

The Type-Theory of Simple Reaction

By E. B. TITCHENER (1895)

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In a recent number of the *Psychological Review*[1] Professor Baldwin has proposed a "type-theory" of the simple reaction, which he opposes to the theory of "a certain mental *Anlage* or aptitude" as held by "Wundt, Külpe and others." I wish to examine this type-theory partly on its own merits, and partly in the light of the conclusion of my previous article on "Simple Reactions"[2]."

A few preliminary remarks seem necessary to the full understanding of the issue. (1) The "theory" of the simple reaction, in the sense in which the word is used by the Leipsic investigators (Wundt, Lange, Martius, Hilpe, etc.), consists in the analysis of the whole process into its constituent part-processes, physiological, psychophysical and psychological, and in the reference of the two latter kinds of part-process to their conditions, physiological or psychological. The theory has undergone very considerable modification between 1887 and 1895: so that the Leipsic names cannot be simply bracketed together, as they are by Professor Baldwin. A "disposition" or "aptitude" theory does not exist. (2) What the term "disposition" in this connection really means can best be shown by quotations[3]. Lange writes: "Our experience shows that there are certain persons who are incapable..... of reacting consistently in the sensorial or muscular way throughout an experimental series, however good their intention and however complete their practice. They are too nervous, too distraught; and they fall into such a state of general mental excitement that they ordinarily do not even possess sufficient presence of mind to disclaim the reactions which they know to have been wrongly executed. It would, of course, be useless for the normal psychologist to make experiments upon subjects in so obviously pathological a condition. [p. 507] -- It is to be noted that individuals who are usually sure of their reactions may lapse into this condition for a day at a time[4].*" Wundt says: "You will find during the course of practice that there are individuals who are entirely incapable of any steady concentration of the attention, and who will therefore never make trustworthy subjects. That should not be surprising. It is not everyone who has the capacity for astronomical or physical observation; and it is not to be expected either that everyone is endowed with the gifts requisite for psychological experimentation.*" writes, in a different connection: "Certain attitudes, habits, and characteristics of mind..... affect results in

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certain ways which are injurious to the experiment.... It is a fact which every psychologist must understand, that certain classes of persons are incapable of introspection*." The "disposition," then, is not a theory: it lies behind theory. Until a subject has been found with the psychological disposition, psychological results cannot be obtained at all, and there can consequently be no theory of psychological results. (3) It follows from this that Professor Baldwin's charge that the Leipsic school "rules out" results which do not accord with the Leipsic theory, but *are nevertheless constant and regular results*, is altogether unfounded. The only results ruled out are those which are wholly irregular and inconstant. Leumann especially emphasises the need of attention to "persönliche Bedingungen" in chronometrical investigations". Külpe says: These two forms of expectation [the sensorial and the muscular] may actually appear in very different psychological shape; not only do we find individual differences in reproductivity, but we may have a variation in the particular condition of preparation in one and the same reagent. If the person is incapable of any vivid ideation of a sense-impression, he will give the appropriate direction to his attention by the formation of a corresponding judgment, or by help of the organic sensations arising from the strain set up in the organ of sense or of movement, or perhaps by visual ideas of the stimulus or of the required movement. So far there has been no accurate discrimination of all these forms of muscular and sensorial preparation. But it is probable that certain differences in the determination of reaction times are largely referable to the differences in the form of expectation*." Here we see a full recognition of the existence of sub-forms of the muscular and sensorial types, and an attempt to furnish an explanation (theory) of their occurrence. (4) It follows further that Professor Baldwin's demand for a statement of the origin and meaning of the "disposition" is a demand for the impossible. We cannot account in detail for any of the "mental dispositions" -- talent, receptive or creative imagination, logical or mechanical memory, temperament, etc. Their explanation must be couched in general terms of nature [p. 508] and nurture, of heredity and education. Our knowledge of the individual reagent, of his family history, etc., is insufficient for any exact theory of his mental disposition. (5) Lastly, in the light of these considerations Professor Baldwin's accusation of a *circulus in probando* falls to the ground. It is not that "certain cases prove the result, and these -- cases are selected because they prove that result." The argument runs somewhat as follows 'Not everyone can react regularly. Persons who can react regularly react in the vast majority of cases in the sensorial-muscular way. Two conclusions are legitimate. There is a psychological disposition involved in regularity of reaction: and the obtaining of the sensorial-muscular types may be regarded as averagely characteristic of it.'-- The theory of the reaction itself, as I said just now, is quite a different matter.

The type-theory sets out from the proposition that "the current distinction between sensory and motor reactions does not hold in the sense that the motor reaction is always shorter than the sensory." "Individual differences are clearly established." Then, reaching his conclusion by way of the pathology of the speech function (aphasia), Professor Baldwin argues that "a man is an 'auditive,' or a 'visual' or a 'motor' in his voluntary movements generally..... If this be true, it is evident that a man's reaction time will show the influence of his memory-type. The motor reaction we should expect to be most abbreviated in the man of the motor type; and less abbreviated, or not so at all, in the 'visual' or 'auditory' man." "In simple hand movements [as in speech] people must show the sensory and motor types" For the man of the motor type, "the thought of movement is the most facile beginning of the movement, just because it is *really the movement*, and nothing else, that he thinks of." "The man who gives relatively shorter sensory reactions is a 'sensory' in his type: with him the attempt to think of the movement as a *movement* interferes with the prompt and exact execution of it, just because he is not accustomed to execute his movements in that way."

It is clear that these sentences constitute the outline of a theory in the strict sense; *i.e.*, that "type" cannot be paralleled with "disposition." It is also clear that the theory is an attempt at the specific formulation of the conditions of those divergences to which Külpe refers only in general terms, and that the formulation has a good measure of aprioristic probability. Külpe, however, believes in the normality of the *sensorial-muscular* difference: Professor Baldwin does not[5]. Some of Professor Baldwin's evidence, it is true, was inaccessible to Külpe. We must ask whether the testimony of the new experiments is sufficient to turn the scale.

Evidence for the type-theory.-- The evidence in favour of any scientific theory is ordinarily of two kinds, constructive and circumstantial.[p. 509] The constructive evidence furnishes a direct experimental verification of the hypothesis; the circumstantial evidence consists in the demonstration of the ability of the hypothesis to account for facts left unexplained by previous hypotheses. Professor Baldwin draws upon both categories of proof. But it is a grave defect in his constructive argument that not one of the subjects to whose reaction times he appeals is recorded to have been specially tested for type-memory, The obvious plan would surely be to make certain of the type first, and then obtain reactions. There are many methods of testing type, apart from the reaction method.

Four persons reacted to sound. Two of them, B. and S., carried out the investigation of which the present Study is a report: presumably, therefore, they had the type-theory in mind throughout. Whether the other two reacted with or without knowledge we are not told. The reactions were of the following kinds: sensory (sensorial), kinaesthetic motor (attention "given to the movement by thought of the hand, the eyes being blindfolded"), visual motor (attention "fixed upon the hand, which is seen"), light sensory (sensorial as before), dark sensory (sensorial in dark room), light motor (kinæsthetic motor, as before), and dark motor (kinæsthetic motor in dark room). Although nos. 1 and 4 and nos. 2 and 6 are identical, the times are given in different tables, and not compared. Tabulating, we have, in values of s:

Reagents :	B.	S.	F.	G.
Sensorial,— } nos. 1 and 4. }	178, 176	235, 237	164	132
Dark Sens.	184	219		
Vis. Motor	171	195	205	
Kin. Motor,— } nos. 2 and 6. }	149, 164	184, 158	202	
Dark Motor	138	179		
(Average Motor				157).

The greatest reliance is placed upon the times of B. and S. But, in the first place, the fourth line of the tables shows that neither of these subjects reacts constantly. In one 1000 experiments, B. gives 149s and S. 184; in another 1000, B. gives 164, and S. 158. If this variation is not due to imperfect practice, it calls for special explanation. Secondly: Professor Baldwin tells us that he used to react in the sensorial-muscular way*. The differences between his sensory and motor reactions amount here only to 29, 7, 12, and 46s, in the different cases. How has this change come about? Thirdly: Professor Baldwin, in drawing conclusions from the two Tables, argues from time-differences (22, 18, 21s) which fall within the limits of the mean variation of the total times (10 to 20s; no specific figures given). Nevertheless, it must be admitted that the Tables show some striking results, and that the construction of types from them is very ingenious.

Much emphasis is laid by Professor Baldwin upon a case reported [p. 510] by Professor Flournoy[6], in which the difference between the time of reaction with sensorial attention and that with motor attention was not a positive 100s, but on the average a negative 110s. The reagent was incapable of the true "muscular reaction," *i.e.*, of reaction "with special preparation of the muscles" M. Flournoy writes of him as follows. "There is no sign of the preparatory [muscular] tension which is one of the characters of the true muscular reaction. And this is not due to any misunderstanding, but to a physical impossibility Whenever he has attempted at my request to give his muscles a certain degree of preliminary tension, he has fallen into the other extreme, and produced a permanent contraction of the whole arm." This contracture appears to the reagent to be a "fatiguing and unnatural operation, which does not assist the reaction in any way." "When the attention is motor," in the manner normal to him, "it is the perception or visual image of his right arm which fills his thoughts." For him "motor attention is always attention to the visual form of the movement." "He is distracted by the visual image." M. Flournoy characterises him as a *visuel géométrique*, as distinguished from a *visuel pittoresque*. "He has no coloured hearing, but possesses schemata, perfectly definite and localised, for the series of numbers, the week, the year, etc."

It is unnecessary to go into further detail either as regards the mentality of the reagent,

or M. Flournoy's analysis of his time results. The facts present no difficulty to the Leipsic theorists,-- who can accept them, just as they accept the facts of differences [p. 511] of memory-type, and can also accept the explanation offered of them. All that they would say is that the "physical impossibility" to react muscularly is not, in laboratory experience, a feature of the normal or average mental constitution, any more than number-forms are. Consequently, the mind so constituted cannot be drawn upon to furnish norms of reaction : however interesting its workings may be in other connections.

Circumstantial evidence is found by Professor Baldwin in certain results published by Cattell, and (doubtfully) in times obtained from Donders. With regard to the former Professor Cattell writes to me as follows:--

"I have always found it difficult to define my own 'memory-type' by introspection. I presume that I am what would be called 'verbal motor.' The length of my reaction-time does not seem to be affected by the direction of attention. The observer J. also gave the same reaction-time, whether attention were directed to the stimulus or the movement. · I am not able to define the 'memory-type' of this observer: but it is not strongly visual. The third observer, D., is a professor of biology and is by nature and training visual; his reaction-time was much lengthened when he attended to the movement, he having normally always attended to the sensation. I presume that his case would support the theory of Flournoy and Baldwin. My own idea is that An unusual direction of the attention lengthens the reaction-time, but that when the reaction has been much practised it becomes reflex. In my own case it requires practically no attention of any sort.

I can, however, give you an instance (unpublished) that supports your point of view. An observer reacted much more slowly for sound than for light. When I enquired into the matter I found that it was because his attention was disturbed (*i.e.* was sensory) by not knowing where the sound was. When I shewed him the place and nature of the sound, his reaction became much quicker and more regular."

Honours are divided. But it is plain enough that we cannot infer type from reaction, whatever may be the effect of type upon reaction, given equality of all other conditions.

The Donders times are 180s for sound, and 188 a for light. Wundt explains the first as sensorial and the second as muscular, 'referring the difference to practice[7]. Donders had reacted to light far more frequently than to sound. Of course, he may have been a 'visual' as Professor Baldwin guesses. But I have so far been unable to find any indication of the fact in the literature: and Wundt's hypothesis is well borne out by the last case cited in Professor Cattell's letter.

Professor Baldwin does not claim support for his theory from the other times which do not show the sensorial-muscular difference, quoted in my previous paper.

Evidence against the type-theory.-- "There are as many kinds of memory," writes Volkman[8] "as there are kinds of ideas." True, it is probable that inequality of memories in the same [p. 512] individual is the rule, not the exception[9]." But there seems to be no good ground for the assumption that this inequality is, on the average, so great as to pass over into a virtually exclusive preponderance of one particular memory. Most people, I imagine, would judge by Jacob's voice *and* by the hands of Esau, though they might incline, by nature or education, to prefer either one of the two criteria. In other words, a "mixed" memory-type must be recognised.

The elucidation of a memory-type is by no means an easy matter. No memory-image is qualitatively constant, even if it persist in its original type. Very frequently it does not: many would-be visual memories are in reality verbal (auditory) memories, --we remember that we "saw" things of which we have merely heard our elders speak; or we say that we remember "seeing" when all that we really remember is the form of words in which we are accustomed to

narrate the experience. Type may shift in other ways: it is possible to break oneself of the habit of piano playing by finger-memory, and to learn to "read," *i.e.* to vary from the motor type to the sensory. In my own experience, memory-type differs considerably, and not always quite accountably, as between special recollections and actions[10].

I have tested and observed the processes of memory in myself since 1890. By nature, my visual memory is the strongest; the motor is available, but a good deal weaker; the auditory lags still farther behind the motor than the motor does behind the visual. Having satisfied myself of these relations, I attempted, in 1891 and 1892, to have special practice to the motor and auditory types; and succeeded in largely increasing their effectiveness. Since 1892 I have been engaged in experiments which have demanded an exclusively visual memorising: and the results show that the effort to rule out conflicting processes has been successful. Yet my visual and auditory reactions, sensorial and muscular, have varied only by a few s during the five years. Moreover, the time-difference showed itself from the moment that I had learned the two possibilities of direction of attention, slid before I knew anything of what 'ought' to happen upon Lange's theory.

Professor Baldwin thinks that distinctions will manifest themselves, within the sensory type, in the times of reaction to stimuli from various sense-departments. A 'visual,' *e.g.*, will react more quickly to light than to sound. Indeed, this belief is essential to the type-theory of reactions. As I have said above, the theory is [p. 513] a "generalisation" from the facts of aphasia. "Voluntary movements generally" will be performed as the speech-movements are performed: the "cue" for reaction will be the "cue" normal to speech, in the given case. M. Binet, who appears to have arrived independently of Professor Baldwin at a similar conclusion, regards the results of his test of M. Inaudi as invalidating the hypothesis[11]. M. Inaudi is a professional "calculator," of the pure auditory type. The auditory 'cue,' *i.e.*, is very strongly predominant in his calculations. There is also a motor 'cue,' but "the movement of articulation only intervenes to reinforce the auditory image." Visual ideation is exceedingly elementary. The reaction-times were: sound, 86s; sight, 89s; touch, 88s. M. Binet writes:

"The average time of reaction remains almost exactly the same, 0.08 sec., whatever the nature of the stimulus. One would have supposed that M. Inaudi, whose type is for all practical purposes exclusively auditory would react most quickly to auditory stimuli. We even imagined at the time that the reaction method could be employed for the determination of the memory-type of different persons. The hypothesis, perhaps, is still not wholly untenable: it may be that experiments upon hysterical subjects would furnish interesting results. But at any rate, it has broken down completely in the case of M. Inaudi."

Professor Baldwin may fairly object that the test is not unexceptionable, as no comparison was instituted between the sensorial and muscular directions of attention. In any event, however, the results appear to tell heavily against the type-theory. If the times are "sensory" they should have shown difference. From the Leipsic standpoint they would be judged to be muscular: (1) because M. Inaudi was new to the reaction experiment, and so would be apt to concentrate his attention upon the hand movement; (2) because of their shortness; (3) because of their small mean variation (10s); and (4) because of their uniformity in the different *sense-departments*. If we grant that they are muscular, we have a man, endowed with an extraordinarily developed sense memory, preferring muscular times, and giving no sign of any inclination to change to the opposite form,-- as the theory requires; while the muscular times are so short that it would be impossible for the sensorial to be shorter,-- as the theory again requires.

M. Binet bows to the facts. "It must not be supposed that M. Inaudi is an auditive outside of his professional exercises in calculation. He is an auditive for calculation, *i.e.* for one partial, special, sharply defined memory: there is nothing to show that he is guided by audition in the use of his other faculties." One cannot argue, with Professor Baldwin, from the "cues, checks, controls," involved in speech to those "affixed to hand actions." A man may speak from predominantly sensory 'cues,' and yet execute a true muscular reaction from a motor: indeed,

he may prefer to take the motor cue for reaction, when he is left free to choose between that and the sensory. [p. 514]

To these two negative instances must be added the weight of all the evidence for the generality of the sensorial-muscular difference. As the argument has been somewhat overweighted with details, it may not be amiss to append a brief summary:

(1) Only a certain proportion of those who offer themselves for test in the psychophysical laboratory prove to be capable of constant and regular reaction. Hence I have spoken of a "disposition" for these psychological experiments.

(2) The great majority of those who react with constancy show the sensorial-muscular difference. Hence I have taken this difference as averagely indicative of the psychological "disposition."

(3) Those who react regularly, but not in the sensorial-muscular way, require special attention at the hands of the experimenter. Their times may be explained by degree of practice (so Wundt of Donders), by automatism[12] from continued practice (Wundt of Cattell, Cattell of himself), by abnormality (uncommon feature) of mental constitution (Flournoy's case), by the character of their reaction education (Dessoir's cases), by novelty of stimulus (Martius) by insufficient education (van Biervliet's cases), etc.

(4) Upon the basis of the foregoing propositions a theory of the simple reaction has been built up. Its stages have been briefly sketched in previous papers in *Mind*. It is connected with the names of Wundt, L. Lange, Martius, Münsterberg, Külpe, etc.

(5) Professor Baldwin offers as a substitute for this theory a theory couched in terms of memory-type. Reaction time is an index of the type of 'cue' used by the subject in speaking. The sensorial-muscular difference is not a fact from which inferences can be drawn for theory. There is no reason why the sensorial time should be averagely longer than the muscular. Sensory speakers react more quickly sensorially than muscularly, and *vice versa*.

(6) The new theory certainly possesses something of the "naturalness and probability" which is claimed for it by its author. But the evidence for it at present is so slight that it is hardly more than a conjecture. It seems fair to say that no unequivocal testimony has been adduced, while the counter-evidence is very strong.

If the *a priori* probability be still emphasised, the objection must be urged that the theory, in its present form, is much too simple. The memory mechanism is more complex than Professor Baldwin recognises.

E. B. TITCHENER.

Footnotes

[1] Vol. II. no. 3, May, 1895.

[2] *Mind*, Jan. 1895, pp. 74 ff.

[3] This particular word has, I believe, been used by myself only. Cf. *l.c.* p. 78: "The distinction drawn by L. Lange [between sensorial and muscular simple reactions] is a valid one, but not obtainable from every observer. Rather is there required for the work a special kind of disposition or *Anlage*."

[4] All passages marked with an asterisk in this Discussion are exactly cited in my

previous paper.

[5] It is hardly necessary to remind the reader that the Leipsic "sensorial-muscular difference and Professor Baldwin's "sensory and motor types" are quite different things.

[6] Professor Baldwin writes (p. 265): "Titchener, in his summing up, does not cite the cases of Flournoy nor the earlier report of one of my present cases (F.) in the [N.Y.] *Medical Record*, April 15, 1893, although they tell directly against his own views..... [He] is... wrong in citing me as favouring the position [of Lange and Wundt]."

I have quoted a remark from Professor Baldwin's report on p. 79. I did not mention it on p. 77 because the reading of it gave me no idea that the author had turned his back upon the sensorial-muscular difference, as a fundamental fact. In the light of later statements (that in the *Psych. Rev.*, and that in *Mental Development*, I. p. 465) it is easy to see that I mistook his meaning,-- for which I am very sorry. The report itself is a preliminary note, without figures.

On p. 79 I have also mentioned M. Flournoy. When I wrote, I had not succeeded in obtaining his articles: I knew them only from Ebbinghaus' summary in the *Zeitschr. f. Psych.* (V. pp. 406, 407) and from Philippe's abstract in the *Rev. phil.* (XXXV. p. 444). They were not cited on p. 77 for the reason that they seemed to me to be irrelevant to the issue. The mechanism of the visual reagent's mind appeared to be as exceptional as that of Stricker's, e.g. Hence I regarded the case as one to be treated apart from the question of the normal or average variations of reaction-time.

The quotations in the text are from M. Flournoy's second paper (*Arch. Des sci. phys, et nat.*, XXVIII pp. 319 ff.). I think that they justify my original opinion. Of the former article (XXVII. p. 575) the author writes to me: "It was only a preliminary note, very brief, and not giving any figures."

[7] *Physiol. Psych.*; 4th ed. II. pp. 322, 313.

[8] *Lehrbuch d. Psych.*, 3rd ed. I. p. 476.

[9] Ribot: *Les maladies de la mémoire*, 7th ed, pp. 110, 111.

[10] Cf. Baldwin, *Mental Development*, pp. 435,461, note. Ch. XIV. XV. of this work call attention to certain of the facts noticed above; but their generalisations appear to be one-sided. Such, at least, is the indication of the details of evidence which I have been able to collect.-- The only explicit recognition of a "mixed" type by Professor Baldwin that I can find occurs in the *Phil. Rev.*, II. p. 396:-- (article on " Internal Speech and Song)." Elsewhere, type is treated as if necessarily simple.

[11] *Psychol. des grands calculateurs*, etc. 1894, pp. 106 ff. 69, 72.

[12] It is to be noted that automatism can only arise where a considerable amount of practice has preceded the attempt to get the sensorial-muscular difference. I have never known the difference, once obtained, to decrease. It rather tends to increase as the sensorial time is constant, but there is great difficulty in the retention of the muscular form intact. Hence I must differ entirely from professor Baldwin, *Psych. Rev.*, II. p. 270.

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