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THE HISTORICAL DEVELOPMENT OF RESPONSE PSYCHOLOGY[1]

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THERE are, I venture to say, few psychologists of the present day so thoroughly mentalistic that they do not incorporate some form of motor response in their psychological system. Where they differ is in the importance they attach to such responses and in the relation they believe exists between response and consciousness. The prevailing, and what might be considered the conservative view, is that response follows perception or ideas either as an effect or as an accompaniment and that such conscious states are only affected by response in so far as such response stimulates proprioceptors, which in turn set up an afferent impulse. According to this view, then, consciousness lies, as it were, between the afferent and efferent impulses and consequently occurs before the response. In a previous paper I have described a view which makes response an essential factor of consciousness.[2] It follows from this position that without response there would be no consciousness. No matter how many or how strong are the stimuli and the resulting afferent impulses, without the efferent impulses and specific response, either incipient or overt, an organism would have no awareness of a world; so far as that organism is concerned there would be no experience.

This view undoubtedly seems extreme to many scientists, but it does not in the least break with the past, nor is it new in any of its essential features. It is my purpose, then, in this paper to sketch briefly its historical development and to describe some of the more recent experimental findings which seem to support it. I should say, at the outset, that many of the authors of the past, especially those who wrote before the birth of experimental psychology, made but brief reference to such a view, and no one of them devel-

[1] Address of the vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Atlantic City, December, 1932.

[2] H. S. Langfeld, "A Response Interpretation of Consciousness," *Psychol. Rev.*, 38: 87–108, 1931.

oped a consistent and thorough response theory. But it is fair to assume that even a chance remark from a respected philosopher or scientific man has often had a strong influence on the future of thought.

There are many of our present psychological concepts whose roots can be traced to the early Greek philosophers. In support of our present thesis we find Plato's identification of thought with inner speech. Inner speech, however, can as well be accepted by the mentalist as by the response psychologist, for the remark may simply mean that we hear ourselves think and need not necessarily refer to incipient response of the vocal organs. Therefore, unless we wish to force the interpretation of Plato's statement, one can only assume that at best it was merely a faint but nevertheless fruitful suggestion. Parmenides, before him, however, wrote in no uncertain terms. He does not even mention vocal response, but takes us at once to the gross movements of the organism. "For just as thought finds at any time the mixture of its erring organs, so does it come to men, for that which thinks is the same, namely, the substance of the limbs, in each and every man; for the highest degree of organization gives the highest degree of thought."[3] Not only did Parmenides plainly identify thought with motor response, but he even went further and, to recast the statement in modern terms, correlated degree of intelligence with degree of muscular coordination, which was the underlying idea in some recent investigations of the relation of intelligence scores to the speed of reaction.

Many centuries later, La Mettrie referred to the identification of thought, or as he called it "faculties of the soul," with the organization not only of the brain but of the entire body.[4] He further stated "that thought is so little incompatible with organized matter, that it seems to be one of its properties on a par with electricity, the faculty of motion, impenetrability, extension, etc."[5] This, the basis of his materialism, is a very general statement. A more specific reference to a response theory is his remark that "the brain has its muscles for thinking, as the legs have muscles for walking."[6] Such a phrase would be highly fantastic from any other point of view than a motor concept of thought, and even his sharpest critic would hardly accuse La Mettrie of phantasy or mysticism.

In much of the literature upon motor response, kinesthesis plays an important if not a leading rôle. There is, in such instances, it seems to me, a serious confusion, as I have explained elsewhere.[7] According to a thoroughgoing motor theory, perception is identical with the response system, not a consequence of it, and kinesthesis, being a perception, must therefore itself be identified with such response. The motor theory does not in any way depend for its verification on introspective reports of kinesthesis. Even if we never had a perception of the feel of our muscles, the motor theory would in no wise be invalidated. As a matter of fact, relative to the total perceptual experience of the individual, kinesthesis is a rarity and, further, it is obvious from what has just been said that for a psychologist to dwell upon the function of kinesthesis does not in itself class him as a response psychologist. If such were the case, there would be very few psychologists who do not fall under that category. In short, kinesthesis can as well fit into an afferent-perception-efferent-response theory as into a response or motor theory. And so when Erasmus Darwin stated in his "Zoonomia" that "the organ of touch is properly the sense of pressure, but the muscular fibres themselves constitute the organ of sense, that feels extension," he does not commit himself to any particular theory.[8] It is difficult for us to-day to interpret accurately this statement which, in the light of our finer distinction of terms, appears to us ambiguous, and this holds for several other authors I shall quote, whose descriptions are in sensory rather than motor terms. When, however, he further states that ". . . the whole muscular system may be considered as one organ of sense, and the various attitudes of the body, as ideas belonging to this organ," there can be little doubt that he attached much importance for consciousness to the motor side of the total organic response.

Professor L. Carmichael in his article on Sir Charles Bell[9] has shown how amazingly broad and prophetic were that scientific man's views on physiology and psychology. It is not surprising, therefore, to find that Bell was cognizant of the important rôle of muscular action in perception, especially in the experience of space. In his book on "The Hand"[10] he remarks that "without a sense of muscular action or consciousness of the degree of effort made, the proper sense of touch could hardly be an inlet to knowledge at all." Just as in one of the above statements of Darwin, so here it is not clear

[3] J. Burnett, "Early Greek Philosophy," 2nd edition, 1908, p. 202. The last clause is G. H. Lewis's translation in his "Biographical History of Philosophy," 1905, Parmenides, 51–52.

[4] La Mettrie, "Man a Machine," p. 128. Chicago, Open Court Pub. Co., 1912.

[5] *Ibid.*, pp. 143–144.

[6] *Ibid.*, p. 132.

[7] H. S. Langfeld, "A Response Interpretation of Consciousness."

[8] Erasmus Darwin, "Zoonomia, or the Laws of Organic Life," Vol. 1, Sect. xiv. London, 1794.

[9] L. Carmichael, "Sir Charles Bell: A Contribution to the History of Physiological Psychology," *Psychol. Rev.*, 33: 188–217, 1926.

[10] Sir Charles Bell, "The Hand," London, William Pickering, p. 195, 1833.

to what extent reference is made merely to kinesthetic sensations. Further, it is not safe to conclude that Bell believed the sensation of touch to be dependent upon motor experience. I am inclined to think, rather, that he had in mind touch localization. Certainly, when he stated that "it is to the muscular apparatus and to the conclusions we are enabled to draw from the consciousness of muscular effort, that we owe that geometrical sense by which we become acquainted with the form, and magnitude, and distance of objects," he is referring to the genetic theory of space based upon movement.[11] Although there may be some doubt from these earlier writings of Bell's adherence to the notion that movement is a *sine qua non* of touch perception, there is little possibility of mistaking his meaning in the article he wrote some twenty years later, entitled "On the Necessity of the Sense of Muscular Action to the Full Exercise of the Organs of the Senses."[12] The title itself is clearly indicative of his position, and Carmichael has pointed out that Bell believed that the stimulation of the sensory nerve was not sufficient for a perceptual experience. Something more is necessary, namely, muscular movement.[13] In other words, Bell held that the total afferent-efferent system is a true correlate of the perception.

Seven years before Bell wrote this last-mentioned paper appeared Baron von Holbach's English translation of the "System of Nature," the original of which was published in 1770. In it he expressed the view that consciousness depends upon organization and specific action. He speaks in the language of the time, but the thought is distinctly modern in that he emphasizes action patterns. "To convince ourselves," he wrote, "that the faculties called *intellectual* are only certain modes of existence, or determinate manners of acting which result from the peculiar organization of the body, we have only to analyze them: we shall then see, that all the operations which are attributed to the soul, are nothing more than certain modifications of the body, etc., etc."[14] This remark refers not only to the doctrine that the mental does not exist without the physical, but also that response is a necessary factor.

In the beginning of this same century, 1801, Destutt De Tracy, in his "Elemens d'Ideologie,"[15] expressed similar views of the direct relation of movement to the mental. He considered "it certain that we cannot conceive of any perception produced in us, even the most purely intellectual, without some kind of movement in some one of our organs." One might think from this statement that he was describing that relation of ideas to action, which later took the form of the ideo-motor theory: but from his further remarks that we can only regard action of thought and of sensing as a particular effect of the act of moving ourselves and that "this notion is worthy of serious consideration," it is clear that he was not thinking of the possibility of movement always following an idea, but rather of the dependence of the idea on the movement.

Of the work of the middle of the last century, Lotze's theory of local signs and his genetic interpretation of space perception have a significant bearing on the motor theory. His idea that spatial localization depends on muscular movement means that at least some quality of our mental experience is in direct relation to if not identical with response. It is true that Lotze spoke of "Muskelgefühl" and thus invited the criticism that sensations of movement can not by some magical alchemy become visual perceptions. We find here the old confusion, noted above, between kinesthesis or feeling of movement and the efferent impulse and the movement itself.

Alexander Bain described localization in terms very similar to those of Lotze, and unfortunately with the same confusion. He states: "An object seems to us to be up or down, according as we raise or lower the pupil of the eye in order to see it; the very notion of up and down is derived from our feelings of movement, and not at all from the optical image formed on the back of the eye." He comes very much closer to the present conception of the rôle of response when he writes: "And now, as to the *sensations,* or the proper mental elements of Sight. These are partly optical, resulting from the effect of light on the retina, and partly muscular, arising through the action of the various muscles. Nearly all sensations of sight combine both elements."[16] There is evidently here a direct reference to movement itself. Bain further specifically calls attention to the function of the organs of speech and believes that "a *suppressed articulation* is in fact the material of our recollection, the intellectual manifestation, the *idea* of speech."[17] He also combats the notion that the brain is the seat of sense impressions and believes emphatically that the total nervous arc is necessary for consciousness, a view which was later elaborated by Professor John

[11] Sir Charles Bell, "On the Motions of the Eye, in Illustration of the Uses of the Muscles and Nerves of the Orbit," *Phil. Trans. Roy. Soc. Lond.*, pt. 1, p. 167, 1823.

[12] Sir Charles Bell, "On the Necessity of the Sense of Muscular Action to the Full Exercise of the Organs of the Senses," *Proc. Roy. Soc. Edinburgh,* 361–363, 1842.

[13] L. Carmichael, "Sir Charles Bell: A Contribution to the History of Physiological Psychology," p. 209.

[14] Baron von Holbach, "System of Nature," English translation, Vol. 1, p. 53, 1835.

[15] Destutt De Tracy, "Elemens d'Ideologie," Paris, 3rd ed., Chap. xii, 1817.

[16] Alexander Bain, "The Senses and the Intellect," p. 246, 4th ed., New York, Appleton, 1894.

[17] *Ibid.*, p. 357.

Dewey.[18] In Bain's words, ". . . nervous action supposes currents passing through these completed circles, or to and fro between the central ganglia and the organs of sense and motion; and that, short of a completed course, no nervous action exists."[19] Continuing, he explains thought by the same nervous mechanism. After citing the example of persons who talk to themselves, he expresses the opinion so frequently quoted that "the tendency of the idea of an action to produce the fact shows that the idea is already the fact in a weaker form. Thinking is restrained speaking or acting."[20]

George Henry Lewes recognized the importance of the motor processes as shown in his statement that "every psychical fact is a product of sense-work, brain-work, and muscle-work,"[21] but one can not say that he ever held to a strictly motor theory of consciousness. His remark that ". . . in all cases an action of some kind results; directly or indirectly, every sensation is *completed* in an action; and thus Action is the pole-star of even the most wide-wandering Speculation"[22] is evidently a formulation of the ideo-motor theory.

It is difficult to evaluate Mach's contributions to the motor theory, for his statements are strangely contradictory. His "thought experiment," so far as we can judge from his description, remains entirely in the realm of ideas. In connection with space, both visual and tactual, he recognizes the importance of the muscles and shows in some detail how they contribute to breadth, depth, right, left, symmetry, etc. If he had throughout been consistent with his statement that "the will to perform movements of the eyes, or the innervation to the act, is itself the space-sensation,"[23] there would be no doubt that at least in spatial experience he was a thoroughgoing motorist, but he later states that it is hard to decide whether "the innervation itself is the space-sensation, or whether . . . the space-sensation is before or behind the innervation."[24] And further on he remarks, "In so far as we have spatial perceptions, these depend, according to our theory, on sensations. What is the nature of these sensations, and what organs are active in connexion with them, we must leave an open question."[25] When he comes to the problem of time, a phenomenon which he would have had little difficulty to explain in motor terms, he assumes a special time sense. In regard to music he clearly denies any function to the response mechanism, for he says, "Music can no more come into being merely through the motor sensations accompanying musical performances, than a deaf man can hear music by watching the movements of players."[26] It is evident from the above quotations that he started with a clear-cut motor concept and became less sure of it as he proceeded.

Georges Dubreuque in his article on "L'Intuition Motrice" in 1898 remarked that Condillac's great mistake was to omit from his statue the principal phenomenon which is necessary in the acquisition of sensation, namely, movement. He discusses in particular the perception of space and numbers which he believes require movement for their realization. His notion that the concept of numbers and such mathematical constructions as infinity have their origin in the response mechanism seems well founded on fact. Similar ideas regarding the origin of mathematical concepts have appeared in recent writings, such as that of Dr. P. Chaslin.[27] In reference to space Dubreuque remarks that it is quite possible to have the perception of an empty space, that is to say, a space without objects. For even though there would be no tactile or visual sensations, there would still be motor sensations.[28]

William James's dualistic view-point colored all his writings. It can not be said that he ever subscribed to a strict motor theory, even though he gave the motor processes a very important place in his psychology. Although not the originator of the principle of the ideo-motor theory, his name is usually associated with the theory, due to the prominence he gave it. But the ideo-motor theory, as its name implies, presupposes the existence of conscious processes before the response, and merely asserts that response is an invariable consequence of idea. It is only in so far as this theory emphasizes the necessity of response that it is a contribution to the development of the motor theory. The same qualification must be made in regard to the James-Lange theory of emotion. Here, too, a dualism underlies the concept. If we could stop with the bare statement that the bodily responses are the emotions, that is to say, identical with the consciousness of the emotions, we would be justified in claiming James as a motor theorist. But James went on to explain that it is our consciousness

[18] John Dewey, "The Reflex Arc Concept in Psychology," *Psychol. Rev.*, 3: 357–370, 1896.
[19] Alexander Bain, "The Senses and the Intellect," p. 355.
[20] *Ibid.*, p. 358.
[21] George Henry Lewes, "Problems of Life and Mind," Vol. 1, p. 147, 1874.
[22] *Ibid.*, p. 145.
[23] E. Mach, "The Analysis of Sensations," p. 129. Tr. by C. M. Williams, Chicago, Open Court Pub. Co., 1914.
[24] *Ibid.*, p. 170.
[25] *Ibid.*, p. 184.
[26] *Ibid.*, p. 280.
[27] P. Chaslin, "Essai sur la Mechanisme Psychologique des Opérations de la Mathématique Pure," Paris, 1926.
[28] G. Dubreuque, "L'Intuition motrice," *Rev. Phil.*, 46, p. 291, 1898.

of these processes which constitute the emotions, in other words, that the afferent impulses back to the brain from the periphery are necessary for the consciousness of the emotion. Dr. Walter Cannon, it seems to me, was correct in rejecting this part of the theory, although on the basis of the motor theory I can not agree that the response as such is not an integral part of the physiological pattern of the emotions. It might be added that James comes very close to a motor theory when he stated that "no impression or idea of eye, ear, or skin comes to us without occasioning a movement, even though the movement be no more than the accommodation of the sense-organs; and all our trains of sensation and sensational imagery have their terms alternated and interpenetrated with motor processes of most of which we practically are unconscious."[29] This statement seems indeed to imply a step beyond the ideo-motor theory.

Hugo Münsterberg made a most signal contribution to response psychology with his action theory. For him the response is a necessary factor for consciousness in that the degree of openness of the motor channels is in direct relation to the degree of vividness of the mental process. Although Münsterberg did not identify response with consciousness, since he placed mental phenomena in another universe of discourse distinct from that of physiological processes, and although he was concerned particularly with the one attribute of vividness of consciousness, yet he and his pupils were primarily interested in the response phase of experience in their experimentation.

In 1899, Professor B. B. Breese, a pupil of Münsterberg, gave a very clear and concise exposition of the motor theory. In his own words, "Consciousness . . . depends for its existence and character upon the transference of sense stimuli into motor paths. This hypothesis considers the incoming, or sense stimulation, and the out-going, or motor innervation, as a single nerve process. There is no point of separation between them. The motor discharge is necessary in order that any central activity take place."[30] In experiments on retinal rivalry Breese found that the time of retention of the field before one eye was increased by the contraction of the muscles of the right or left side of the body respectively. From the results of his experiments on retinal rivalry he concludes that "in general, *inhibition of the motor elements tends to inhibit consciousness.*"[31] He is even more emphatic when he states that "the limitations of the motor adjustments become the limitations of thought,"[32] which means, if this is true, that we should expect to find a correlation between thought and muscular coordination. In regard to the inhibition of the spoken word during the learning of nonsense syllables by requiring the subject to count during the learning, Breese remarked that the increase of errors was not due to distraction but to the fact that the words could not find their natural expression in vocalization.[33] That is to say, the proper motor adjustment for the series was partially inhibited. Experiments recently conducted by Mr. Michael Blankfort in the Princeton Laboratory on the rôle of the motor processes in learning seem to confirm the assertion of Breese that the distraction was not the main cause of the increase of errors. In Blankfort's experiment the subject performed an act of skill with one hand, while the other hand merely carried out simple tapping movements during one series and remained idle during the other series. There was a greater transfer of training from one member to the other when the hand not performing the main task was idle. Check experiments indicated that distraction was not the cause of the difference. The explanation seems to lie rather in the fact that the other hand, when idle so far as a definite task was concerned, could carry out incipient responses similar to the movements of the hand performing the skilled movements, and was thus practising synchronously with the latter hand.

Josiah Royce believed in the close relationship of ideas and activity. Thought, for him, is "our consciousness of an act or of a series of acts adjusted to an object, in such a wise as fittingly to represent that object, etc."[34] He believed further that our mental images of an object can not be separated from our response. It is not clear, however, just where Royce places the motor process, but it is fair to assume that he did not unequivocally identify motor processes with consciousness.

Theodore Ribot throughout his writings insisted upon the importance of the rôle of movement in mental life. He has expressed himself most decidedly, perhaps, in his "Psychologie de l'Attention."[35] He asks if "the movements of the face, the body, the limbs, and the respiratory changes, which accompany attention, are as is usually asserted merely effects, signs." Are they not, on the contrary, he questions, "the necessary condition, the indispensable factors of attention"? He holds the second thesis, for, as he says, "if one suppresses all movement one entirely inhibits attention."[36] He argues for a motor theory of attention in terms similar to those used by James

[29] W. James, "Principles of Psychology," p. 581, Vol. 2, London, Macmillan, 1901.
[30] B. B. Breese, "On Inhibition," *Psychol. Rev. Monog.*, 3: 47–48, 1899.
[31] *Ibid.*, p. 58.
[32] *Ibid.*, p. 62.
[33] *Ibid.*, p. 58.
[34] Josiah Royce, "Outlines of Psychology," p. 285, New York, Macmillan, 1906.
[35] Theodore Ribot, "Psychologie de l'Attention," Paris, Alcan, 1906.
[36] *Ibid.*, p. 32.

for the emotions when he says that if a spectator at the opera could suppress all responses of the eyes, head, etc., what would remain of attention would be a very empty function, would in fact not be attention at all.[37] He further makes the emphatic statement that we must either assume elements of movement in all cases of voluntary attention or admit that an explanation of the mechanism is impossible.[38]

During the first decade of the present century a number of French psychologists incorporated the motor theory in their explanation of mental phenomena. B. Bourdon[39] attributes a secondary rôle to tactual and muscular sensations in the perception of form. As he uses the term sensation rather than response, it is probable that he had merely kinesthesis in mind. Dr. R. Nuel, on the other hand, is more explicit in his book on "La Vision." "The visual phenomena," he explains, "are entirely motor. There can be absolutely no question of visual consciousness in the infant before it has made bodily responses to visual stimuli."[40]

Dr. N. Kostyleff tries to break from an explanation of experience in purely mental terms by his theory of reflexes. For example, in discussing abstract ideas, he states that "it is only necessary to substitute for a psychological explanation the objective notion of reflexes in order that the general scheme of an objective explanation shall form a clear picture."[41] Throughout his writings Kostyleff makes constant use of the term reflex, and it is unfortunately not always clear what he means exactly by this expression. In fact, one gains the impression at times that it may be one of those magical phrases which are supposed to solve all psychological problems.

P. Souriau, writing about the same time as Kostyleff, implies an acceptance of the response theory so far as the emotions are concerned. For example, he remarks that the drop of the mouth which is a sign of sadness is without doubt the sadness itself.[42]

Professor Judd in a series of articles has explained the functional nature of the efferent response in a manner with which I find the theory I have expressed here and elsewhere to be in entire agreement. In criticizing the long-discarded innervation sensations, he makes it evident that the motor theory does not imply a direct representation in consciousness of the efferent impulse, but rather that consciousness is functionally dependent upon it. He rightly states that the advantage of the innervation theory was lost by calling the conscious processes innervation sensations. He regrets that no one had "asserted that the outgoing motor processes are indeed related to consciousness, but not in such a way as to arouse new sensations, etc."[43] In "What is Perception?"[44] he describes the function of motor tendencies in spatial perception and in the "Motor Processes and Consciousness" the unifying functions of such tendencies. "Unity of percepts," he writes, "and unity of ideas are . . . phrases which describe an aspect of consciousness dependent on motor tendencies."[45]

In the minds of the present-day psychologists, the motor theory is most closely associated with the names of Professor Washburn and of Professor Holt. Space does not permit a review of the many important contributions to the subject which Washburn has made, beginning with the book on "Movement and Mental Imagery."[46] Nor is such a review necessary in this place, since she has been extensively quoted in recent articles on response. Holt has not written so much directly on the motor theory, but the monistic view of consciousness and the identification of response with consciousness form the foundation of all his work. Perhaps the most concrete exposition of his view is to be found in the Supplement to "The Freudian Wish" on "Response and Cognition." To quote one phrase from this chapter, "The volitional element in behavioristic attention will be, . . . the process whereby the body assumes and exercises an adjustment or motor set such that its activities are some function of an object; are focused on an object."[47] He goes on to show that the behaviorists in describing objective action are describing consciousness.

Dr. Eugene Posch's psychology[48] is in close agreement with Holt's views. Posch explains the higher mental processes as well as the sensations in terms of verbal and postural response, muscle tonus and innervation. At about the same time as Posch, Dr. R. Müller-Freienfels published his views on the nature of thought and phantasy. He also stresses motor responses as essential to thought, but he does not

[37] *Ibid.*, 37–38.

[38] *Ibid.*, p. 73.

[39] B. Bourdon, "La perception visuelle de l'Espace," Paris, Schleicher Fréres, 1902.

[40] R. Nuel, "La Vision," p. 256, Paris, Doin, 1904.

[41] N. Kostyleff, "Les Substituts de l'Ame dans la Psychologie moderne," p. 194, Paris, Alcan, 1906.

[42] P. Souriau, "La perception des Faits psychiques," p. 56, *Année Psychol.*, 1907, 13.

[43] C. H. Judd, "The Doctrine of Attitudes," *Jour. Phil., Psychol. and Sci. Meth.*, 5, p. 682, 1908.

[44] C. H. Judd, "What is Perception?" *Jour. Phil., Psychol. and Sci. Meth.*, 6, 36–44, 1909.

[45] C. H. Judd, "Motor Processes and Consciousness," *Jour. Phil., Psychol. and Sci. Meth.*, 6, p. 91, 1909.

[46] M. Washburn, "Movement and Mental Imagery," Boston, Houghton Mifflin, 1916.

[47] E. B. Holt, "The Freudian Wish," p. 178, New York, Henry Holt, 1915.

[48] Posch published a book in Hungarian in 1915 which was finished in 1911. I obtained his views from an article entitled "Umriss einer realistischen Psychologie," *Arch. f. d. ges. Psychol.*, 1923, 44, 191–243, in which he summarized the contents of his book.

consider them the exclusive condition of mental processes.[49] Posch states that he is in accord with Müller-Freienfels, except in so far as the latter retains a remnant of ideational elements in his theory. Posch affirms that "What one calls ideas, memory pictures, visual images, etc., can one and all be entirely resolved in attitudes, poses, etc., and must be, if one is to pursue a realistic psychology."[50] He holds to a strict monism and vigorously attacks the notion that mental qualities reside in the brain.

Professor J. F. Dashiell has given a clear account of the identification of the whole nervous arc with consciousness. He translates the thought experiment of Mach into motor terms. In his words, "if, now, we recognize that the process of thinking differs from any other trial and error activity mainly in degree of explicitness, are we not presented with another physiological conception of thinking, an alternative to the intra-cerebral conception. . . .?"[51] And on the subject of meaning he states that "it is my thesis that such abbreviated, anticipatory reactions aroused by a thing are that thing's meaning."[52]

The phenomenon of empathy, as described by Lipps, Vernon Lee and others, is a striking example of the function of the motor processes and can only, it seems to me, be explained by the motor theory. The work of neither of the above-named authors, however, did more than suggest to future writers the possibility of such an explanation. Dr. H. Friedländer, on the other hand, makes a contribution to both empathy and the motor theory in his description of the perception of weight when he states that, "The sensations in the arm, hand, and finger are almost entirely absent from consciousness and the object is filled with a 'sensory something' that appeared directly as the *weight* of the object. *This weight formed a unity with the visual appearance of the object.*"[53] It must be said, however, that Professor David Katz and his pupils, of whom Friedländer is one, can not be classed as motor theorists. It is true that we find many statements like the above which could well have been written by an adherent of the motor theory. Katz, for example, states that "we *produce* quasi through our muscular activities characteristics such as roughness and smoothness, hardness and softness; we are really the *creator of these qualities.*"[54] We also find them referring to movement as a form-giving factor and they give many results of their valuable researches which can well be interpreted according to the motor theory, but they always refer to kinesthesis in their own descriptions.

In England Professor S. Alexander is the chief exponent of a motor theory and many of his writings are based upon this concept. It would be difficult to find a clearer account than the following: "all knowledge from bare sensation up to the highest truth is revealed to our apprehensions and revealed through action."[55] And further, "The older writers used to say that afferent nerves conveyed sensations to the brain and mind, awakening there pictures which represent external things, upon which pictures we then behave appropriately. These pictures are mythology, and exist only in the fancy of theorists who are not content with facts. What the afferent nerves convey to the brain is nervous (or mental) excitement. It is the efferent or motor reaction (always in their continuity with the afferent process) in which these excitements discharge in virtue of which we apprehend the qualities of external things."[56]

Dr. M. J. Piaget emphasizes the importance of motor response in the development of intelligence. There are, according to him, three levels of mental activity of the child. The first is the "intelligence motrice," which occurs before or independent of language. There is a progressive accommodation of the organism to the objects of the environment due to the motor patterns and a reciprocal adaptation of the object to the organism, as when weight is felt as a force. The child is, however, ignorant of the real meaning of the motor activity. There is no active control, merely a passive acceptance. In the further development of the child there occurs the second level, egocentric thought and lastly rational thought.[57]

In Germany Dr. L. Grünhut has recently, in answer to the Gestalt theory, contended that we perceive form by running our eyes over the given visual stimuli. We do not merely open our eyes for possible sensations, but rather create our perception by allowing our eyes to wander over the object. We do not see isolated points, but through this active process we perceive a unity in a given manifold. In other words, he explains that the picture on the retina and the afferent impulses are not yet a perception. It is only through response that discrete points in space are formed into a coordinated whole.[58] In an article which has appeared this year, Professor F. M. Gregg

[49] R. Müller-Freienfels, "Das Denken und die Phantasie," p. 10, Leipzig, Barth, 1916.

[50] E. Posch, "Umriss einer realistischen Psychologie," p. 205.

[51] J. F. Dashiell, "Is the Cerebrum the Seat of Thinking?" *Psychol. Rev.*, 33, p. 18, 1926.

[52] *Ibid.*, p. 25.

[53] H. Friedländer, "Die Wahrnehmung der Schwere," *Zsch. f. Psychol.*, 1920, 83, p. 135. See also my article, "A Response Interpretation of Consciousness," p. 98.

[54] D. Katz, "Der Aufbau der Tastwelt," *Zsch. f. Psychol.*, Ergänzungs bd., 11, p. 260, 1925.

[55] S. Alexander, "Art and the Material," p. 19, New York, Longmans, 1925.

[56] *Ibid.*, pp. 20–21.

[57] M. J. Piaget, "Les trois Systemes de la Pensée de L'Enfant," *Bull. Soc. fr. de Phil.*, 28, p. 100, 1928.

[58] E. Jaensch and L. Grünhut, "Über Gestalt Psychologie und Gestalt Theorie," *Mann's Pädagogisches Magazin*, No. 1262, p. 134, 1929.

also applies the motor theory to explain certain of the phenomena which have interested the Gestalt psychologists.[59]

Professor M. Ponzo has expressed his general view in the statement that there is not only a concomitance of motor phenomena and mental states, but an invariable participation of motor response in all forms of mental activity.[60] He has described the rôle of response in his account of the experimental work of the Turin laboratory. Several of his examples are the following: Illusions of size of objects occur through changes in the motor response;[61] we understand better what is said by internal repetition or murmur of the words,[62] an observation which was also made some time previously by O. Jespersen;[63] each individual expresses himself in motor terms in a fashion as characteristic as are certain of his anatomical features.[64]

Finally, we have a successful attempt by Dr. E. Jacobson to detect directly the muscular response during mental activity by means of the action potentials. He found that the action patterns during silent thought correspond to those obtained when the words were actually spoken. He concludes that "during imagination, recollection and concrete or abstract thinking involving words or numbers, muscular contractions characteristically appear as specific components of the physiologic process of mental activity."[65]

We have seen from this brief historical sketch that the rôle of motor response in consciousness has been emphasized by many thinkers throughout the centuries, either directly or by suggestion through the reference to kinesthesis. Much of the discussion has been theoretical, or at best what Titchener after Brentano has termed empirical, but this is true of most of the fundamental theories of psychology until the nineteenth century. Since then a number of experiments have yielded results which seem to support the theory. It is fair to predict that in the future there will be less theorizing and more research of a nature similar to that of Jacobson. The theory itself must wait upon further experimental findings for its development and more precise refinement.

OBITUARY

JOHN BELLING

JOHN BELLING died on February 28, 1933, in San Francisco. He was born at Aldershot, England, on October 7, 1866, and taught in private and public schools in England, taking instruction meanwhile at London and Birmingham. In the university at the former place he received the degree of bachelor of science. In later life he was given the honorary degree of doctor of science by the University of Maine in 1922.

He lectured in the Horticultural College at Swanley, England, and later at Llandidloes, Wales, in 1900–01. Shortly after this he migrated to the British West Indies, where he became investigator in the Department of Agriculture. In 1907 he came to the Florida Experiment Station as assistant botanist and published important researches there on hybrid beans.

Shortly after the war he came to the Carnegie Institution of Washington as cytologist in the department of genetics, and was associated with Dr. A. F. Blakeslee in the investigation of the chromosomes of Datura. Here his genius in microscopy and his philosophic insight opened up a new field in the study of the behavior of chromosomes and in the interchange of segments between non-homologous chromosomes. Belling was subject to periods of depression during which he did some of his most brilliant work. Believing that it was important for him to have a change of scene he was transferred by the institution to Berkeley, California, where he worked in a corner of Professor E. B. Babcock's laboratory, continuing his fundamental researches on the structure of chromosomes in hyacinths and various lilies. In these investigations, under superlative technique, he believed he was able to see structures, which on account of their number and size, he identified with genes.

Belling was the author of a book on the use of the microscope, which has been eminently successful. A book on the study of the chromosomes has been written, but not published. After the sixth International Congress of Genetics, held in Ithaca last summer, a number of foreign delegates traveled to Berkeley to examine Belling's preparations showing the structure of the chromosomes, and to discuss with him his interpretations of them.

He married Miss Hannah Sewall, who died in 1926

[59] F. M. Gregg, "Materializing the Ghost of Köhler's Gestalt Psychology," *Psychol. Rev.*, 39, 257–270, 1932.

[60] M. Ponzo, "Principes et Facteurs du Dynamism psychologie dans les Recherches de l'Ecole de Psychologie de Turin," *Jour. de Psychol.*, 27, p. 617, 1930.

[61] *Ibid.*, p. 630.

[62] *Ibid.*, p. 624.

[63] O. Jespersen, "Lehrbuch der Phonetik," p. 6, 2te aufl., Leipzig, Tuebner, 1913.

[64] M. Ponzo, *loc. cit.*, p. 641.

[65] E. Jacobson, "Electrical Measurements of Neuromuscular States during Mental Activities," vii, "Imagination, Recollection and Abstract Thinking Involving the Speech Musculature," *Amer. Jour. Physiol.*, 97, p. 209, 1931.