't get N well identified in my scheme of standards." *M*, quite similarly, came to suppose that there were three groups of standards, with about three tones in each region. She could also frequently assign the standard to these groups correctly, *e. g.*, "That was one of the middle ones, neither high nor low; a very ordinary tone, hard to remember and discriminate. These middle tones seem more spread out, less graspable." "Sometimes the sounding of N clears up a sort of confusion which begins at the 'ready' signal [anxiety or curiosity about N]. It is like a ray of light coming through smoke. Even then, there is a fraction of an instant between hearing N as *a tone* and knowing it as *this tone*, a high one, low one, etc. This identification is quite pleasant. I often feel like 'shaking hands' with N, and saying 'Hullo, there.'"

Observer *B*, it is perhaps not too much to say, actually came to have an absolute pitch memory for the three standards. We say "perhaps," because the identification was of a peculiar sort. *B* did not say that a given standard was the high, middle or low one, although she thought there were three (or four) standards, but that a given tone was the one used in this or that test, usually recognizing the identity of standards in successive tests. The accuracy and the positiveness of *B*'s assertions are remarkable because often fully five minutes elapsed between the tests, and the report of the introspection sufficed completely to distract the attention from the auditory experience. Once *B* recognized V (instead of N, curiously) as identical with the V of the preceding test, but could not place it with certainty in relation to its own N. In another instance, the standard given in the eleventh test was positively identified as that given in the first test. *B* herself thinks this capacity is due to the fact that since the identification is not the object of the experiment, she is free from expectation and from the feelings of confusion incident to the task of reaction. But it should also be remembered that the identification calls for the discrimination of discrete tones only, that the three standards are 14 vibs. apart, and that there has been long practice with these same three standards. *B*'s identification of a given tone with a certain other previously experienced may still be, at bottom, a discrimination based upon an acquired absolute pitch memory of a moderate degree.[1]

A minor effect of the long time-interval is to lessen the *assurance*. "After V is 'placed' (higher or lower), I like to watch its movement for a moment to get added security." "If I have a bias for a given position of V, and it turns out otherwise, my confidence in the outcome of the whole test is shaken" (*Wh*).

[1] *Cf.* M. Meyer, *Psych. Rev.*, VI, 1899, 514.

Series 3.

This series is a repetition of Series 1, but by the method of procedure with knowledge. The subjects knew that there were three standards, three D's, and they were told the direction, but not the amount, of the D for each test. The object was, of course, to see what effect, especially upon the expectation error, would result from the previous knowledge of the direction of V.

Quantitative Results.

TABLE VIII.

10 Second Interval. Procedure with Knowledge.

Obs.	D	V_o III N	m. v.	V_u III N	m. v.	Aver. Limit of Error.	Estimation Value of N.
M	8.4	3.08	0.86	—2.91	1.34	2.99	0.08
	11.2	5.35	1.29	—4.37	1.15	4.87	0.05
	14.0	6.30	1.20	—6.55	0.90	6.44	—0.14
B	8.4	—0.11	0.64	—1.46	0.90	0.78	—0.78
	11.2	3.02	1.43	—2.10	1.70	2.58	0.48
	14.0	3.58	2.10	—3.83	2.16	3.72	—0.14
S	8.4	0.86	1.45	1.23	2.94	0.71	0.71
	11.2	2.57	2.27	—2.01	1.60	2.29	0.28
	14.0	4.14	2.46	—1.45	2.01	2.80	0.92
Wh	8.4	—0.39	1.20	0.33	1.23	0.36	—0.06
	11.2	—0.11	1.09	—1.45	0.75	0.78	—0.78
	14.0	—0.08	2.10	—3.11	2.60	1.60	—1.60

Table VIII shows the quantitative results of Series 3. In comparing it with Table VII, one must bear in mind that the tests are relatively few in number, that the results are influenced by the increasing amount of practice, and that the procedure with knowledge is not, after all, very different from that without knowledge, for the difference lies mainly in the acquaintance with the coming position of V. Now, with the short time-interval, as we have pointed out, the observers, with the exception of *S*, had practically no difficulty in recognizing at once the position of V. In view of these facts, it is not surprising that, on the one hand, certain minor differences are observable, but that, on the other hand, the general features of Table VII are repeated in Table VIII. We are, indeed, almost repeating verbatim our résumé of Table VII when we sum up Table VIII by saying:

(1) With one exception for *B*, one exception for *S* and four for *Wh*, the 24 values indicate an error of expectation.

(2) For all observers the expectation error increases with increase of D.

(3) The mean variations are large, though, as a rule, less than in Table VII.

(4) *Wh* constantly underestimates, *S* constantly overestimates, N.

(5) All of the observers have a lower average value for the estimation of N, *i. e.*, exhibit a more accurate recognition.

The reduction of the mean variations and the increased accuracy of recognition are, we think, due to the simple growth of practice, not to the procedure with knowledge. The increase of expectation in the case of *M* is not easily explained. Possibly the procedure with knowledge engendered some carelessness, but, as will be shown presently, the contrary effect is given by other observers.

Qualitative Results.

The *general effect* of the knowledge of the coming position of V is simply, as reported by *M*, *B* and *S*, to give a feeling of security, to do away with the momentary perplexity or attentive curiosity as to whether V would be easily placed.[1] The attention, toward the end of the interval, can be kept more completely upon the image. There is greater quiet and calmness throughout the test.

Curiously enough, V does not always seem to start from the direction announced. *M* had one instance, *B* three instances and *S* two, in which, after 'higher' had been designated, V started from below or at equality. In all six cases the smallest difference was in use.

A second effect, reported by *M*, *S* and *Wh*, is the presence of an *anticipatory image of V*. *M* had this experience but once: "While my image was going on, I heard also what was to be V. I thought 'well, that 's my imagination,' and tried to attend only to N. Behold the real V matched this secondary image perfectly." *S*, who says she never hears a tone in any test which is not visualized as a spot or line at a definite point in space, and that the procedure with knowledge makes this effect clearer and more intense, very naturally visualizes the expected V, though frequently she also hears it. "In many tests, as soon as the operator says 'plus' or 'minus,' I project two spots, one in the middle for N, one above or below it for V." "During the interval kept going visually from N to a lower place, but heard only N." "This time had both auditory and visual image of the coming V. I anticipate usually in about the same

[1] *Wh*, perhaps because of never feeling this anxiety very keenly, found little difference in this regard.

place."[1] In the case of *Wh* the anticipatory image is far more prominent and largely auditory. "There is a strong tendency to ideate V. I actually hear another tone lower or higher than N. This I usually try to repress in part by attending sharply to the image of N." This sentence is an indication of an interesting effect of the knowledge method. It looks as if, for some observers, the knowledge of the position to be taken by V might be more distracting than helpful. It frees the observer's mind from anxiety as to 'placing' V, but it thrusts upon consciousness an obsession which is still more bothersome. *S* voices this idea when she says: "I think that the expectation of a 'plus' V raised the image of N both visually and auditorily."

Series 3 also gives us further data concerning the *method of decision*. The points brought out are to be ascribed to the influence of continued practice rather than to the method with knowledge itself. In general, each observer's report has become more settled and uniform. There are a larger percentage of tests in which the same method is described. At the same time, the differences between individual observers are more clearly defined. Thus we find that *M* never uses the amount of D as a basis for calculating the time of the reaction, and that, with her, auditory-verbal judgments are very frequent, *e. g.*, "Ah!" "There!" "That's it," "Now," etc., etc. We find that *Wh* has settled down to a single method which is used constantly save when some accidental variation (*e. g.*, the anticipatory image just mentioned) interrupts its course. This method (practically the first main method of this observer in Series 1) is to attend with all diligence to the auditory image throughout the interval. When V begins, the image stands out sharply in contrast, but as V continues the image rapidly dies out, so that when V nears equality, the attention goes over to V and is kept there till the reaction. In the case of *B*, we find that practice has induced more caution; she attends more sharply to the image during the interval (though still to V when it comes) and attempts voluntarily to inhibit premature reactions, especially with a large D. On this account the expectation is largely reduced. Indeed, it disappears with the smallest 'plus' D.

It is of interest to note that, in contrast especially to *M*, *B* never thinks of V as fusing with the image. It could n't "because the image is in the head, the tone outside." "I never thought that the tone could have anything to do with the image." The reaction is entirely automatic: "goes off when

[1] When we also read that in the majority of tests, D is found to be "surprisingly small," we are led to surmise that her anticipated position is too far away from the standard, and that this process may be a source of a constant error in the reactions, though the quantitative results cannot be said to give definite indications of such an influence.

familiarity is reached." *B* is very much bothered by periods of loudness or swelling in V; these are noted, however, only with a descending V. During these periods she is unable to react or to tell anything about the place or movement of V.[1]

S continues to make occasional reactions based upon a bodily glow, significant of familiarity. At other times, there is a "sense of ownership:" That part of V which is like the image is 'mine,' the rest of it is 'foreign.'" There are usually two distinct tendencies to react before the finally successful tendency. These tendencies appear in a sort of rhythmic sequence, and are so related that it would be impossible to react during the interval between them. All this suggests an optimal-time factor. *S* does not, however, make reactions based upon the lapse of time as determined by the size of D. She may, like *Wh*, estimate the size of D erroneously, but usually neglects this estimate if V does not reach equality at the expected time.

Series 4.

Series 4 comprises 36 tests with a time-interval of 10 seconds, the image being eliminated, so far as possible, by distraction set up by odors. This series is, therefore, comparable to Series 1 of this Part and to Series 4 of Part II.[2]

The effects of distraction.

(1) *On the image.* The results of distraction, are, in general, similar to those recorded in Part II, although the continuous change method produces some individual variations not observed before. These variations, which are correlated with the individual variations in the method of decision, are all due, at bottom, to the continual sounding of V. To be more explicit: in Part II distraction was employed with discrete tones; if distraction was complete during the interval, the judgment was usually made without the appearance of the image. In the present series, from six to ten seconds intervene after the cessation of the distraction before the time for the decision arrives. During this period the image may very well assert itself, even if it has been successfully repressed during the time-interval proper. The possibility of this recall has been foreshadowed by our previous citations of cases in which the sounding of V "revived" the image, or caused it to "stand out in contrast."

In Table IX data are supplied showing the outcome of distraction as regards this point of the suppression of the image.

[1] This phenomenon is entirely subjective. *S* had a few such instances with an ascending V. *Wh* was never bothered. The uneven movement in pitch, previously discussed, is quite independent of this intensive variation.

[2] See first article, 455-6, for further details.

As in Table VI, four possible types of distraction are recognized: viz., (*a*), the total disappearance of the image, (*b*), momentary reappearance once (or twice) during the ten seconds without being present thereafter, (*c*), a similar momentary reappearance during the interval with a persistence into V, or another reappearance during V, and (*d*) an appearance at the first sounding of V or during its course. The fifth column gives the sum of the first two columns.

TABLE IX.

The effect of Distraction. (36 cases for each observer.)

Obs.	None	Momentarily in Interval	In Interval and at V	At or after V only	Not at V
M	17	10	4	5	27
B	27	9	0	0	36
S	19	3	2	12	22
Wh	17	5	10	4	22
Total.	80	27	16	21	107

From this Table, in comparison with Table VI of Part II, the tendencies just discussed are easily apparent: thus *Wh*, just as before, attained complete distraction in 17 cases, but, whereas before there were 17 instances of type *b*, and *none* of type *c*, the latter type is now twice as frequent as the former, while type *d* is doubled. Again, observer *S*, although reporting more instances of complete distraction, has twice as many of type *d*. All these cases show clearly this tendency of the auditory image to make its appearance at or during V under the conditions of the continuous change method.

But this tendency may be modified or entirely suppressed in the case of an observer who is not in the habit of using the image as a basis for the reaction. Thus the striking fact, that, for *B*, the image was never present at all during V, is explicable because, in the first place, *B* probably never attends as keenly to the image as do the other observers; and, in the second place, odors readily attract her attention, so that a high degree of distraction is easily produced during the time-interval. This is evinced by the 75% of cases under type *a*. And, finally, *B* does not, as a rule, make use of the image in the decision. Hence when the image is absent at the beginning of V, *B* naturally adopts the method of decision in which the attention is directed entirely to V and the reaction conditioned upon the arousal of some symbol of familiarity.

M exhibits neither the tendency of *S* and *Wh*, nor the contrary one of *B*, but the figures in her case closely correspond to those of Table VI. It should be borne in mind that when

the image reappears, especially during the time-interval, it is present only in the vaguest form and with a very short duration. Thus *M* reports: "Image very faintly, almost unconsciously, present. Felt it was near me without being there." "Half remembered N during interval." A typical case for *B* is: "Complete distraction. Odor bergamot; many associations, stories of bergamot and lavender, old New England people, etc." Her type *b* is thus illustrated: "Image back faintly once near the beginning of the time-interval, but at V had no idea where he was or where the reaction should come." *S*'s prominent type *d* is given as follows: "Faint auditory image appeared half-way through V and was used in reaction." "Image appeared very quickly after V started in response to voluntary effort to haul it up." *Wh* has, as a rule, either complete distraction (which he secures by vigorous attention to the odor, "seeking for its name, encouraging associations, testing its intensity for each nostril, etc.") or distraction of the third type. "Image back a moment at about the seventh second, and also at V so that it served as a standard, though I could not keep it throughout as I wished." These two types are very clear, and are correlated, as will be shown below, with two distinct methods of decision.

(2) *On the identification of N.* Observers *B* and *S*, who had both developed the process of identifying the standard to a high degree, find that the direction of the attention to the odor immediately upon the cessation of N, interferes with this process, and, to a certain extent, renders the entire test more difficult. "I have come now to attend very closely to N when it sounds. I find this necessary with distraction" (*B*). "Distraction makes the experiment harder. Don't have time to place N in my scale" (*S*).

(3) *On the 'placing' of V.* Just as the attention to the odor at the beginning of the interval wrenches the attention from N before it is entirely apperceived, so the attention to the odor at the end of the interval is so well established that V comes as something foreign to the consciousness,[1] a shift which consumes a noticeable time. The gap is estimated by the observers at from a quarter of a second to a second and a half. This gap plays a distinct part in the quantitative results as will appear in Table X. Another and more immediate consequence is that the place of V is often known, not directly, but by the observation of its movement. "V sounded one second before I knew what I was doing." "Have to gather yourself up to attend to V." "Did n't get V's direction till I watched it move" (*M*). "Slight gap between attention to odor and apprehension of tone, but usually place V after that, at once" (*B*). "Takes a short

[1] *Cf.* first article, 455.

time to get adjusted to V which I never recognize immediately." "Took one second to know V was going up and then got it from the movement. Took a long time to forget the smell" (*S*). "Complete distraction. Took one and one-half seconds to know V" (*Wh*).

(4) *On the method of decision.* In our discussion of the effects of distraction upon the image, we have already foreshadowed its effects upon the method of decision. In general, we may say that complete distraction compels those observers who formerly made use of the image to resort to the other chief method, that of attending to V and reacting to familiarity of some sort. Now, since *B* naturally used this method, her introspection may be dismissed herewith, as bringing out nothing essentially new. *M* shows the correlation clearly; with complete distraction she attends to V "until N seems to be sounding again." "Fine distraction; no image; matched where N was." If, on the other hand, the image is clearly present during V, it becomes the object of attention and is used as a standard. There is, too, a sort of intermediate type. "If I have the image at all during the interval, I am half-way ready for V."

Wh, who uniformly used the image whenever possible, presented, as we saw, two main types of distraction, viz: *a* and *c*. His method of decision consequently was of two distinct sorts, much akin to those of *M*, but even more clearly demarcated, as the following instances will show. Type *a*. "Complete distraction, V placed by its own movement; no idea of pitch or place of N, reaction absolute guess-work, touched off by the merest trace of resemblance." "Knew V at once as lower, but had no idea *how much* lower."[1] "Reaction came as a sort of despair." Type *c*: "If the image has been present at any moment during the time-interval, it is more apt to emerge during V. Even if not, it at any rate seems to 'fix' N, so that the reaction is much more easily and confidently made." "Image back a moment about the middle of the interval and also at V, so that it gave a basis for the reaction." Between these two main types there are, as with observer *M*, intermediate varieties which are interesting from the light they throw upon the others; *e. g.*, "Distraction good, though possibly the image was on the verge of reappearance once. Judgment uncertain, but less so than in some. Had general idea (auditory-verbal) 'wide D,' but no concrete idea as to how wide this one was." Here one may

[1] The same report is often given by *B*. These cases are instructive when compared to similar instances in the discrete experiments when V was cognized as absolutely 'high' or 'low,' but not as 'higher' or 'lower' than any standard. Note that there such knowledge sufficed to produce a successful judgment; here it is of no avail in determining a successful reaction, for the *how much* is all important.

suppose that the faint re-establishment of N was sufficient to arouse the general idea "wide D," but not sufficient to relate N and V more definitely. The assurance is likewise of an intermediate grade.

When distraction is complete, *S* often characterizes her reaction as "wild," "vague," "quite in the air," etc. In such cases the reaction is determined by some vague feeling of familiarity: "V stands out visually." But frequently, perhaps in the majority of these cases, *S* has a visual-spatial idea of the place of V in relation to N; *e. g.*, "Image not present at all, but I had a general estimation: let V go about so far,—half way down or to the middle of the screen where N is put."[1] "Reacted to vague idea of place." "Have a vague feeling of the amount of D." Least frequent is a type of decision similar to that of *M*. "Try to see a clue to the image in each 'tone' of V." This is, of course, in contrast to her general method of keeping the image in attention and trying to find something like it in V. Occasionally *S* entirely fails to react, but simply exclaims: "I don't know anything about it."

(5) *On the assurance.* Distraction, like a long time-interval, lessens assurance.[2] This is especially true for observers *M* and *Wh*. *B*, who makes little use of the image generally, is also less certain under distraction. *Wh.* is the more uncertain, the greater the distraction, yet "none of these results are quite as satisfactory as if there was no odor at all to distract." "The image in the continuous change experiments is so useful to me that any weakening of it makes the decision less assured." Very many of the reactions which seem most doubtful to the observer are relatively accurate objectively; in other words, assurance and accuracy do not vary in common. Good reactions are made, not only when the observer pronounces them definitely bad, but also when the observer is "utterly at sea" and knows nothing about the reaction. The explanation of this will appear in a moment.

(6) *On the quantitative results.* In Table X will be found the quantitative results for Series 4. The effects of distraction, as we have already intimated, vary with the observer.

Let us first take the results for observer *B*, who, it will be remembered, was relatively little affected by distraction because her normal method of decision involved attention to V with little or no attempt to relate it definitely with the image. Her results in the present Table are practically identical with those

[1] To make this intelligible, it should be explained that *S* habitually sat with her right ear toward the source of sound, and hence facing the cardboard screen (first article, 417) upon which she projected her visualizations of the tones.

[2] *Cf.* first article, 456.

TABLE X.

10 Seconds Interval, with Distraction.

Obs.	D	V_o III N	m. v.	V_u III N	m. v.	Aver. Limit of Error.	Estimation Value of N.
M	8.4	—0.35	2.24	—2.06	1.37	1.20	—1.20
	11.2	0.64	1.37	—0.37	1.12	0.50	0.14
	14.0	1.29	3.02	—4.28	2.71	2.79	—1.50
B	8.4	1.90	1.23	—1.93	1.85	1.92	—0.02
	11.2	3.53	1.48	—3.33	0.53	3.43	0.10
	14.0	4.48	1.65	—6.41	0.87	5.45	—0.97
S	8.4	—2.44	1.20	5.88	1.76	4.16	1.72
	11.2	—3.36	1.26	3.05	2.01	3.20	—0.16
	14.0	0.53	0.73	0.28	2.69	0.40	0.13
Wh	8.4	—1.88	1.40	2.43	2.27	2.16	0.28
	11.2	0.28	0.92	—0.22	1.76	0.25	0.03
	14.0	0.14	1.06	0.20	2.80	0.17	0.17

of Table VII, save that the size of the expectation error is slightly reduced.[1] This general reduction may be due either (1) to a slight caution, born of practice, or (2) to the slight 'gap,' above mentioned, between the odor consciousness and the tone consciousness.

The results for *S* and *Wh* are likewise correlated directly with what the introspection had indicated as the effects of distraction. Both of these observers felt keenly the loss of the image (*Wh* of the auditory image, *S* of the auditory image and of the opportunity to identify N visually and otherwise), and it is reasonable to suppose that its loss minimized the expectation error, for if there is not in consciousness a certain definite place which V is expected to reach, there is an absence of material for expectation.[2] This factor is, now, supplemented by the influence of the 'gap,' which is of longer duration for *S* and *Wh* than for *B*. Finally, *S* and *Wh*, in their confusion at the loss of the standard, turn to V for some indication of familiarity, and are apt to wait too long in this effort to gain

[1] The reduction was, on the whole, more apparent with a descending variable (just why cannot be stated), so that the estimation value of N has changed its sign with the smallest and the largest D. But this change is insignificant; the values have actually changed but little, and are, all of them, less than one vibration in amount.

[2] It may be objected that *B* ought, on this line of argument, to show no expectation error. But *B* adopted her method of decision quite naturally, whereas *S* and *Wh* in the present series are thrown upon this method which is foreign to their natural procedure. Moreover *B*, as we have explained at some length, is influenced by an habitual-time factor which produces an expectation error.

"some clue to N." Whether these three are the essential or the sole factors involved, the fact that the expectation error is very materially broken up is very patent from the Table. Note especially the reversal of the sign of the error in five out of six cases for *S*, and half the cases for *Wh*, and, more striking yet, the complete reversal of the rule that the average limit of error increases as D increases.

M, as might again be predicted from the introspection, occupies an intermediate position between *B* on the one hand and *S* and *Wh* on the other. There is a single change of sign and the progression of the average limit of error is partially destroyed.

Résumé of Part III.

In Part III we have continued our examination of the problem set forth in the title, giving special attention, however, to the second phase of the question, *i. e.*, to the structural analysis of the consciousness present in the functions of discrimination and recognition.

All the experiments of Part III were made by what we may term the method of reaction or the method of continuous change; its essential feature was the use of a continuously sounding variable which moved from above or from below the standard toward this standard at a uniform rate until arrested by the observer at subjective equality. Four series were conducted: Series 1, ten seconds time-interval, image held; Series 2, 40 seconds interval, image held; Series 3, ten seconds interval, procedure with knowledge, image held; Series 4, ten seconds interval, image lapsing with the aid of artificial distraction.

The quantitative results of these four series are best gleaned from Tables VII to X.

The qualitative results (largely gained from the introspection) are given below in general outline. It should be understood that, owing to the extremely individual character of the treatment of the results (a character which it has been the aim of this thesis to exploit), such a summary is at best merely a very rough outline of the more striking facts which are common to most of the observers. The individual variations which have been discussed at length in the text are, in our opinion, psychologically even more important than any number of generalizations.

(1) Some observers are able to classify and identify the standards in use by auditory-verbal, visual and other associative supplementing. This process is apparently helpful in the reaction.

(2) The variable tone seems to move toward N by stages

which may be regular or irregular. The movement is frequently visualized, and observers have distinct emotional preferences, some for an ascending, some for a descending, tone. The direction of movement is frequently misinterpreted, and illusory movements appear even during the procedure with knowledge.

(3) The method and basis of the decision is distinctly an individual matter; we may, however, distinguish certain types. The attention may be directed (1) upon the image, (2) upon the variable, or (3) alternately upon the image and the variable. (1) When the attention is upon the image, the decision results from the appearance in the variable of a tone (or visual substitute) which 'matches' the image. (2) When the attention is upon the variable, the decision results (*a*) from the appearance of some tone or 'place' in the variable which resembles the standard (whether the image is recalled or not), (*b*) from some subjective change in the intensity, timbre or movement of the variable, or (*c*) from some change felt in the observer's body which is indicative of familiarity. (3) Attention of the alternating type, in so far as it involves a series of auditory comparisons between the image and the variable, is present only in the early tests before the observers attain practice: a form of alternating attention not involving comparison (a single shift from the image to the variable when near equality) is also used by some observers occasionally. Still other decisions are the result of an inference, based upon the size of D, as to the time required to reach equality. Finally, some decisions are not recognitions at all, but mere guesses set off without regard to the actual tonal relations.

(4) The movement of reaction (finger-key) becomes automatic for all observers, though much sooner for some than for others.

(5) After the reaction there is heard a distinct additional movement of the variable which we have termed the 'after-tone;' some observers make use of this to evaluate their reactions.

(6) There is a strong tendency to react too soon; in other words, an error of expectation. This is fostered by several contributory factors, but partially counteracted with varying success by conscious attempts at restraint.

(7) Expectation increases as D increases, save for some observers when under distraction.

(8) No observer can say definitely that a given reaction is exactly correct. Reactions possess merely a varying degree of satisfaction. There is an area, rather than a point, of equality.

(9) Procedure with knowledge of the position of the coming

variable has little effect upon the quantitative results. It merely gives a sense of security to those observers who had occasional difficulty in apprehending at once the position of the variable. On the other hand, there is a tendency to be obsessed by an anticipatory image of the variable,—a tendency which may be a source of some disturbance.

(10) The long time-interval produces irregular quantitative results, owing largely to its deleterious effect upon the image. It is helpful to have the image persist in some form through the interval, so that the amount of D at least may be used as a basis for the reaction; but it is possible to make objectively satisfactory reactions when the image has been permanently lost before the sounding of the variable. Such decisions are usually based upon 'familiarity feels,' and are subjectively quite unsatisfactory to observers accustomed to the use of the image. Difficulties in the apprehension of the position and movement of the variable, which are increased by the long time-interval, confirm a previous assertion that there is a tendency to sharp the image with long times.

(11) Distraction by odors is successful in the majority of instances, though observers using the image in the decision are more apt, with the continuous change method, to have the image in consciousness during the decision. Distraction interferes with the process of identifying the standard, and renders the apprehension of the position of the variable more difficult; there is a distinct gap between the odor consciousness and the tone consciousness. Complete distraction compels all observers to attend to the variable and to react without reference to an image. All observers have less assurance. Those addicted to the use of the image no longer exhibit an expectation error.

(12) Practice lessens the mean variation, and unifies the course of the reaction consciousness of each observer, though, at the same time, individual differences are accentuated.

(13) The method of reaction, since it calls, so to speak, for a 'quantitative' as well as a 'qualitative' discrimination, leads to certain results quite different from those of the tests with discrete tones. Most important is the fact that observers who excelled in the discrimination of discrete tones without the use of the auditory image find the reaction to auditory equality is most satisfactorily accomplished by the keenest attention to the standard and the use of the auditory image as a basis for the reaction.

Part IV.

Miscellaneous tests.

The miscellaneous tests of Part IV deal with points raised during the previous experiments, especially those with discrete stimuli in Parts I and II. Of these tests, those involving the associations of color to tones have already been discussed.[1] There remain to be mentioned the pneumographic tests, the drawings of the movement of continuous tones and the chronometric measurements of the judgment-time.

The *tracings of respiration*, obtained under various conditions by means of a Verdin pneumograph and a continuous-paper kymograph driven noiselessly by a distant water-motor, failed to establish any very instructive correlations. The one obvious result worthy of mention was that shallow and irregular breathing ensued whenever the attention was sharply concentrated,[2] as, for example, in the endeavor to bring back an image clearly just before V, or, better yet, in the reaction-consciousness, where, as we have already pointed out, there was nearly always visible excitement and a high degree of expectant attention.

The *drawings of the movement of the variable tone* used in the continuous-change method were made partly to elucidate the general nature of the subjective movement of the variable, but in particular to see how far the visualizations reported by observer *S* could be objectively recorded. At first, in accordance with the suggestion of Stern,[3] we tried to register these movements by means of the kymograph above mentioned. The observer rested her wrist upon a smooth metal rod fastened horizontally parallel to the plane of the paper. A cardboard screen, in which was cut a narrow slit the length of the width of the paper, was then attached to the apparatus just above the paper: the object of this screen was to allow the observer to trace the movement of the tone with a pen, the point of which was free to move to the right or left along the slit, while at the same time, the tracing was covered up as fast as it was made. A time-marker gave the requisite control. The tests then proceeded in the following manner. When N sounded, *S* touched the paper for a moment to indicate the place (visually and spatially) of the standard; when V sounded, *S* again placed the pen up-

[1] First article, 420; also this *Journal*, X, 1900, 318.

[2] *Cf.* the results lately attained by P. Zoneff and E. Meumann (*Phil. Stud.*, XVIII, 1901, 1-113) who say (p. 44) "Alle diese Angaben . . . . führen zu der Annahme, dass eine willkurliche Concentration der Aufmerksamkeit eine Verlangsamung des Pulses und eine Hemmung der Athmung bewirkt."

[3] *Veränderungsauffassung*, 117.

on the moving paper at the right or left, for a 'plus' or 'minus' D respectively, and then moved her hand in toward the center of the strip just as V seemed to her to move, taking the pen off when she thought V reached the position (auditorily and visually) taken by N. This method of procedure was at first reported to be quite natural and easy, though the movement from right to left was less natural than the opposite one. As the experiments continued, however, objections appeared. To begin with, there was so much for the observer to think about, the starting of the machine, execution of the drawing, making the reaction, etc., that procedure without knowledge of the position of the coming V (always more difficult for *S*) had to be given up. Finally *S* was never satisfied with the resulting curves; the ordinates were not commensurate with the actually experienced tonal 'slumps,' so that the curves represented little but the number and frequency of the 'steps' taken by the tone. Accordingly, at the observer's suggestion, the moving paper device was given up. In its place the following method was adopted. With closed eyes, *S* indicated the place of N, and the starting point and entire movement of V, upon a stationary sheet of paper. The results were entirely adequate representations of the spatial behavior of the tones.

It is rather difficult to describe these drawings briefly. To begin with, N is almost always identified as one of a series of standards, this series consisting of six or seven round, grayish spots. The whole series is not seen at once, but merely the two or three spots in the region of N.[1] But the actual N is not only identified as one of these gray spots; it is always manifested as a horizontal line about three-fourths of an inch long, moving from left to right. The variable starts at a point in space about four inches to the right[2] and four or five inches above or below the place of the standard. When above, it descends vertically, but when below, it rises obliquely to the left. In either case, the movement is such that the gray ball representing V executes a series of curves with the result that, on the side toward *S*, *i. e.*, on the left (naturally the only visible) side, a gray rope is formed, whose outline is an index of the number and nature of the slurs in the movement of V. The actual number is a very uniform function of the time consumed by the tone; each slur representing two seconds, *e. g.*, when D = 14.0 vibs. (ten seconds necessary to reach equality) five slurs would be drawn. Finally it was found, much to the surprise of *S*, that the stop-

[1] We have noted that *S* thought, at first, that there were six or seven, later, three or four standards. Apparently, she finally came to classify correctly into a high, medium and low *region*, only she thought that each region contained several tones.

[2] This distance is more or less arbitrary; occasionally it is shorter.

ping point of the tracing of V (subjective equality) was almost invariably exactly opposite the point at which N had been placed, this giving a most striking confirmation of the vividness and distinctness of the visualizations, and of the readiness with which they might serve in the determination of the reaction.

The recognition-time in immediate judgments. In Parts I and II it was clearly demonstrated that, under the conditions of our experiments (8 vibs. D, with three possible judgments, etc.), the variable stimulus could be recognized as the same as, or as higher or lower than, the standard, in a very brief time after the sounding of the variable; this though the time-interval were 2 or 60 seconds. The introspection bore out this observation, for it was evident that these judgments were made without any process of comparison between the variable stimulus and the image of the standard; they could be made when all trace of the image was removed by suitable distraction during the interval. We termed these judgments *immediate*, meaning that no comparison was present, whether or not there was at the moment any trace of the auditory image in consciousness. That, within the judgments thus classed as immediate, there might be differences in the actual rapidity of the decision has been definitely stated.[1] It now remains to be seen whether these judgments are actually as rapid as the introspective reports indicate, and whether they are fast enough to warrant the conclusion that it would be impossible to have in the consciousness under measurement any process, however fleeting, involving reference to the image.

In order to investigate these points, the following arrangements were made. The air-cock of the blown bottle apparatus was equipped with metal contacts such that a circuit passing by way of a lip-key to a Hipp chronoscope was completed as soon as the air-cock was opened far enough to produce an audible tone from the bottle.[2] Observers *M*, *B* and *Wh* were then practiced in the use of the lip-key and the, at first rather difficult, task of expressing their judgments audibly. Advantage was taken incidentally to secure what we may call the 'speaking-times,' *i. e.*, the time necessary to pronounce the

[1] For example, first article, 443, 3.

[2] It is to be noted that this arrangement is open to a slight error, for, in actual operation, the air-cock is opened suddenly to its full extent so that contact must be made slightly before the current of air has rushed through the four feet or so of tube and set the bottle in action. This, error, however, is very slight, and the form of apparatus used was the most feasible of several that were tried. Moreover, the error, whatever its size may be, lengthens the reaction-time, and hence cannot be construed as contributing to the advantage of the results sought.

judgment words, 'higher,' 'lower,' 'same,' etc.,[1] in response to a single isolated tone, the actual conditions of the experiment thus being in play, with the exception that no standard was given, and that the time measured was, therefore, a single perception-time instead of a recognition-time.

The figures in Table XI represent introspectively valid tests only, those in which the judgments are rated by the observer as correct and immediate. From this Table we wish to make simply the following points, both of which are in complete accord with the introspective evidence already given.

TABLE XI.*

(*Recognition-Times. All results in sigma.*)

Obs.	Cases	D=+8	m. v.	D=0	m. v.	D=−8	m. v.
M	4	657	46	849	37	787	47
	6	407	48	402	49	341	42
B	4	464	99	659	70	609	56
	5	312	63	315	56	384	96
Wh	8	754	101	815	87	709	55
	6	317	36	350	27	294	21

* For each observer the first line represents the recognition-times, the second line the simple reaction.

(1) The recognition of tonal equality or specific difference can be given verbally in about three-quarters of a second. Hence, under the conditions of our tests, judgment is complete before the variable ceases to sound.

(2) Difference and its direction are more quickly recognized than equality.

One is tempted to carry the interpretation of the results still farther, to show, *e. g.*, that the relative speed of judgments of higher and lower in the case of *B* is in accord with her introspective verdict that 'higher' is the easiest and quickest judgment, and that it is to be related to the tendency to pass that judgment.[2] But the cases are very few in number and the mean variations are large. Even after the preliminary practice it was rather curiously difficult to secure a satisfactory series; a half-dozen tests were sometimes necessary to secure a

[1] The observers had strong preferences for the particular word which they used for the judgment, so that it was thought best not to insist upon uniformity in this respect: accordingly *M* used 'higher,' 'equal,' 'lower;' *B* 'high,' 'sa-' (for same), 'low;' while *Wh* used 'higher,' 'equal,' 'lower.'

[2] First article, 450.

single entirely valid result.[1] Of interest, finally, are the times of a few incidental judgments in which the observer was uncertain. The correlation of uncertainty with slow rates is clearly shown for in all these instances the times are over one second.

The chronometric tests, then, give objective verification to our assertion that immediate judgments are made so rapidly as to exclude the possibility of the process of image-comparison.

CHAPTER III.

CONCLUSIONS AND THEORETICAL IMPLICATIONS.

To gather together all the principal results of our investigation into brief compass, and, at the same time, to allow each item its proper significance is quite out of the question. Most of the results were obtained under specific conditions, and should not be stated baldly without reference to those conditions. The reader is accordingly referred to those portions of our text in which summaries and conclusions have already been given: most important are,—for the quantitative results, first article, 421, 422, present article, 223-4, 243-4, 250-1; for the qualitative results, first article, 443-6, 448, 455-6, present article, 230, 239, 252-4.

While we keep these specific conclusions in mind, we may venture, however, to discuss the outcome of our investigation, taken as a whole, upon the two problems set forth in the introduction,—the nature of the memory image for tones, and the nature of the consciousness involved in the judgment or decision.

THE NATURE AND COURSE OF THE IMAGE.

In regard to the nature and course of the memory image of both clangs and tones, we may conclude that:

(1) The auditory image is but one part of a complex structure which represents the original experience. Put briefly: the memory image of a tone is not a tonal memory image; it is that and much more. A tone is held in memory not only as an auditory quality, but also as a definite quality, possessing marks which help to identify it. These marks of identifica-

[1] Some of the difficulties are indicated by the following quotations: "Possibly opened lips too soon." "Said 'same' instead of 'equal.'" "Hesitated slightly for word." "Completely rattled: too anxious to make a quick decision." "Opened lips before I said the word." "Tendency to say 'equal,' then said 'higher.'" "Slow judgment." "Not sure of judgment." "'Equal' judgments naturally need the verbal expression to 'cap' them, but 'higher' and 'lower' I know before I can speak the word. Not natural for me to put the verbal sign on till later."

tion are supplementary contributions from various modalities,—visual, temperature and strain sensations, associations of various sorts, affective reactions, etc. The relative importance of these various features varies with the individual observer, and the conditions under which he is placed.

(2) The auditory image proper, usually of the timbre of the stimulus and localized at the instrument, attains its maximal excellence about two seconds after the stimulus; thence, despite the active use of memorial aids such as visualization, contraction of throat muscles, etc., it gradually wanes, suffering most in intensity, less in clearness, least in quality. It is in a very unsatisfactory condition at 40 seconds, and often entirely gone at 60 seconds.

(3) The image apparently *tends* to flat, but this tendency is more or less consciously resisted by most observers, so that, at least at 30 seconds or afterwards, it is more often sharp.

(4) The other constituents of the memory image do not necessarily follow the course of the auditory core; they may be serviceable for purposes of discrimination when the auditory image has disappeared entirely. This independence of the supplementary features of the memory image complex is best shown in the course of the memory image during long time-intervals. We have frequently mentioned the disappearance of the auditory core or its arbitrary alteration under these conditions.

(5) Continued practice with a stimulus of a particular clang color (tonometer or bottle) increases the serviceability of the image: it becomes more intense, clearer and of longer duration.

(6) The task of actively holding the image very soon develops a habit of imaging; the image, that is, of itself becomes insistent, and so insistent that, when exclusion of the image is desired, very active attention to naturally powerful distractors is necessary completely to repress it for relatively short intervals (10 seconds). Yet the ease with which distractors overpower the image is largely dependent upon the mental constitution of the individual: observers who make little use of the auditory image in the decision, observers who are not auditory-minded, and observers naturally attracted to odors, are able to repress the image with relative ease.

The Process of Judgment.

In turning to our second problem, the analysis of the judgment consciousness, let us note (1) that the method of right and wrong cases which we employed in the earlier tests really yields results obtained under two quite dissimilar conditions, viz.: (*a*) when $D = 0$, and (*b*) when $D = \pm 8$. However the quantitative results are treated, one must differentiate qualitatively between judgments of identity and judgments of difference, and, again, between simple judgments of difference without direction, and definite judgments of a difference and its direction.[1]

We must further note (2) that the values yielded by the reaction method, on account of the peculiar conditions which we have attempted to analyze, cannot be compared off-hand with those obtained by right and wrong cases. We cannot even say that the determination of subjective equality in the former method is akin to the judgment of equality in the latter. Yet, despite these radical differences, both methods furnish us with data which admit of unification in generalizations as to the mechanism of judgment.[2]

The following conclusions summarize the evidence we have obtained in regard to the structure of the judgment consciousness.

(1) The presence of the auditory image is not necessary to the recognition of either difference or equality. Judgments without the slightest trace of comparison were so frequent as to be the prevailing type for most observers. Their existence is attested by the introspection of the observers, by the tests made under distraction and by the chronometric measurement of recognition-times.

(2) The auditory image may be present in the judgment consciousness, but not itself an object of attention, not serving as a basis for comparison.

(*a*) This is most common in judgments of identity, when, although the recognition is immediate, the variable tone seems to re-enforce, or flow into, the image. Two interesting questions arise here: is the presence of such an image useful? Again, is it possible that its absence is the cause of the rapid

[1] It is clear that this division disregards the distinction between right and wrong cases: judgments of difference might be given with objective equality, etc. But the errors have already been discussed; for present purposes our immediate object is to deal with the right cases only.

[2] It may possibly be objected that the term 'judgment' cannot properly be applied to the reactions of the continuous change method or to the flash-like immediate answers in the case of discrete tones, on account of their simplicity and semi-automatic nature. J. Royce (*Psych. Rev.*, IX, 1902) seems to imply that Marbe's experiments (*Experimentell-psychologische Untersuchungen über das Urteil*, Leipzig, 1901) are open to this objection, for, after stating that Marbe undertook to investigate the psychology of the judgment, he says (115): "therefore it was the experimenter and not the subject in whom the process that was to be studied went on." We must, however, remember that mind is full of short cuts, that mental processes follow psychological courses rather than logical patterns. The experimentalist must work at first upon the analysis of comparatively simple bits of content; *cf.* our recommendation below, p. 268.

decline of right cases for D = o, as time-interval increases? The fact of this decline is clearly established: it was found by Angell and Harwood and by Wolfe. That long time-intervals seriously affect the auditory image is equally definitely made out. Let us, then, consider this question first.

One must bear in mind that long time-intervals affect the image in several different ways; its pitch, its clearness and its intensity, all are influenced. Now, though we have just stated that the image suffers least in pitch, it is, nevertheless, evident that a slight change just here would be most disastrous to the successful execution of *qualitative* discrimination. We have, as a matter of fact, been several times forced to take cognizance of the tendency to sharp the image, and we have shown definitely[1] that this tendency, as manifested by the error of judging — instead of = (and possibly, also, that of = instead of +, though the conditions are there rather different), is markedly increased by long time-intervals. In other words, the effect of time-interval upon right cases is largely due to the sharping of the memory image (including both auditory and supplementary components) rather than to its absence. Further discussion of this point would, therefore, lead us into the matter of judgments of higher and lower, and this we must defer to a later point.

The first question still remains:—is the auditory image which is merely present and not the object of attention, at all useful in those judgments of equality which are *correct?* We are of the opinion that, on account of its not being a direct object of attention, the image in these cases forms simply one feature in the 'familiarity feel,' which, as we shall try to show in a moment, is, in part, characterized by the ready provocability of centrally excited sensations. If the particular pitch which is recognized happens, when V sounds, to be actually in process of central excitation in the form of an auditory image of the standard, then the recognition is, in all probability, aided by this fact. The ease of the reception of the variable stimulus is distinctly enhanced, and the variable is then, for the observer, recognized as the *same tone* as N, rather than as merely familiar.

(*b*) In judgments of difference, likewise, the image may be present when the variable sounds, but it is then almost invariably thrust out of consciousness by the direction of the attention to the variable, and the judgment is determined for the most part by other factors. The advantage of the persistence of the image into the beginning only of the variable, in the reaction method, constitutes a special case. The image is not then present in the judgment proper; it is merely an accessory

[1] First article, 422, 2 (*b*).

to a preliminary judgment of the position of the variable at the start. Here it seems to aid some observers who react in terms of elapsed time, to make a more definite notion of the amount of D.

(3) The auditory image may be an essential component of the judgment consciousness, becoming a direct object of the attention, after the attention has once been given to the variable. Such judgments exhibit a true process of comparison.

(*a*) When working with discrete tones, judgments by comparison appear in cases of difficulty, when the conditions are novel, when the variable fails to touch off the decision at once, when two contradictory impulses are felt. In short, the deliberate use of the image as a standard of comparison is a more complicated device, a round-about path, indicative of obstacles, uncertainty and hesitancy. Its results, moreover, are themselves uncertain and quite as likely to be wrong as right.

(*b*) When working with continuously changing tones, the auditory image may be, even for observers who entirely neglected it with discrete tones, the object of constant attention, the standard to which the variable is compared,—whether by a series of rapid alternations of attention, or by active attention to the image (the variable itself being, since peripherally excited, sufficiently insistent without attention). This apparent change in the function of the image is but apparent. The conditions of the reaction method demand an exact identification of the variable and the standard, not a simple choice of one out of two or three possible answers. We have frequently shown that the reaction was felt to be merely an approximation, and that there was never absolute certainty. Now all this is tantamount to saying that the reaction calls for a very careful discrimination. This is more difficult, and hence it is not surprising that some observers make the fullest use of the memorial representation of the standard.

We have already mentioned, also, that, in many cases, the auditory image received attention up to the time the variable sounded in order to get a more exact determination of the amount of D, and hence to furnish indirectly a basis for the execution of a reaction at the expiration of a definite time-period.

We must now consider cases (1) and (2), especially the former, more fully, and seek to show what replaces the auditory image as the basis of judgment. Two main types must be explained, viz.: positive judgments of 'higher' and 'lower,' and judgments of identity. We may then discuss, finally, judgments of difference only, which may or may not involve the image.

4. Judgments of 'higher' and 'lower,' made without conscious reference to the image, are largely analyzable into com-

plexes of strain sensations, with less prominent visual and organic elements, set free neurologically by the variable stimulus. The two chief factors, feelings of tightening and relaxation for 'higher' and 'lower' respectively, were reported throughout the tests with discrete tones, and were also well brought out with the wide differences used in the reaction method. We believe that these strains, which are especially noticeable in the chest, throat, eyebrows, scalp, and about the ears, are explicable as symbols for 'upness' and 'downness' in the tonal continuum, set up by every-day experience, especially in executing and listening to music. Of course, it is impossible actually to differentiate innervations of the vocal cords within the small limits of tonal differences employed (the maximum D with discrete tones being less than ⅛ of a whole tone), yet the variable stimulus may arouse a complex of sensations,—partly centrally, partly peripherally excited,—which means simply '*high*' or '*low*.'

For certain observers who are extremely visually minded, the visual features set up by the stimuli may play a more important part than the strain sensations. The actual muscles concerned in mediating the strain sensations are also quite different for the different observers, but the general fact exemplified throughout is that judgments of 'higher' and 'lower' are usually mediated by the associated or supplementary components of the consciousness set up by the variable. Strain sensations seem to be, *par excellence*, the symbols of rise and fall in the tonal continuum.

The reasonableness of this explanation is, we think, attested very definitely by occasional instances in which imagery more specifically associated with the tonal scale was the deciding element in the judgment. The instances referred to are visualizations of a printed musical scale, of a piano key-board, the kinaesthetic imagery of striking one piano note a half tone above another, etc.

(5) Judgments of equality or identity without the presence and use of the auditory image are, as we have said, not so frequent as judgments of difference. When working with discrete tones, V is apt to bring up the image of N, though equality may be immediately recognized without comparison. We have intimated that in these cases the image simply became one part of the familiarity feel. We have now to consider more fully the nature of this feel, and to take into account, especially, judgments of equality in which the auditory image is entirely absent, (*e. g.*, with long intervals and distraction in the case of discrete tones, and with both these and the cases of observers who attend to V, in the reaction method).

Both of these types of judgment present clearly the problem of the *familiarity feel*, since in both types, there is absence of

any image and of the process of comparison. What is the structure, then, of the familiarity feel? Most pertinent in this connection are the continuous change experiments, for every reaction is an indication of equality. Discarding all tests in which an image of N was present, we find that the remainder may be placed in two groups, according as to whether familiarity was based (*a*) upon some subjective indication in the variable tone itself, or (*b*) upon some general indication afforded by the observer's own body.

The indications of the first type are exemplified by the following phrases culled from the introspection: the variable at equality is said to be,—graspable, appealing, more noticeable, louder, stronger, lingering along, standing out, a warmer gray, rounded-up visually, splayed out, etc. It is evident that many of these modifications of the variable refer to other than auditory features; thus, the first is tactual, the last four obviously visual. We are again reminded of the prominence of the associated and supplementary components of the auditory experience which were in evidence in judgments of 'higher' and 'lower.' It may be supposed, then, that the standard arouses a more or less definite complex of sensations, and that when the variable stimulus arouses the same, or a closely similar, content, the identification is affected. In other words, that point of the variable stimulus is familiar which has a peculiar effectiveness for the arousal of centrally excited sensations.[1] Such phrases as 'appealing' and 'my tone' indicate very obviously that the identified tonal quality is, if one may use the the term, peculiarly 'apperceptible.'

The indications in the second type are much less varied in nature and much less frequent in occurrence. Typical experiences are given in the phrases:—"glow of warmth," "kind of jumped all over," "felt a sense of ownership." These experiences seem always tinged with more or less pleasantness. They remind us of the pleasant "mood of feeling at home" which has often been attributed to the recognitory consciousness.[2] It is to

[1] *Cf.* Külpe, *Outlines of Psych.* New York, 1895, 172; Titchener, *An Outline of Psych.*, New York, 1899, 274.

[2] *E. g.*, Külpe, *op. cit.*, 172 ff; Titchener, *op. cit.*, 274 ff. The term 'mood' is, we think, rather objectionable as it connotes, to use the latter author's terms (241), "the weaker emotive states which persist for some time together." The affective reaction present in our recognitions may be very short-lived. On the other hand the term 'mood' has the distinct advantage of indicating the origin of the feeling of familiarity, since it refers us to an emotion as the primary source, and thus gives a biological explanation for the experience. There should be something in our terminology to indicate the distinction between such 'weakened' and 'degenerated' feelings and other feelings which are not the products of this line of development. Possibly the term 'secondary feelings,' on the analogy of the secondary reflexes, might serve to distinguish

be noted that, in common with the familiarity marks of the first type, these indications are components of the associative fringe which gathers about the auditory core and serves to give it individuality and identity. On the other hand, these components must be different in origin. The changes felt in the tone serve to identify that particular experience. But the general bodily reaction stands for familiarity in general; the variable is not the-same-as-N, but simply familiar. Such a reaction might identify as familiar, experiences quite other than those with which we have been concerned. Indeed, one would be very much more likely to experience the 'glow' of familiarity in situations in which the content of the experience had more complexity, more interest and vital importance than can be instilled into laboratory tests in the recognition of pitches.

Finally, recognitions of familiarity were not, at times, analyzable to the extent just described. The first thing to appear may be merely some auditory-verbal reaction,—perhaps the words 'equal' or 'same,' or, in the reaction method, the phrases 'that 's it,' 'now 's the time,' etc. In these cases we think the explanation is simple. The relatively complex content which marks more definite identification is replaced by merely the word content, 'known.' In all probability, even such recognitions are not made indifferently. We may suppose that the feeling of 'at-homeness' is also weakly present. The conditions of experimentation, however, lead the observer's attention to the verbal formulation, and the other features escape notice in that particular judgment. We have already called attention to the one-sidedness of individual bits of introspection. If we admit, then, that the cases under consideration exhibit both the auditory-verbal 'known' and a weak feeling of ease, we have shown enough to explain the execution of the judgment. A good analogy, which shows how the auditory-verbal consciousness may represent what was once more complex, is to be found in the development of cutaneous local signature, where the marks of locality, once, in every probability, made up of a complex of pressure-strain-articular-muscular sensations, became visual, and, ultimately, auditory-verbal.

Now the familiarity mark is quite as difficult of analysis as the locality mark, so that when we have procured, as in the present study, several thousand introspective analyses, we are warranted in assuming that the evidence of the majority of the cases, taken together, is most illuminative, and that, in the light of this evidence, those cases in which introspection fails to discover all the customary marks of familiarity, and, too,

these from the others which might then be termed the 'primary feelings.'

those cases in which introspection fails to reveal any trace of the mechanism whatever (*i. e.*, in which the tones is simply familiar, and that is all), that these cases are not to be mistaken as evidence for the unanalyzability of the familiarity feel, but rather of the limitations of the particular bits of introspection involved. We are not compelled to assume an unanalyzable 'quality of knownness' (Höffding), or an irreducible attribute of centrally excited sensations (Washburn).

(6) Judgments of difference in which the direction of the difference is unknown are quite common for some observers. They rarely appear except when there is an actual objective difference.

To explain them it must first be noted that they are of different types. We may distinguish at least three.

(*a*) Those involving the process of comparison and the use of the auditory image. This type is found in the case of observers who make most use of comparison (*e. g.*, *W*). The attention alternates several times between the two images,—that of N and that of V,— until the identity of the two becomes confused, so that the observer knows that one is higher, but cannot tell whether it is the image of N or of V.

(*b*) Those in which there is no comparison and no use of the image. Judgment results from a 'motor' or visual 'shift' set up by V, only this reaction is not definite like that symbolic of 'high' or 'low;' it simply indicates a change or difference. The possibility that a stimulus can reproduce the judgment of difference without producing a more definite judgment of the direction of the difference has been frequently stated. The explanation given by Külpe[1] and by Stern[2] seems quite adequate in the present connection. Finally, we may distinguish a third type.

(*c*) Those in which judgment does not stop at the assertion of difference as in (*b*), but in which the direction of the difference is afterwards successfully ascertained by voluntarily "hauling up" the image of N and performing the process of comparison.

This completes our problem. We have endeavored to present an exhaustive analytical investigation, with the aid of two distinct experimental methods, of the mental processes involved in the discrimination of simple tones and clangs as conditioned by time-interval and by the mental constitution of the observer. We have endeavored finally to express in as compact a manner as possible the generalizations of the facts

[1] *Op. cit.*, 173 f.
[2] *Veränderungsauffassung*, 251.

adduced and the theoretical significance of these generalizations.

Certain problems have appeared in the course of the investigation which might well receive further discussion and further investigation. We have, for example, been impressed with the prominence of the spatial characteristics of tones. While we cannot here amplify the proposition, we may assert that, in the light of our introspective evidence, there is nothing immanently or innately spatial about tones; that all their spatial characteristics are secondary and supplementary, the product of experience with very special emphasis upon the spatial characteristics of the source of the sound.

Another problem which would be suitable for experimental investigation, and closely related to our own subject is to be found in the recognition and discrimination of auditory qualities whose pitch (at least that of the standard) is not that of a single isolated note, but that of a cadence or melody, or of a chord. Such a content would present conditions more nearly resembling those of actual life. The mechanism of recognition might conceivably be more complex, but at the same time more open to view. The influence of absolute pitch, of musical training, of the nature of the imagery, would all be more apparent than in the case of isolated tones. From the writer's own experience it seems probable, also, that such tests might be made with time-intervals greater than those here employed.[1] The point of attack must be throughout qualitative (though fidelity of memory, or, to speak more strictly, capacity of recognition, might be incidentally determined), and great attention must be paid to the peculiarities of individual observers.

[1] *Cf.* Stern, *Veränderungsauffassung*, 206, "Für einen einzelnen Ton ist die Reproducierbarkeit zeitlich eine viel beschränktere, als für den Klang einer Stimme oder für eine Melodie."