

A PHYSIOLOGICAL-BEHAVIORISTIC DESCRIPTION OF THINKING

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Latter-day reinterpretations of the process of thinking have been suggested along two different lines. The various classical descriptions of thought from the Aristotelian down to that of the contemporary analytical psychology have shown in varying degrees the interpretation of it as intellectualistic and as self-contained. Of late years the writings of the pragmatists (whose philosophy really 'takes off' from this psychological insight) have made clearer in its implications for a *Weltanschauung* the viewpoint of the functional school in psychology. For this school "reasoning is always for a subjective interest," "thinking is set up in situations of stress and problems," "ideas, meanings are cues or leads to further dealing with the object or situation," "inductive reasoning is the seeking for a general interpretation under which the given data may assume some shape that can be dealt with effectively," etc. A very different line of re-interpretation is that taken by the behaviorists. For them "thinking is a matter of implicit responses," "one's reactions to a stimulus may be shunted away from the grosser skeletal musculature and through the more refined musculature of the vocal apparatus," "habits of thought are laryngeal habits," etc.

The behavioristic emphasis—or, more accurately, the emphasis of the behaviorists—has been upon a certain type of physiological process as the essential thing in thinking. Now as has been recognized by Tolman and others, a behaviorism is not necessarily nor essentially physiological; its legitimate primary emphasis is upon the importance of the 'biological situation' in which the organism 'behaves' with reference to its environmental circumstances. (Here the line of emphasis 54

would seem to merge with that of the functionalists.) Whatever intraorganic processes are found to occur may be of great value in bridging gaps in the purely behavioristic account of phenomena, but as intraorganic they are not behavior. A confusion of the converse sort seems also to be abroad. Emphasis upon a physiological description as being in the last analysis the only explanatory description is widely enough held among all brands of psychologists; and any particular line of emphasis on the physiological side, such as upon the part played by vocal mechanisms, does not legitimately set one off as a behaviorist.

In expansion of this point attention should be called to another current misunderstanding. The ascription of thinking to vocal, gestural, or other bodily processes is not in itself any challenge to the legitimacy of introspective descriptions for the plain reason that this is only a move to substitute what is thought to be a more adequate physiological basis for a less adequate one. Stripped of other motives that are not necessarily and essentially affiliated with this, we have here only a revision of one of the assumptions of practically all psychological doctrines heretofore, namely, that the physiological mechanism underlying thought processes is the cerebrum and the cerebrum alone; and a recasting of this into the form of a more inclusive and extensive mechanism. *The change is from one physiological to another physiological description; and no further implications necessarily follow as to the value or as to the legitimacy of descriptions of thinking in terms of the conscious experiences of the thinker.* Confusion on this really obvious point is, the writer feels, at the bottom of some contemporary discussion.

Let us look more closely at this change in the physiological point of view. On the traditional conception, the bodily mechanism at work when one thinks consists of one or more neural impulses that reach some area of the cortex, then, instead of passing more or less immediately to some motor organs as in activity involving unthinking awareness, shift along association fibres to another cortical area, thence to another, etc.; making a picture of impulses shooting back

and forth, here, there, and elsewhere, all between innumerable cortical centers, and the whole field of operation being comprised within the cerebrum. With the realization of the ludicrousness of reasoning conceived in the ancient classical way as a self-contained and self-maintained operation, recognition has been increasingly allowed to the functions of some sensory stimulus *to* the reasoning and some motor outcome *from* it; but during the process of reasoning itself, *i.e.* after the afferent nerves had delivered their burden to the cerebral centers and before the efferent nerves had received theirs for conveyance to effectors, these peripheral mechanisms have still been considered inoperative and inactive (so far as the above thinking process is concerned). The succession of ideas experienced by the subject in his chain of reasoning is then traceable to (or paralleled by, or the other aspect of) the succession of cells or of cell-constellations at which the shifting, shunting nervous impulses arrive and leave. It should legitimately follow that the anatomical locus of a given idea (so far as it has any) is some theoretically localizable cluster of cortical neurons; but protests against this inference may be respected without affecting the point at issue.

An incidental query concerning this mode of interpretation may be stated. What factor or factors determine that the impulses shall at certain moments in this story continue to shoot about inside the cerebrum and, on the other hand, at a certain moment leave the cerebrum by efferent channels? Is it wholly a matter of what cells happen to be traversed, so that when the neural impulses chance to travel to motor centers they are then transferred to the peripherally bound tracts, but when on the contrary they travel to non-motor centers the nature of the connections made there are such as to redirect them to other parts of the cerebrum? Or, shall we look for some inhibitory factor—perhaps in the form of certain other nerve impulses a-going inside the cerebrum inhibiting the first? But this problem is incidental.

As a contrast to this *intracerebral* view of the physiological aspect of thinking, let us consider the *peripheral* view. It

might be more accurately styled a peripheral-central-peripheral-central-peripheral view. In essence, the difference between the intracerebral interpretation and this one can be put in terms of the stimulus-response circuit concept. For the former, thinking is statable as a complication, refinement, prolongation, elaboration, etc., of the *central* segment of the whole 'reflex arc'. The simpler human activities involve fairly close and immediate connections between afferent and efferent pathways, shading down to the simplest reflexes; but as organization or integration of these simpler acts into more complex ones progresses, the central associative phases become more and more important, until in deliberative thinking these central connections are found to be indefinitely complicated, involving in part a great elongation of the total pathway traversed by the impulse from the place and time of its first arrival at the center to the place and time of its ultimate leaving the center. In contrast with this, on the peripheral interpretation the associative pathways serve merely as connectors between peripheral tracts; the connectors being subject to an enormous amount of modification, to be sure, but this modification being largely limited in character to the joining and disjoining of simultaneously and successively operating central connections, and little if any to the hitching end-to-end of merely central paths in a serial order, as according to the other view. In other words, the emphasis is here upon *whole arcs*. Modification of human activity is on the anatomical side largely describable as joinings and disjoinings of whole arcs. Where modification does produce a serial pattern of organization, this is due to a serial hitching together of the whole arcs.

This description of the physical side of the process of thinking in terms of the interplay of entire sensori-motor circuits instead of merely the central segments thereof, possesses on its face the advantage of fitting in with the undeniable modern tendency to interpret psychological phenomena as reducible to a matter of stimulus-and-response circuits.

The train of ideas and the mental seesaw of deliberation

experienced by the thinking person, are on this physical view, a matter of sensori-central-motor arcs active in various relations to each other. Let us consider two traits of thinking that have been universally remarked.

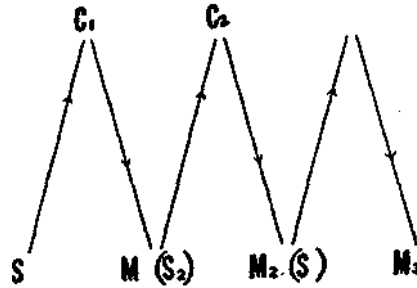


FIG. 1

(A) In the first place, there is the phenomenon of 'thoughts' in series, a train of 'ideas.' This is theoretically describable on the physiological side as a series of sensorimotor activities, occurring in succession. In pattern the 'ideas' resemble (in last analysis, are) the part-processes in a serial habit. A diagram of the latter will help to clarify the point (see Fig. 1). An afferent impulse originating at peripheral sense-organ *S*, arouses by central connection *C*, the motor response at *M*; this indirectly—through excitation of receptors resident in a muscle tissue by the very contraction of the latter, or through excitation of receptors situated in the vicinity and sensitive to certain changes produced in the vicinity by the effectors—arouses a second sensory impulse from *S*, which in turn arouses through a center *C*, another motor response *M*, etc. Now, according to this view, the serial character of thinking is physiologically a process to which this scheme is applicable, the sequence of experiences the subject calls his 'ideas' being describable as the sequence of motor adjustments arousing each other in turn, and not as the sequence of intracerebral shuntings of associative impulses represented in Fig. 2. A challenge may be anticipated: How can an idea be represented physiologically as the activity of an arc? To such a challenge the most

convenient retort would be: How, on the other hand, can an idea be represented physiologically as the activity of a group of cortical neurons or as the passage of an association impulse? A more serious attempt to meet the need will be made below.

Meanwhile we must consider the other well-recognized trait of thinking taken in its narrower sense: (*B*) that thinking involves some seesaw, some competing alternatives. Sher-

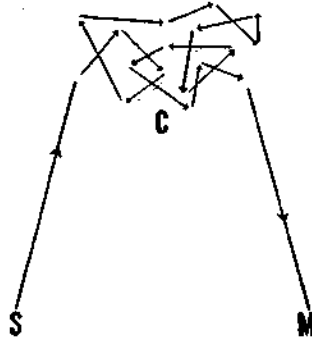


FIG. 2

ington has familiarized us with the notion of reaction systems as being allied or antagonistic, reinforcing and inhibiting with reference to each other. And nothing resembles the introspective phenomena of thinking more than some of the interrelations of reaction arcs. On the one hand, the subject reports hesitations, the pondering of alternative suggestions, and the final acceptance of one either in the non-logical decision or logically after a new consideration has appeared and strengthened that alternative; on the other hand, we can observe antagonistic reaction systems blocking each other on the reception of certain stimuli, other systems meanwhile constantly varying in their tension until some one of these waxes strong enough to reinforce one of the original antagonistic units so that it may appropriate the 'common path.'

But observe! The 'consideration' that enters to reinforce successfully one of the competing tendencies is in the more

logical types of judgment not wholly from 'without' the individual, not merely an enhancement of an external environmental stimulation, but is from 'within' his own 'mind.' Clearly, then, we must make room for just those 'inside' reaction systems pointed out in the diagrams above.

The James-Lange theory of the emotions, especially the broader statement of the position by James, has in it much more suggestiveness than the discussions thereof have ever evidenced—suggestiveness for the interpretation of far more psychology than is connoted by the term 'emotional.' Indeed, we are tempted to assert that that 'theory' (still so-called, although it should surely deserve by this day to be called a law!) could without much alteration be used as the central core of all psychology. The point may be summarized in advance: the representation of the phenomena of psychology in terms of (external) stimulus and (overt) response that has had such vogue is grossly inadequate; *it fails to take account of intraorganic reactions and stimulations, and of the fact that most objectively observable stimulus-response phenomena have interlarded layers of shunt line processes via the viscera and soma.*

But to make the point clearer let it be stated in more detail. First, let us make a statement of the James doctrine of emotion. It consists essentially of the two propositions that external stimuli can and do arouse a variety of 'inside' changes, and that alterations of 'inside' physiological activity can be and are in many cases the sources of afferent impulses leading back to the central system. Stated in some such way this doctrine avoids the objections of the extreme behaviorists who can see nothing valuable in it; it does not stand or fall with the legitimacy of the introspective approach, for the real contribution consists of James' insight into this one fundamental thing—that an afferent impulse from an ex-teroceptor does not discharge completely into paths to effectors producing overt reactions, but in some degree discharges into efferent paths leading to motor organs internally placed and produces there changes that usually arouse adjacent sense-organs, these in turn bombarding the central

system and contributing this internal quota to the sum total of mutually reinforcing and inhibiting processes a-going through the centers. "A process set up anywhere in the centers reverberates everywhere, and in some way or other affects the organism throughout, making its activities either greater or less." That the subject is *aware* of these internally aroused afferent impulses, as implied in many of James' statements of the doctrine, is after all not essential to this insight and should not damn it for those who are sensitive of any references to the experiential side.

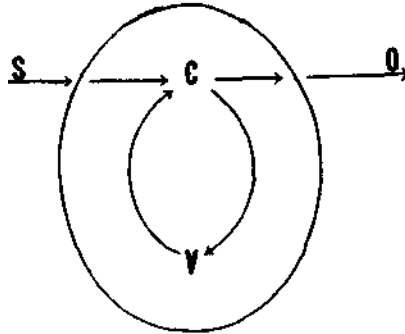


FIG. 3. Stage I. The afferent impulse aroused by the stimulus *S* may at *C* lead immediately to overt action upon object *O*, but also may lead to reaction of viscera *V*, in turn furnishing new afferent supply to and through *C*.

Stage II. This new afferent supply inevitably affects and is affected by other impulses in passage, thus modifying the overt reaction on *O* as well as further modifying the internal changes.

To make clearer the fact that this conception of emotion may without loss of essence be stated in wholly objective terms, the writer has schematized the matter down to its skeleton in Figure 3, and has introduced some details in Figure 4.

Before applying this analysis of emotion to the description of thinking we must get the process of thinking 'placed' in a general way, its locus in the general life economy of the human being. The emphasis placed by the functional psychology upon the part thinking plays in the life history of the individual would seem to be as genuinely 'behavioristic'

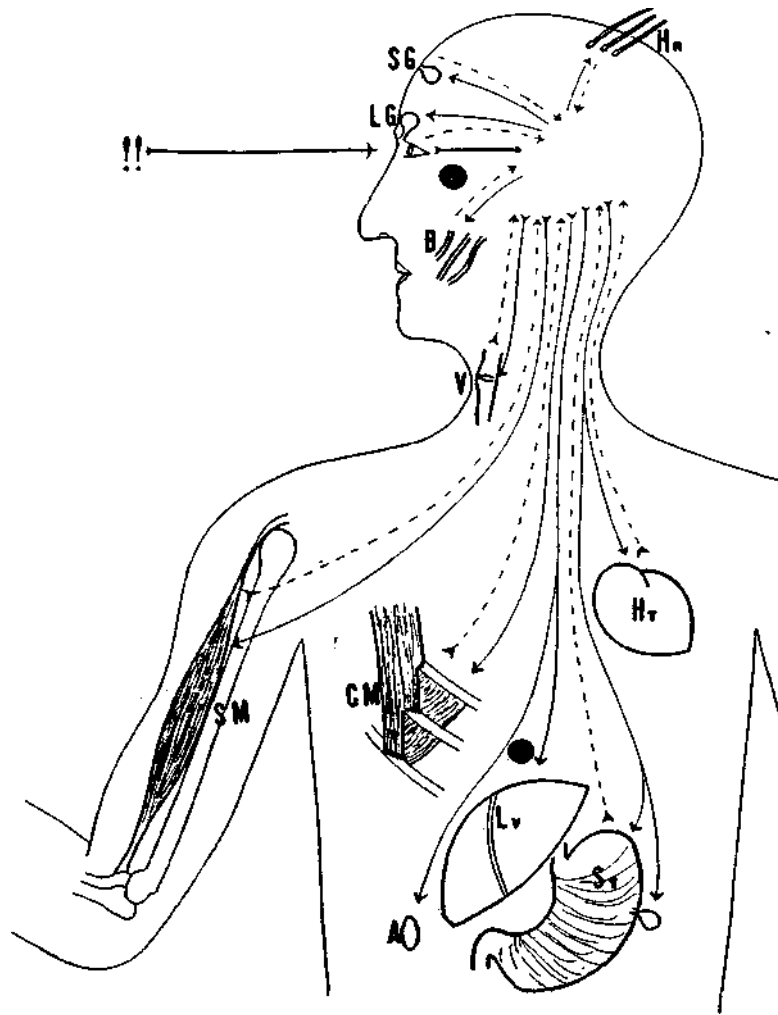


FIG. 4. An external stimulus (as a ghost) arouses an afferent nerve impulse from eye to brain in turn arousing a team of motor pathways. These then produce changes in lacrimal gland (*LG*), in sweat glands (*SG*), in position of hair on head (*Hr*), in blood vessels of skin as in blanching (*B*), in skeletal muscles as in straining, 'excited' activity (*SM*), in heart beat (*Hi*), in stomach's digestion involving both muscles and glands (*St*), in secretion of adrenin at (*A*) and glycogen from liver (*Lv*) into blood, in skeletal muscles of chest controlling breathing (*CM*), in vocal sounds from larynx (*F*), etc.

as the newer physiological conception stated in the first pages of this paper. At any rate, the two treatments of the subject dovetail excellently, and in the writer's opinion, strengthen each other, the one stating the original occasion as well as the final outcome of thinking, the other describing the particular processes so occasioned and leading to such an outcome.

The type example of the functionalist's interpretation of thinking is that of a man baffled by some characteristic of the environment. Characteristically, if his behavior is of a rational type, he is not content to kick and squeal, pull and tug, run to and fro; he 'stops to think it over,' he may 'sit down to consider.' Does this mean that all motor activity is stopped? Hardly! It means rather that it is 'toned down,' partially inhibited from full explosion. The degree to which this abbreviation of his acts is carried varies, of course, by all gradations. At one time we may observe him tentatively but actually starting to do this, then that, then the other; again, we may see him sitting still but shifting his eyes here, there, elsewhere, with slight turnings of head and body, with minor movements of fingers and hand; or, he may by all superficial appearances be motionless and his reactions escape all observation but that aided by delicate instrumentation applied to tongue, larynx, artery, chest, and finger tips. Then at the conclusion of this period of more or less implicit reactions our man may be seen to resume his more large-scale, gross behavior, and he deals with the situation now in some definitive and manifest way; his problem is solved and he is acting accordingly.

No consideration of thinking can proceed far without a wrestle with the problem of '*meaning*.' To be sure, a behaviorist (Watson) may deny the usefulness of the term and insist that "the question of meaning is an abstraction, a

Dotted lines show how the changes aroused in different parts of the body may contribute new afferent impulses to the centers. In terms of the usual analysis of the subject's awareness, these secondary impulses give him the feeling or emotional quality modifying or coloring the externally aroused sensations. Objectively speaking, these secondary impulses now play a modifying part in further stimulus-response phenomena.

rationalization and a speculation serving no useful scientific purpose. . . . From the . . . behaviorist's point of view the problem never arises. We watch what the animal or human being is doing. He means what he does. . . . His action is the meaning." Now, as shown above, frequently the action does not occur, or does not completely occur; hence not only is his action but also are his tendencies-to-action and his general motor attitude the meaning of the stimulus. At any rate, the term serves as a useful shorthand expression; and no doubt the behaviorist's discarding of it is motivated in part by the fact that it has heretofore been used almost exclusively in a structuralistic and introspective manner. Some tendency to break away from the use of the term as referring only to certain aspects of conscious experience has been shown in the seeking of description of it as an 'attitude,' an 'adjustment,' as by Bolton.

An excellent approach to this position is via the study of children's definitions. It is too well known for elaboration that the child of four or six will define nearly everything he is questioned on in terms of its use, *i.e.* in terms of his own dealings with it. A chair is 'what you sit on,' a horse is 'to ride on,' a pencil is 'something you can write with,' etc. A child of the writer's during his second December frequently telephoned Santa Claus a detailed schedule of Christmas expectations, and whenever he mentioned the word 'football' involuntarily kicked the wall. It may be maintained that that is what a football *is*—a kickable thing; should such an article become permanently deflated it has lost (in Aristotelian phraseology) its virtue, it is no longer a football but a wad of stuff to be thrown away; and the naïve youngster will turn into a 'football' anything that is kickable, whether describable by his elders as made of leather-and-rubber, of black rubber only, of a hog's bladder, or of a cotton stuffed calico bag. To be sure, the adults do apply these names of composition and structure, but are not they and all other 'ideas' or terms really *shorthand symbols for the mass of dealings-with* that the adult may at one time or another employ, a naming reaction that has by conditioning come to do duty for a mass of overt manipulations?

It is now high time to be calling attention to a new point in our description of thinking, a point that has all along been lurking in the "background". No small part of a child's reaction upon a thing, of his attitude toward it on later occasions, or of the meaning it has for him when mentioned, is the affective-emotional phase. And we can extend the point to cover the topic of perceiving in general. The skull-and-crossbones in red on a poison label, the funniness of the clown, the attention-arresting character of the name LOUVAIN in the latter months of 1914, all these point us to the observation that these affective aspects of a thing perceived do not merely *accompany* the perceiving act but are part and parcel *of it*. One might put this still more vigorously by showing that one's perception of a thing is dependent upon this as one of the integral factors; the meaning given a thing is based upon the overt motor responses that thing arouses in whole or part and also upon the covert visceral and somatic responses it arouses. Going back again to our Fig. 4, it is evident that the stimulating thing really arouses *one complex* response (or series of responses), each response then 'being only formally analyzable for pedagogical or experimental purposes in psychology into the more observable 'outside' and the more private 'inside' parts of the whole. In human experience, the sun is first of all a cheery fellow, greeting us in the morning, warming us in the chilly breeze, mayhap sunburning us at times, ripening our corn, drying our clothes, playing generally a striking part in this world of weal and woe and of things-to-be-done. Only with later stages of mental development when most habits become abbreviated and short-circuited and symbolized under the needs of social communication and of greater rapidity of action does the sun become the incandescent body in space familiar to us in astronomy. On this evolution, some words below.

The foregoing remarks suggest that we are face to face again with one of those distinctions of convenience which have so often in the history of knowledge become crystallized and fossilized into hard and fast divisions. This attack upon the

over-intellectualized psychology of perceiving carries within its womb—and for the present the writer will not play the part of a mid-wife—a discussion matter involving fundamentals of all brands of psychology, at least all approached by introspective methods. Perhaps, after all, there is no legitimate and final line of demarcation between 'cognitive' and 'affective,' between intellect and emotion, any more than there is a clear line between the motor responses called overt and those called implicit. Has the distinction not been drawn originally as one of convenience?

Viewed objectively, *the 'meaning' of a thing is determined by—is constituted of—the whole motor-emotive set or attitude aroused by that thing*, these attitudes being nothing other than habits formed in response to the thing.

Language.—One of the commonest recognitions in the history of psychology has been that of the peculiar intimacy of thought development and language development. And such questions have at times been posed as, Can one have thoughts without words to frame them by? Yet the possibility of reducing them one to the other, making them not one the real process and the other only its tool, but both merely two ways of regarding the same human performance, had not vividly possessed psychologists—due, no doubt, to that lurking feeling of the sacrosanct and always-somewhat-mysterious about thinking. Today, however, it is becoming increasingly evident to some that in language itself, in its origins and developments, we may find the key to the problem of the physiological processes we call thinking.

To understand the original and primitive significance of language we must first be reminded of those inherited pattern-reactions that may be styled instinctive-emotional (again, with these two words we have with us a petrified distinction that in truth cannot be made out in definite lines). Now, given animals or humans manifesting these earliest appearing tendencies in behavior, tendencies to reactions in manifold ways differing by all degrees in observableness from the gross movements of pushing away by arm or leg to the subtle changing of a hormone secretion; given also a situation in

which these organisms live in proximity so that they may stimulate and react upon each other; and an exceedingly important series of phenomena occurs. Let us imagine that Rover is eating a piece of meat, and assume that none of the learning process we want to trace has yet taken place on his part nor on that of the dog, Towser, appearing in the offing. What is more inevitable than that Towser, whose olfactory and visual receptors are assailed by the food, should approach and bite into the meat? But now the situation is accurately set for arousing in Rover (and, it may be assumed, not as an acquired but as a native tendency) a pugnacious or attacking response (involving the whole complex of visceral-and-skeletal action systems) and it proceeds to the point where an effectual biting attack has removed the Towser obstacle or interruption. Here occurs a change in the latter's neuromotor organization known by the term 'conditioning'; the original situation for Towser in which his cutaneous sense-organs were receiving the intense pain stimulation and thus arousing his own withdrawal movements included also such incidental stimuli as the visual from bristling hairs and bared teeth on Rover's part and the auditory from the latter's growl; and on later occasions of similar character the representation merely of growl and bristling hair may be potent to excite the complete act of withdrawal.

Henceforth, whenever Towser's proximity is objectionable Rover need only growl and bristle to control the former's conduct satisfactorily, and the growling-and-bristling soon becomes an habitual attitude, usable toward a variety of animals and persons and usable in situations not actually demanding a full biting attack, but in which a retreating behavior by the other subject is desirable. And now, if only Rover were able to want intentionally to frighten the 'other-fellow,' he could deliberately do it by voluntary control of his growling and his bristling mechanisms. At all events, this intentional using of *some* of the whole complex of overt-and-visceral reactions involved in actual direct dealing with the other-one is observable early enough in childhood; crying to bring mother, drawing back hand to threaten a younger

brother, forcing a smile to secure more favorable treatment— such instances are legion.

If there is this development of ability to use *abbreviations of instinctive-emotional reactions to influence others* there is to be remarked also the development of ability to be sensitive to these abbreviated acts when made on the part of others. Indeed, so essential in human social life is the development of both the active and the receptive sides that we find children surprisingly quick to read and to convey meanings with gestures and vocal sounds, much quicker than to do so with articulate words. We may conceive the latter as artificial symbols, shorthand indications of the former; and it is interesting to observe how in different social cultures varying amounts of this substitution have occurred, from the American Indian of many grunts, shrugs, manual gestures and few words, to the Chinese or Englishmen of stolid face, reserving his meanings, his personal attitudes to be detected almost only from his articulate vocal sounds.

This interstimulation and response (suggested years ago by Mead) becomes a very broad fact, inclusive of a wide range of phenomena of social nature. A few illustrations may assist us. In a flirtation both individuals put their best foot forward and with sufficient tentativeness; A's advances being made first with hardly noticeable casualness, then, if B's reactions thereto be not of an unfavorable tenor, later with more boldness, but always the bits of conduct of each principal serving in turn as cues to the other. Consider the attitudes of not-too-pugnacious men found facing each other in a quarrel that has collected a crowd: let one lower more darkly and approach ever so little, the other visibly grows more tense and pugnacious, then let either relax from this fist-clenched vigilance and the other is fairly sure to follow with the same degree of relaxation. Incidentally, we find in this general description of social interstimulation and response the principle of 'minimal stimuli.' In ballroom dancing, the leader may be largely unaware of his slight changes of movement of right or left hand or of body generally, yet these serve as sufficient cues to his partner so that without being

aware of them on her own part she nevertheless follows accurately.

The development of articulate language proceeds largely out of this social setting. By degrees certain vocal signs come to be the symbols for certain motor-emotive attitudes, and thus gesture and the more native vocal sounds tend to be replaced by these conventionalized signals. We need not here follow up this development, but in general we see the stabilizing and conventionalizing of human social attitudes, the evolving of artificial signs to signify personal motor-emotive reaction tendencies.

For an understanding of the process of thinking, now, it is essential to note one aspect of the further development of language: the *gradual shift from overt speech and gesture to covert forms*. The movements and gross bodily acts that become conveniently abbreviated and delimited to vocal and manual signs to the other fellow, in certain social situations gradually become further condensed and more nascent. The average three-year-old has progressed far in the substituting of mimetic movements and verbal reactions for his earlier actual manipulations of objects; but he is due to go much further in this direction of abridgment, through the mumbling, *sotto voce*, and the lip-moving stages to that of silent reading and silent speech.

It is important to note that this abbreviating of behavior now is no longer principally a social phenomenon. It is observable characteristically when the child is playing by himself. While building his blocks or adjusting his doll clothes, his activity is interleaved with words, with facial grimaces, with manual demonstrations; some of this being of the nature merely of accompanying activity, but much of it too of an anticipatory and a tentative sort. By degrees it becomes evident that *one anticipatory act may lead to another, this to a third*, and so on; and the same interplay of stimulus and response by mere signals or symbols used in a social relationship, now appears *within the one child's own organism*. The sight of a block askew may initiate an emotionally facilitated act of knocking the whole thing over, but this may

not get beyond the mere start to do it, on account of a 'set' to keep on building based on the previous building acts; the left hand may start to adjust the poorly placed block, only to be 'headed off' before fairly begun by the influence of a developing dextrality shown in the using of the right hand instead; in case the result of the right hand's work is to disarrange the block further we may observe a drooping mouth, a sudden expiration, a falling cadence of vocal sound, and can guess at the unobservable 'inside' changes; and some further manipulations are then called out, ending perhaps in a drawing back of body and head, a deeper breathing, a reduction of muscular tonus, and audible vocal sounds. Now, most of these acts are neither actual dealings with the situation nor signals to a social object—they are mutually interacting and reciprocally influencing within the one child alone.

When one first learns to add a column of figures he 'says' the numbers and sums aloud, but with practice subdues this pronunciation to a whispering and lip movement stage which some of us never outgrow, and later still represses even these outwardly observable vocal acts, leaving only the necessary eye excursions and pencil pointings and writings to be seen.

Evidences bearing directly toward our thesis may be found on many sides. The case of Inaudi, the lightning calculator, is instructive: Meumann reports that he was unable to do his prodigious feats in 'mental' multiplication when he was hoarse. The well-known line of experiments with the automatograph by Jastrow and others have been introduced in connection with a variety of psychological topics but they surely bear witness to the fact that the direction and play of our 'ideas' is with sufficiently adequate technique shown to be a motor phenomenon. The recognition that attention is a matter of a-tension is in point. The training of animals to respond to minimal cues, as with the Elberfeld horses or the German police dogs reported by Most, has significance for human psychology in the fact that the men present were thinking more or less overtly! Thus, too, with the aphorism that mind reading is muscle reading.

In attempting the solution of Morgan's railroad puzzle¹ students of the writer showed great individual variations, but all found themselves, or were seen to be, making motor responses throughout—in the form either of eye-ball to-and-fro movements, or of hand and finger partial pointings, or of scarcely voiced verbal tryings-out.

What, now, are the mutual interactions of these more abridged and implicit responses? They are in no wise different from the interactions of responses generally. Upon analysis the following principles are among those that appear.

1. One act or motor set may lead naturally (*i.e.* by virtue of well-formed central connections) to another—the explanation being mainly, habit. The phenomena of memory for serial impressions is an obvious example; one may add, the train of one's thoughts show some factors of association, which are none other than factors well known in determining the re-awakening of old habits. The learning of a bit of 'knowledge,' of a fact, likewise requires no other principles than the conditioning of reactions.

2. One act or motor set may lead away from another. Again, witness the identity of principles involved in memory and association, on the one hand, and in the succession of acts, on the other.

3. One act or motor set may inhibit, interfere with,

¹ A one-track railroad has a switch which will hold 25 cars and an engine. This switch is connected at each end with the main track. Two 50-car trains (*A* and *B*), each having but one engine, meet and must pass at this switch. Mark in order from 1 to 9 the steps that would have to be taken to pass the trains.

.....Engine *B* couples with second half of train *A*.

.....Engine *B* uncouples from the second half of train *A* and backs out of the switch.

.....Train *A* divides into two halves.

.....Engine *B* backs train *B* over the switch until it has placed the second half of train *A* on the switch.

.....Engine *A* pulls the first section of train *A* off the switch on to the main track.

.....Engine *A* backs the first section of train *A* and couples with the second section of train *A*.

.....Engine *A* pulls the first section of train *A* on to the switch.

.....Train *B* running on the main track passes the engine and first section of train *A*.

.....Engine *B* pulls train *B* past the second section of train *A*.

This puzzle is taken from 'Morgan's Mental Test,' by John J. B. Morgan, State University of Iowa. The object of the puzzle is to rearrange the steps in correct order.

or antagonize another. The antipathetic or contradictory relations between many of the meanings we think in terms of, is paralleled physiologically by antagonistic relations between reaction systems, even those as simple as Sherrington's reflexes, and including visceral changes.

4. One act or motor set may facilitate, support, reinforce another. The same remarks apply here as in 3.

5. The integration of one's knowledge into a more and more inclusive conceptual organization is physiologically paralleled by the integration of part-reactions into higher-level habits, the hierarchical type of organization being striking in both cases.

6. The schematizing and condensing of meanings that goes on in the maturing and elaborating of one's thought life, introspectively observed, is not in essence different from the short-circuiting of part-reactions in the organization of habit-wholes. In adding, we have a borderline example of both: after adding digit to digit, one comes to 'read' his number combinations, taking in two, three, and more figures as one meaning. Similarly with the building up of word reactions in Book's pioneer study of typewriting.

Truly, it only remains for some one to work out a complete set of experimental demonstrations of the phenomena and principles of *habit making and breaking*, to show thereby that *the laws of conscious psychic life are after all nothing other than these*. Meyer has opened the way in his 'Psychology Demonstrations.'

Resume.—1. Thinking is coming to be recognized today as a human function that involves some substituting of implicit for explicit reactions.

2. This substituting occurs most clearly when the explicit activities are inadequate, often in conflict.

3. The implicit reactions can be given a physiological treatment most consistent with other physiological facts when described in terms of reflex arcs: thinking being a matter of interacting and mutually influencing motor sets or responses, not of intracerebral shiftings of association impulses.

4. The James-Lange theory of emotion by extension of application reminds us that thinking is done by the whole body, and not by the vocal apparatus and gestural apparatus alone.

5. It reminds us also that thinking is done not merely with striped muscles but also with visceral muscular and glandular effectors, and that one cannot deny the emotional and affective contributions to the whole performance.

6. That motor-emotive responses of abbreviated types can be the determinants of meanings appears from the development of gestural and vocal communications of signs.

7. The social communication-meanings become meanings for the individual's soliloquy, and this leads to a change from overt to more or less implicit.

8. The phenomena of thinking are consequently restatable as the physiological phenomena of interacting reaction circuits, or the behavioristic phenomena of interrelated motor acts and motor sets of varying degrees of explicitness.