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SOME FACTS IN PARTIAL JUSTIFICATION OF THE SO-CALLED DOGMA OF DISCIPLINE

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INTRODUCTORY STATEMENT

This paper substantially as printed was read before the Illinois School Masters' Club at Peoria, Oct. 8, 1909. On the following morning the question of formal discipline was discussed, President David Felmley of the Illinois State Normal University, leading. There seemed to be a substantial agreement that transfer of training was possible to a greater or less degree, and that it was best accomplished by making the habit set up a conscious end of action. President Felmley disagreed with the speaker of the previous evening chiefly on two points: (1) That a "generalized" habit was possible and (2) That pure science had a superior value to applied science. In the light of President Felmley's discussion these two topics in the paper have been slightly amplified. Otherwise the paper is printed as read.

University of Illinois, Nov. 15, 1909.

I. THE STATEMENT OF THE PROBLEM.

In the early years of the nineteenth century Gall and his pupil Spurzheim gave to the world the *Anatomie et physiologie du système nerveux,* in which is to be found a detailed exposition of Gall's System of Phrenology. According to this system the brain is supposed to contain more than thirty separate and individual organs which are the seat of the most complex psychic capacities, or internal senses, such as combativeness, the fear-of-God, a sense-of-fact, the impluse-of-self-preservation, philoprogenitiveness, and the sense-of-language. It was only an incident to this system that the locality of these internal senses was found on the surface of the brain, and that the external evidence for them existed in certain prominences on the skull. The interest in this now bizarre theory lies as far as the discussion of this evening is concerned, in the fact that here we find in a most pronounced form two basal assumptions, one of which has served as a convenient vehicle for the justification of the dogma of formal discipline, while the other lies, in part at least, at the basis of the theories of those who in their reaction against this dogma have gone in the other direction to extremes which seem equally absurd and incapable of justification. The first of these assumptions is that the mind is composed of a number of separate faculties, and from this it readily followed that these can be educated in their entirety and made to serve in the various situations of life equally well for all purposes. The second assumption has looked upon the various activities of the nervous system, particularly of the cortex, as highly specialized and definitely localized, and has viewed the corresponding psychic functions as something quite discrete and separate. Carried to its logical extreme it would seem to imply that, for example, there is not only a cortical centre for language, but a distinct area for nouns, or for verbs, or what not; not only a cortical centre for vision, but a definite area for color; then why not for all the thirty-two thousand color qualities which the eye can sense? There seems to be no limit to the multiplication of centres which can result from such a theory, and it surely serves as a firm foundation for the doctrine that there is no education in general, and that the best we can do is to train the individual to interpret a certain number of definite sense stimuli and to respond to a limited number of concrete situations in the same old way. The faculty psychology assumed a

number of fabulous entities which worked out the destinies of the individual, while the doctrine of absolute localization of nervous function has made the brain a machine of relatively unrelated parts and has created a doctrine of psychic atomism which is as untrue as it is impossible of practical application.

The faculty psychology of the last century is long since dead, and its resting place has almost been forgotten by the scientist of today; its ghost, however, stalks abroad among the masses, and its spirit still lives in the pedagogical theories of many an uncritical thinker. From this faculty psychology it is no far cry to the dogma of formal discipline in all its purity. The assumptions it contains are well expressed by a clergyman quoted by Prof. James in the first volume of his larger Psychology: "As for my memory" writes the clergyman, "it has improved year by year....like a gymnast's muscle". This is a favorite comparison, the likening of memory, or attention or any other supposed psychic faculty to a muscle that can be developed for any use by any kind of exercise, and that is made equally strong by rowing, or boxing, or chopping wood, provided that the exercise is vigorous enough; and having been made strong by one exercise, can be used equally well for all activities. No less a scientist than Helmholtz is quoted by Coover and Angell[1] as valuing particularly certain studies as a means of intellectual training since these studies taxed "equally all the intellectual powers". Here we have the doctrine of formal discipline and its pedagogical consequence expressed definitely and clearly. The implication of Helmholtz assumption seems to be that there are definite mental powers and that these powers can be developed in all directions by certain well chosen studies.

Bagley in his Educative Process[2] puts the matter concretely in this way; "Certain subjects of the curriculum, if properly pursued, were believed to develop what might be termed 'generalized' habits. For example, a pupil may acquire a specific habit of producing neat papers in arithmetic. The doctrine of formal discipline assumes that if this habit is once thoroughly established, it will function equally well in connection with language and drawing; that, functioning successfully here, it cannot fail to insure neatness of person and attire and that the habit of neatness thus ingrained upon the pupil will surely be carried into mature years."

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[1] *American Journal of Psychology*, Vol. XVIII, pages 328-340 (1907).

[2] Chapter XIII, page 203.

Thus it is assumed that there is a general faculty or habit of neatness, and that this when trained by one set of exercises, will be serviceable in all the specific situations in life where neatness may be employed. Stated thus the dogma of formal discipline is absolutely untenable. There is no general faculty of neatness, nor of any mental capacity, and if there were such an entity, training it to function in one direction would not mean that it was trained equally well to function in all directions. If there was nothing more to the doctrine of formal discipline than the old faculty psychology, or the thought that training in one direction can be transferred equally well in all directions, I should not attempt even a partial justification of it here. It is quite obvious and beyond argument that training in mathematical reasoning does not necessarily mean ability to reason equally well in the affairs of every day life; it seems certain that if I wish to increase my ability to discriminate between shades of gray, the best training is to attempt such discriminations and not, for example, to practice discriminating between intensities of sound. It is a vastly different matter to affirm, however, that mathematical reasoning has no effect on other rational processes, and that as far as distinguishing shades of gray is concerned it is quite indifferent whether the person has had previous training in sensory discrimination in other fields. To affirm that when the mind is trained in one direction it is first of all trained in that direction and not in some other is one thing; to affirm, however, that the training in one direction has no influence in other direction is quite a different affair. No one, I think, would be quite so rash as to make the latter assertion; but many would believe that such a transfer of training is in most instances slight, and in some cases such a transfer is not probable, even in the slightest degree. Some seem to assume that about all that education can hope to do is to give to the pupil certain facts in a limited department of knowledge, and to habituate him to definite reactions in a circumscribed field of human activity. They seem to despair of any education in general that amounts to much. Having, however, admitted the possibility of transfer from one field to another, never mind how little, they are incapable of determining *a priori* how great this transfer may be and what general effects it may have. Such persons may try to bring some definiteness into their conceptions as to the extent of this transfer, by saying that such a transfer can take place only where there is a similar situation, and where like elements are involved; but it must be remembered

that similarity and likeness are not primarily objective categories, but that they are constituted by the mind of the person who finds such similarity or likeness, and that it is never certain beforehand just where this similarity and likeness is to be found.

Such a contention can be determined only by actual tests either in life itself, or in the psychological experiment. Fortunately we have had in the last few years a considerable number of such experiments reported, and the light which they throw on the whole question of formal discipline is more illuminating than that which can be secured from a discussion of *a priori* assumptions, or 'half-baked' psychological theories. I therefore turn to them and call the most important of them briefly to your attention.

II. EXPERIMENTAL EVIDENCE RELATING TO THE PROBLEM.

The two pieces of experimental evidence which have probably had the most influence in descrediting the doctrine of formal discipline and in over-emphasizing the opposite doctrine are those of Prof. James of two decades ago, and the more recent series inspired by Prof. Thorndike of Columbia University. James in his chapter on Memory in the larger Psychology[3] says: *All improvement of memory consists, then, in the improvement of one's habitual methods of recording facts.* By this he means to deny that there is any improvement in memory-power as such, the improvement being solely due to the method or the technique of memorizing. He then gives in a footnote a description of certain tests carried on by himself in support of his assertion. Since these tests are the first of a considerable number of later experiments conducted in a similar way, I will venture here to give a brief description of their general nature. Like those that have been undertaken later by other investigators, the essential technique of these earliest experiments consisted in giving the subject of the test some material to learn, thereby determining his capacity for learning as measured by a certain standard. The material for this first learning constitutes what is termed the "test series"; it is followed by a period of practice in learning some other kind of material and this second material is known as the "practice series"; this practice series is then followed by another learning of the material of the test series, and the improvement or lack of

[3]Vol. 1, page 667.

improvement over the first trials gives a measure of the effect of the practice series on the ability to learn.

To take a concrete case, James tested himself by learning on eight successive days 150 lines of Victor Hugo's 'Satyr'. He says: "The total number of minutes required for this was 131 5-6 —it should be said that I had learned nothing by heart for many years. I then, working for twenty-odd minutes daily, learned the entire first book of Paradise Lost, occupying 38 consecutive days in the process". He then went back to the learning of Victor Hugo and found that while before the training he had learned at the rate of one line in 50 seconds, after the training he learned at the slower rate of one line in 57 seconds. James added that during the second learning series he was perceptibly fagged with other work, which of course, invalidated the entire experiment.

Other persons under Professor James' direction carried on similar experiments under somewhat better conditions and the results showed a slight positive effect of the training.

These experiments are today chiefly of historical interest. They were not carried on under the strictest experimental conditions and are valuable mainly as pioneer investigations in the field. They are important also because their conclusions were given to the world with the tremendous authority that the *ipse dixit* of their author has always carried. Thus they have done much to reform the entire notion of the possibilities of memory training and of training in general.

The second set of experiments which I have mentioned above as having had an important pedagogical consequence are those of Thorndike and Woodworth[4] reported under the title, The Influence of Improvement in One Mental Function upon the Efficiency of Other Functions. Tests were conducted to determine the influence of the training in the estimation of magnitudes on the ability to estimate magnitudes of the same general sort; the influence of training in estimating weights, on the ability to estimate the weight of miscellaneous objects of similar weight; and the influence of the practice in marking words containing certain letters on the marking of words containing other letters, misspelled words, et cetera.

In these varied tests most of the subjects showed some improvement when tested after the practice series. Thorndike's general conclusion is that while there is some transfer it is not due to any "mysterious transfer of practice, to an unanalyzable

[4] *Psychological Review*, Vol. VIII, pages 247-261; 348-395; 553-564.

property of mental functions", but rather to a transfer of identical elements from the practice series to the final test series. This transfer on the whole does not seem to be great, and its spread is limited largely to activities that closely resemble one another. Thorndike's experiments have been criticised as giving results in part at varience with his conclusions, and as lacking entirely in introspective analysis, making it difficult to interpret the true significance of the numerical results.

Another experimental study which seems to point in part to the same general conclusions as those of Thorndike and Woodworth was conducted also at Columbia University by Bair[5]. This experimenter made an extensive investigation and analysis of the practice curve. The writer, however, concludes that "any bit of special training also helps us to receive training in general. Any training helps us to find ourselves. It gives us a method of orientation which leaves us in our reactions not entirely at the mercy of chance even in unfamiliar situations. The experience which we get from special training gives us a general power to meet an entirely new situation with a more favorable response than had we not had this special training".

Among the earlier experiments, the transfer of training from one specific set of reactions to another was investigated under the direction of Scripture in the psychological laboratory at Yale University[6]. The first series of experiments considered the increase of muscular steadiness through practice in inserting a needle in a very small hole, and the transfer of this increase to the corresponding muscles of the opposite half of the body. The left hand was tested first and showed 50 per cent of correct trials, but after practice with the right hand for ten days the left hand showed 76 per cent of successes. Scripture explains these results as due primarily to a training of the attention rather than to any carrying over of skill in adjustment. Experiments on the increase of muscular power after practice showed " a steady increase in the muscular power of the right hand due to practice and also an increase in the power of the left hand due to what might be called 'indirect practice' ".

[5]*Columbia University, Contributions to Philosophy, Psychology and Education*, Vol. IX (1902).

[6]On the education of muscular control and power, E. W. Scripture, T. L. Smith, and Emily M. Brown, *Studies from the Yale Psychological Laboratory*. Vol. II, pages 105-114, (1894). Also Researches in cross-education by Walter W. Davis; *ibid*, Vol. VI, pages 6-50 (1898) and VIII, pages 64-109 (1900).

Further experiments conducted by Davis under Scripture's direction on the rapidity of tapping a telegraph key showed improvement through practice not only for the part of the body practiced but for other members as well. Experiments in strength of voluntary effort in lifting dumbells showed a transferrence of the effects of practice from the right to the left arm and in muscular development and endurance. Experiments in lunging at a target with a fencer's foil showed that practice with the right hand affected the left hand positively. According to Davis the results of the experiments showed not only that effects of exercise may be transferred, but also that "will power and attention are educated by physical training and that when developed by any special act they are developed for all other acts".

Later Judd[7] carried on a series of experiments on the effect of practice without knowledge of results.

The person tested was required to judge the length of certain lines and he was seated in such a position that his right hand and arm were entirely hidden from view by a large screen. Whatever he did with his right hand was, therefore, unseen by him. "On the left side of the screen and in full view, nine different lines were shown in succession, and he was required to place a pencil held in the unseen right hand in the direction indicated by the several lines seen before him". After this the reactor was given "fuller visual experience" with one line and an improvement at once took place in regard to this line. This improvement was found to be transferred by later test to the other lines, but in some instances this transfer was negative. The lines that in the original series had shown an error similar to that of the line with which fuller visual experience had been obtained, showed a positive improvement in the test series, those in which the error had been in an oppisite direction grew worse. In both cases, howver, there were clear evidences of a transfer effect, but in the second case the transfer was negative.

In a second series of tests, geometrical figures were compared. Because of an illusion, one of these was over estimated, another underestimated. During the experiment one observer was kept in ignorance of the results, while the other was fully informed. Then the figures were reversed and a second series of tests were begun. In this the observer who knew the effect of practice ad-

[7]These experiments are reported in the *Psychological Review*, Vol. IX, pages 27-30 (1902); also in a symposium on formal discipline in the *Educational Review*, June 1908.

justed himself to the new conditions. The other observer who did not know the effects showed a greater error than at any time, and was unable to improve, because, as Judd believes, the habit had now became so firmly fixed that training could no longer modify the reaction.

A similar test was later carried on with school children, who were required to hit a target placed under water. This was difficult because of the deflection of the light through refraction. In the test one group was instructed in the nature of refraction, while the others were kept in ignorance. The boys in this test who had been instructed did no better than the others, but in a second test in which the depth of the target in the water was reduced from twelve inches to four, the boys who had the theory fitted themselves quickly to the new conditions, while with the other group the errors were large and persistent. These experiments clearly show the value of a knowledge of conditions in connection with the transfer of training.

A somewhat analogous fact is brought out by Ruediger in a test reported in the *Educational Review*[8] for November, 1908. Ruediger's experiment was suggested by Bagley's results[9] with children tested at the Montana State Normal College. Bagley attempted "to determine whether the habit of producing neat papers in arithmetic will function with reference to neat written work in other studies". He states that "the results are almost startling in their failure to show the slightest improvement in language and spelling papers, although the improvement in the arithmetic papers was noticeable from the first." Ruediger's tests were carried on for eight weeks in three different schools, all of the seventh grade. He found that when the emphasis on neatness in one subject was accompanied by talks to pupils on neatness, so that the habit was raised to clear consciousness, decided improvement was shown in subjects no more closely related than geography, arithmetic, grammar, and history. In other words, the habit was constructed into an ideal and a transfer was thus made which seemed entirely lacking when the whole procedure was on the level of the subconscious. This matter will be brought up again in a later part of the discussion.

Another important series of experiments on transfer was conducted a few years ago by Coover and Angell[10] on the general

[8]Improvement of mental functions through ideals.

[9]*The Educative Process*, Chap. XIII, p. 208.

[10]*American Journal of Psychology*, Vol. XVIII, pages 328-340 (1907).

practice effects of special exercises. In one experiment the training series consisted in the discrimination of sound intensities, the test series in discriminating shades of gray. A clear transfer of the practice effect was shown, as was also the case in a lesser degree in a second test in which the training series consisted in sorting cards and the test series in typewriter reactions. The authors conclude from the objective results and the introspections of the subjcts that the improvement consists in "divesting the essential process of the unessential factors. There is a greater habituation and more economical adaption of attention."

Franker[11] recently carried on a series of experiments on the transference of training in memory in the psychological laboratory of the State University of Iowa. The same general methods in the use of training and practice series were employed as in the previous experiments cited.

The training series consisted in memorizing the order of four tones. The test series were eight in number as follows: (1) memory for poetry; (2) memory for the order of four shades of gray; (3) memory for the order of nine tones; (4) memory for the order of nine shades of gray; (5) memory for the order of four tones; (6) memory for the order of nine geometrical figures; (7) memory for the order of nine numbers; (8) memory for the extent of arm movement. Clear indication of transfer was found, generally more marked in those cases where the test series and the practice series were similar, although it sometimes happened as in Thorndike's experiments that improvement was not noted in some cases where there was great similarity between the practice and test series; indeed, the practice seemed to have a negative effect. The results of the experiment did not, however, support Thorndike's contention that "improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar". In many cases Franker found that improvement was absolutely greater in amount in the test than in the training series. During the experiment the introspections of the observers were carefully recorded and they indicate that mental imagery and properly controlled attention have much to do with the transfer.

Another investigation of some importance in clearly indicating the existence of transfer is that of Winch[12] who gave his

[11] *The Psychological Review Monograph Supplements*, Vol. IX, No. 2, pages 56-102.

[12] *British Journal of Psychology*, Vol. II, p. 284.

observers as a test series, the learning of selections from an historical reader and as a training series the committing of poetry. More than one hundred children were tested. The investigator concludes that "improvement gained by practice in memorizing one subject of instruction, is transferred to the memory work in other subjects whose nature is certainly diverse from that in which the improvement was gained". *Rote* memory can certainly be improved.

Among minor investigations and observations bearing more or less directly on the problem of the evening's discussion may be mentioned Volkmann's[13] tests of a half century ago on the influence of practice on spatial discrimination. He investigated the fineness of space discrimination on the skin by means of the Weber compass and found that practice with the finger tips of the left hand increased the fineness of discrimination of the finger tips of the right hand, but not of the left fore-arm. Practice with the third phalanx increased the fineness of discrimination on the first phalanx.

Also of interest are the investigations of Urbantschisch, of Epstein and of Vogt cited by Coover and Angel[14]. Urbantschisch found that a sound stimuls increased the sensitivity of the subject for visual, gustatory, olfactory and tactile stimuli. Similar results are reported by Epstein in regard to the relation between auditory and visual stimuli. Vogt showed that habituation to distractions in one situation could be carried over to other fields.

A piece of work bearing less directly on the question of transfer but yet indicating something in regard to mental correlations which may be variously interpreted, was recently conducted at the University of Illinois by H. L. Rietz and Imogene Shade[15]. This concerned itself with inquiring into "the facts of correlation between the efficiency of students in mathematics and their efficiency in (1) foreign languages, (2) natural science". The method of investigation may be characterized in a general way as that of Galton and Pearson. The source of the data is the records of the registrar of the University of Illinois. The results of the investigation are, in brief, that "a high correlation exists between efficiency in mathematics and natural sciences, and also between efficiency

[13] *Bericht d. k. sächs.. Ges. d. Wissenschaft*, 1858.

[14] *Op. cit.* p. 328.

[15] Correlation of efficiency in mathematics and efficiency in other subjects. *The Univ. of Illinois Studies*, Vol. VI., No. 10, (1908).

in mathematics and foreign languages". While the results here do not in any way indicate whether there has been a transfer of training in mathematics to the other subjects they seem to show that studies as far apart as mathematics and foreign language evidently have many points in common, so that training in one subject might very well be made effective in the other.

I have reserved for consideration until the last, one of the most extensive and important series of experiments relating to the question of transfer of training[16], namely those of Ebert and Meumann. These tests, though with a greatly improved technique and with a larger number of subjects, are in general like the pioneer investigations conducted by James, The results, however, are decidedly different and the conclusions arrived at by Meumann are on the whole at variance with those of James. At the beginning of the Meumann tests, the memories of the subjects were determined for nonsense syllables, numbers, letters, one-syllabled substantives, Italian words, poetic words, prose words, and visual signs. In the training series which followed, the subjects were given nonsense syllables to memorize and then the original test series was repeated to determine improvement, if any, both for immediate recall and for permanent retention. In some cases the experiment was carried still farther, a second training series followed by another test series being introduced. The special training with nonsense syllables evidently increased the ability of the subjects to memorize and retain the materials of the test series. The amount of the transfer was found to be great. The ability to memorize philosophic prose, for example, showed an increase of 70 per cent after the practice series, and to memorize visual signs 55 per cent. Ebert and Meumann consider that increased power of attending, increase in voluntary effort, improvement in the technique of learning and general decrease in discomfort and tediousness are the chief auxiliary causes for the improvement after practice. They believe, however, that beyond these conditions and fundamental to the process of transfer, lies a sympathetic interaction of allied memory functions, based on an assumed psychophysical activity. The existence of such an uncertain relationship is denied by the reviewers of this piece of work. Both Müller and Dearborn, who have criticized these experiments, believe that the transfer can be best explained by considering the so-called auxiliary aids as the *sole cause* of the results obtained. Be this as it may, Ebert and Meumann,

[16] *Arch. f. d. gesamte Psychol.*, Vol. IV.

experienced investigators of high scholarship, have found that so mechanical a procedure as memorizing nonsense syllables has a pronounced effect on learning in general. Whatever the explanation may be, the results seem beyond reasonable dispute, both on account of the ability of the investigators and the unequivocal nature of their findings.

I have spent, perhaps, an undue amount of time in attempting to present the above experimental evidence. It has been my wish, however, to avoid as much as possible, speculation, hypothesis, and conjecture, and get down to the basis of undoubted facts. There can be no dispute, I think, in regard to the significance of these facts. *Transfer is indicated in practically all of the experiments, and in some, particularly in the last described, this transfer is striking.* The only investigations which showed no transfer were those of James, performed admittedly under unsatisfactory conditions, and the tests of Bagley in the Montana Normal School. Bagley's experiments, however, when continued under somewhat different conditions, as conducted by Ruediger, show clear evidence of transfer. Of the remaining experiments those of Thorndike show the least positive result.

I take it that in the light of all the evidence there cannot be the slightest doubt that practice effects may be, and generally are, transferred from one set of activities to another. The extent of such transfer and the conditions under which it takes place are, however, matters for further investigation and of great pedagogical significance. Whether the results are due to transfer of identical elements (Thorndike); to improvement of habitual methods of recording facts (James); to training the attention and will-power (Scripture and Davis); to devesting the essential process of the unessential factors, greater habituation and more economical adaptation of attention (Coover and Angell); to the effective use of mental imagery and properly controlled attention (Franker); to the development of ideals (Bagley and Ruediger); to general improvement in technique of learning, attention and will-power, but chiefly to a sympathetic interaction of allied memory functions (Ebert and Meumann), or to some other factors as yet not analyzed out, may still be a matter of investigation and debate. My own personal opinion is that practically all of these are more or less important elements in the transfer.

III. THE POSSIBILITIES OF FORMING A GENERAL HABIT.

Although the evidence of transfer seems unequivocal the extreme anti-formalist may still insist that the results of the investigations above cited are misleading and declare on theoretical grounds that any general transfer of training is impossible, since there is no such thing as a "generalized" habit. As Bagley puts it, "A simple habit is a specific response to a specific stimulus; a generalized habit would be a specific response common to a number of different stimuli". As such, "the term is a psychological absurdity". In a similar vein Thorndike asserts that "the mind is on its dynamic side a machine for making *particular reactions* to *particular situations.* It works in great detail, adapting itself to *special* data of which it has had experience". The case seems very simple. A habit is a definite response to a definite stimulus, and as all training tends to the formation of habits, there can be no training that is not specific. This line of reasoning might seem all very well if it did not prove too much. If habit is of this decidedly specific character, then it would seem to follow of necessity that the aim of the process of learning is merely to make facile and subconscious those things which have already been done after a fashion, and not to prepare the individual properly to react to essentially new situations. If this were the case we should be in a sorry plight indeed. We should be obliged to revise all our former notions of an education, and substitute for our present procedure a narrow and illiberal training, habituating the pupil to a limited sphere of predetermined activities. The child would be but little better off, then, in his learning processes than is the brute, who manifestly is trained in just such a manner as described and is in no sense educated. Thorndike attempts to escape from this obvious difficulty by admitting the transfer of training through elements identical in two situations.

Such a transfer in the simplest form is well illustrated by a series of experiment carried on several years ago in the psychological laboratory of the University of Illinois. In these experiments three dogs among other animals were tested in regard to their ability to discriminate between various colors. Throughout most of the experiments a standard red was the color which they were trained to associate with the obtaining of food. This color was painted on the food-box, and the dogs soon formed the habit of reacting directly to this red-box stimulus, thus obtaining their

food. Later one of the dogs was tested to see how far he could associate the color red when presented not merely on a box of a certain size and appearance but on various receptacles and under various conditions, with the obtaining of food. Gradually this dog was trained to recognize the color red under varied conditions as the food signal. Thus, quite mechanically, he seems to have transferred his habit from one situation to another through the identity of the color element in the various situations. Such a transfer is not of a high type, nor is it very promising from the standpoint of educational procedure. The possibilities of getting much general training through the identity of objective elements in a total situation do not seem to be great. It should be stated, however, that Thorndike understands by identical elements not only identity of the objective stimulus as in the cease of the food-box stimulus, but the identity of those elements that constitute the reaction to a stimulus, the identity of adjustment in two situations.

Bagley has got around the difficulty much better by emphasizing the identity or similarity of certain subjective elements in a situation (indeed he would define a situation in terms of conscious meaning rather than in terms of objective elements) in his doctrine of a transfer through the creation of ideals. He says in regard to the habit of neatness, for example, that "those who appear to carry this habit over from one department of life to another really carry over the ideal of neatness." The importance of this general principle, thus formulated by Bagley, cannot be overestimated, yet I am inclined to believe that neither this, nor the principle of identical elements as set forth by Thorndike is sufficient to explain all there is in the transfer, nor to exhaust the possibilities of a general training.

In several senses I believe that we are warranted in speaking of a generalized habit. Such an expression seems to me admissable under the following conditions:

(1.) When the specific stimulus that calls forth a specific reaction is common to a large variety of situations, which situations may have little in common beyond the presence in each of the specific stimulus. In the case of the food-box reaction, for example, described above, the color red was the element in the many situations which produced under varying circumstances the fool-seeking response. Such a reaction would be general in the sense that it could take place under may objective conditions, and thus as far as the environment is concerned, constitute a generalized re-

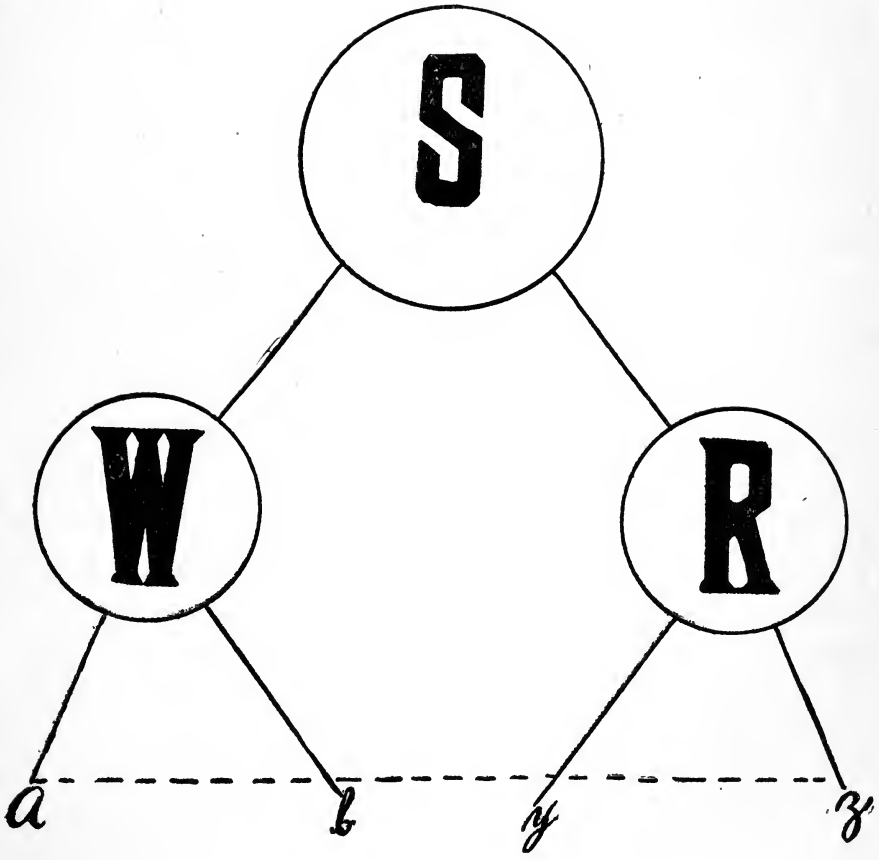
sponse through the similarity or identity of a single element in that environment. Take another example of a similar sort: The soldier who has learned to come to attention at the word of command will do so on the parade ground, the battlefield or the street. It, of course, may be said that for the soldier who so responds the actual situation is the same under these varying conditions. However, this is true only as far as the dominant element in the situation remains similar, this dominant element being determined not only by its objective importance to the ordinary observer, but by the fact that the soldier does thus react under various circumstances (the reaction thus being the criterion of identity of stimulus.) For the ordinary observer, however, this dominant element may be of but slight importance, and thus in his relations with his fellowmen, the soldier may appear to have acquired a generalized habit and for all practical purposes his reaction may be treated as such.

(2) There is another class of habitual reactions which do not seem to be called forth by any definite objective stimulus, but which appear under a large variety of objective conditions in which no single common element can be found. These latter cases arise when the reaction is under the dominance of a mood or emotion that so colors the objective environment that several different stimuli may call forth the habitual response. A person, for example, of a choleric disposition may have established a very definite set of reactions which habitually expresses his angry moods. The insignificant external causes which set off this definite response may vary greatly and it may thus be urged, that not one stimulus, but many, are capable of producing the reaction. In cases of morbid pity, irrational fear, religious enthusiasm, and the like, the object which gives expression to these moods is apparently indifferent. Of course it may be replied that the mood itself is due to a complex of bodily stimuli (such as those set forth in the James-Lange theory of the emotions) and what really is true is that in all the habitual expressions of the emotion there exist certain common and definite stimuli discharging themselves into the higher centres, and that this second class of habitual responses really belongs with the first class, mainly of response to identical stimuli. Whether this is theoretically true or not, we again have, and to a greater extent than in the cases cited under the first class, what may be practically considered as a very general response to a large number of different environmental conditions.

(3) We further have in any definite reaction to a given situation not merely one elemental adjustment, but generally many both positive and negative. This the following discussion will attempt to make clear:

Let us suppose that a child in the school room is being taught to correctly form the letter *a* in his copy book. Here we have the example of training in a special habit. We have a certain definite stimulus of sight, namely the letter *a* of the copy book, which constitutes the essential stimulus to which there is a specific response, the writing of the letter *a*. This gradually becomes more and more an habitual process and we have set up a definite habit of stimulus and response. I wish to submit, however, that besides this specific stimulus of the written or printed *a* on the copy book, there are other stimuli which constitute the total situation which might function just as well for copying *b*, or any other letter, as *a*. We have not merely the specific *a*-copying reaction but we have as well a more general reaction based on the seeing of the copy book, the "feel" of the pen in the hand, etc., which may be termed the "copy-book" reaction; beyond this we have a still more general group of motor expressions and exhibitions which constitute the "school" reaction as such and differentiate it from the "home" reaction, for example. Now in the copying of the letter *a* all these various reactions are involved, but only a very small part of the total reaction functions solely for the *a*-copying habit; much of it might function equally well for the reading-habit, or the number-work habit. There is then a considerable part of the *a*-copying habit that is not specific in the sense that it is confined to the one particular reaction of copying the *a*. It is general in the sense that it concerns itself with many other school activities. For example, the ignoring of the noises on the street, the holding of the body in the proper position at the desk, etc., are reactions that apply to various school situations other than the one concerned with the business of copying the *a*.

Perhaps this thought may be made more clear by the accompanying diagram. In this the script letters *a, b, y, z,* represent certain specific activities in which the pupil is being trained. *a,* however, involves the more general adjustment W, which in turn involves the still more general adjustment S. Now while in the activity *a,* W and S are both involved, these may also be involved equally well in still other activities. For example, W is involved among other things in the activity b, while S is involved not only in W, but in R as well. To be more concrete, let us suppose that


S
W
R
a
b
y
z

a represents the *a*-copying habit, and W the writing habit and S the school habit, while R represents the reading habit and *y* the habit of reading in verse. Now it is quite obvious that in learning to copy *a,* the other higher habits, if they have not already been formed, will of necessity gradually be set up. Suppose the child should begin his activities in school (which of course, he actually would not) by learning to copy the letter *a.* In this activity he would gradually acquire the more fundamental habit of paying attention in the school room and of the general technique of learning to write. Thus in learning to copy the *a,* he would have also acquired a stock of habits which could be transferred to other school situations. In other words, learning to copy *a* would constitute a general training as well as a specific habit-forming activity.

So we are justified in speaking of general habits of attending, or of thinking, or of willing, although as Bagley would urge with justice, attention, thought and resolution are mental states, which as highly conscious, raise the individual above the plane of habitual activities, and make it possible for him to respond in a new way to a new situation. The fact, however, that he does attend, has the attitude of attention, is due to certain specific tendencies toward reaction which have been gradually acquired and made reflex. The attending to the dictation of the teacher, for example, brings into the consciousness of the child a situation to which he may intelligently react, but the possibility of getting the attitude of this attention is largely dependent on many subconscious and habitual factors, such as ignoring unessential stimuli, disregarding tedium, and in general having developed a technique of learning. These elements have been emphasized by most of the investigators above cited as essential in the process of transfer.

If we consider again the diagram just discussed we shall be able to see how it explains some of the facts of transfer or its lack, as shown in investigations above considered.

In one of the tests of Thorndike, for example, the subjects were given practice in marking the words on a printed page containing the two letters *e* and *s.* Before and after this training these subjects were tested in marking the words containing other combinations of letters, misspelled words, different parts of speech, etc. Improvement in the second test series was measured by increased speed and accuracy. In general speed was more likely to be improved than accuracy. The reason for this I think

is perfectly obvious in terms of our diagram, as can be seen from the following. Suppose that *a* represents the practice in marking the words containing *e* and *s,* while *b* represents the marking of words containing other letters, etc. It is quite obvious that the specific marking habit acquired in the first series, enters into conflict in a certain sense with the marking of words containing *m* and *l,* for example, since the attention is turned from words of one general make-up in the practice series to those of another composition, in the test series. Thus the acquired tendency to mark words containing *e* and *s* will actually tend to inhibit the marking of words containing *m* and *l.* Hence there may be a falling off in accuracy. On the other hand the more general reaction of marking words has been trained at the same time as the habit of marking specific words. This latter phase of the habit (which Thorndike would term an identical element, but which I prefer to call a more general attitude) may be transferred from the marking of one kind of word to the other. This might result in greater speed and at the same time diminished accuracy. I venture to say that if a subject had been trained to high efficiency in the word-marking habit, further training in marking certain specific words would tend to exercise a negative influence in marking other words similar to them. The nearer the activities were alike in this case, the greater would be the distraction of attention, and the greater the falling off in efficiency.

It would seem probable for this reason that highly trained laboratory subjects would show less general effect of training than would näive subjects, and that adults would show less effect than would children. The laboratory subject who has mastered the technique of giving himself over to the test at hand, who knows how to hold his attention down to the minimum of fluctuation and to overcome the loss of interest arising through ennui, can expect to get little general training in carrying on some specific activity like judging areas, tapping at dots on paper, or learning nonsense syllables. The greatest possibilities of transferring general attitudes of attention, thinking, etc., except as conscious ideals or purposes, lie, then, with untrained adults and with children, especially with the latter. This makes the educative process so hopeful where children are concerned and relatively hopeless with adults. It is not that adults cannot learn new habits, as James maintains in his famous chapter on habit; it is that they cannot generalize these habits, that makes the man of forty an old fogy.

Transfer of training is then possible in the ways indicated: (1) Where a single element to which a specific response is made functions under various environmental conditions because it is a common element in these various, and otherwise to a greater or less degree, dissimilar environments; (2) When a dominant mood or emotion so colors various environments that a characteristic response is obtained without identity of any one objective condition; (3) Where a single response in reality involves other and more general adjustments. (4) It is also possible, as Bagley suggests, through making the end of the activity a clearly conscious ideal. In this case the transfer takes place by a direct carrying over by consciousness not of the activity itself, but of the purpose of the activity, to another field. This transfer may be represented in the diagram by the dotted lines from *a* to *b* from *a* to *z*, and so on, showing a direct transfer without involving the adjustments at W, S, or R. To illustrate by a concrete example, the habit of attention in school (S) may function quite unconsciously, from having been acquired in the reading of poetry (y); in connection with the writing of certain letters in the copy-book (b), or it may function rather because the school-attention attitude has been made a conscious ideal in connection with *y* and is therefore carried over as an end of action rather than as a habit. This general scheme with this modification suggests, I believe, all the possibilities of transfer; general moods and attitudes that have grown up quite unconsciously as well as developed conscious purposes finding their place in the transfer. Whether beyond this there is some mysterious sort of harmony, or sympathetic vibration, in the nervous system that makes it possible for one habit to set up another without a transfer in the ways suggested, we do not know. But if it exists it is buried at present so far below the threshold of consciousness that it has no practical educational significance and need not be considered here.

IV. RULES FOR SECURING TRANSFER.

The possibility of a general training is thus seemingly established both in theory and in fact, and it becomes the business of education to consider how such a training can best be secured. I believe that it is possible in the light of all the evidence presented on the subject of transfer to lay down with tolerable certainty a few rules of procedure.

(1). The first rule should be: Make those specific activi-

ties which you wish to transfer the object of thought. Let the significance of the habit and its general bearings become known to the person who is the subject of the training. Bagley has emphasized this factor in training in his doctrine of transference through ideals, and the experiments of Ruediger seem to justify the contention. The results of Judd, who, as previously stated, has shown that practice with knowledge has a value in the transfer of training which practice without knowledge does not possess, also point to the same general conclusion. Likewise, Meumann states that it is desirable in training children formally to bring to their attention the significance of such training. It further should be said that our knowledge of the functioning of the nervous system is in strict accord with this general position in regard to transfer, since the association fibres of the cortex are the ones which connect various sensory and motor areas and their function is probably primarily related to the higher conscious processes.

It would seem then that we have a definite means which education can pursue in formal training, and this means removes the criticism that such training is merely mechanical and deadening.

(2) Train the child in the technique of learning and in the processes that make learning effective and economical. Nearly all the investigations emphasize the value of properly adapted attention, of satisfactory physical and mental attitudes in securing transfer. Sustained attention should be developed in the school training, not merely for the sake of the object attended to (perhaps not primarily for the object's sake), but rather for the sake of attention itself. The whole art of learning should be carefully and skillfully controlled. The importance of right method of learning has been emphasized in recent years largely through the work of Meumann. It appears that one of the chief aims of education should be to teach the child how to acquire knowledge with the least expenditure of time and energy compatible with its retention for effective use. Personally I am convinced that one of the greatest needs of formal training in this connection is the development of the child's mental imagery. See to it that children can employ various kinds of imagery effectively, develop the imagery for form and for color, the imagery for sounds and for kinaesthetic sensation of throat, hand, and fingers when possible. Many a poor reader cannot visualize, many a child deficient in nicety of motor control lacks kinaesthetic imagery; all

training in musical notation is worthless knowledge unless the child has a fair auditory imagery.

(3) In seeking to secure transfer, especially where purpose does not play an important part, see to it that the stimulus which is to call forth the desired reaction is such that it may be a common element in many objective situations. If, for example, it is desired to promote in general the habit of observation, it will be unwise to cultivate this habit in a very narrow and unusual field of experience. Habits of observation may doubtless be secured by training the observer to give careful attention to objects appearing under the miscroscope. This training in observation will on the whole probably have less possibilities of transfer to other fields than observation cultivated in the study of more common objects of life, such as those of plants and animals that are often met with in the daily environment.

(4) Education should cultivate through specific training general emotional attitudes. Moods and feelings often are the dominant elements in a situation and these can readily be transferred, I believe. The child who has the proper emotional attitude toward his school life will be the one who will act most capably in the school environment. Education should see to it that such general feeling attitudes as docility, respect for authority, eagerness to be of service, and the like are developed through the school training. Such attitudes, unlike the ideals which Bagley emphasizes, need not (perhaps should not) be raised to full consciousness. This, I believe, has a bearing on moral instruction in the schools. I have sometimes thought that intellectulizing what ought to be an emotional attitude is a dangerous procedure. This thought has significance in relation to temperance instruction and the like. I think that the question may well be raised,—Has not the instruction on the effect of alcohol and narcotics the tendency to make the child's attitude merely a matter of intellect, when it should primarily remain one of feeling and of will?

V. THE SUPERIOR DISCLIPLINARY VALUE OF PURE AS COMPARED WITH APPLIED SCIENCE.

Finally, if it is true that a formal training is possible, and if it is desirable that the schools furnish such a training, we come back to the old question as to whether there are certain studies that are better suited than others to offer this discipline. It

would seem probable that there are subjects which either because of the nature of their subject matter, or because of the better technique that goes with their instruction are today more valuable than others from the standpoint of mental training. Other studies which are not now so well developed will, perhaps, some day take the place of mathematics, or natural science, or foreign language, but today they are less valuable from a disciplinary standpoint.

Just at present the most important controversy concerning educational values is being carried on between those who advocate the advantages of applied science and those who hold to the greater value of pure science. The proper solution of the relative importance of the two spheres of human knowledge will doubtless have much to do with the development of the most valuable curriculum of studies in our secondary schools and colleges. I am inclined to believe that at least as far as mental discipline is concerned, pure science has much in its favor as a subject of instruction. In a forthcoming volume, Bagley emphasizes the probable superiority of pure mathematics over applied mathematics with its utilitarian ends which tend to color every other consideration; thus obscuring the ideals of accuracy and rigidity that the pure science teaches. "Applied mathematics", says Bagley, "will inevitably demand a quantity rather than quality.....With the better and more intelligent students, the discipline may come in spite of haste. With the average student, the longer and more penetrating processes from which the perception of the unique values of mathematical reasoning will emerge, will be omitted".

What is true in regard to pure mathematics as compared with applied mathematics is, I believe, true in regard to other pure sciences as compared with other applied sciences. The application of a science tends to emphasize certain human values more or less remote from the value of the science as science; hence, to restrict the field of the inquiry to those phases of the science that seem to relate most definitely to economic and other more-or-less narrow human values. With this point of view the investigator is apt not only to lose the ideals of rigidity which Bagley points out, but also the ideal of truth merely as truth; truth that is self-sufficient and confident, that knows that whatever is true is human and whatever is untrue or partially true can never have ultimate worth in human experience. This ideal

gained in one pure science and made a conscious end of endeavor in all fields of human experience has a rich promise for the future. The great discoveries of science have been made by those who were primarily scientists, who had the scientific ideal. Applied science comes later and uses the knowledge of a Helmholtz playing with the opthalmoscope or a Darwin, in the spirit of scientific curiosity, collecting specimens and data from which has developed the theory of evolution with its countless applications to human life. The mere *facts* of science are worth much; relatively less, however, in the first years of study before specialization has begun in the technical school or university; but the fact as fact has slight disciplinary value unless from it grows the spirit of curiosity, the emotional ideal, which the Greeks realized gave birth to all knowledge, and through which modern education has achieved such results. My own conclusions would be that pure science is of greater disciplinary value because (1) through the facts which it presents, ideal of procedure and of truth may be developed which function in a wider human experience, greatly to the uplift of the race; (2) the content and method of pure science is such that it has a broader field of application than has applied science, and can function as an identical or similar element in more situations than can applied science; (3) the emotion which the pure seeking after truth arouse is higher and less likely to be deadened by other emotions than are the ideals of economic improvement and social betterment, which are the aims of an applied science. These latter are apt to conflict with each other and to obscure the greater issue. Truth has but one aim, to know itself; it has a greater emotional uplift and is one of the fundamental passions of the human race; as fundamental as the economic and social needs, and capable of ranges of flight toward the ideal that are denied the other instinctive longings.

We must realize that not every subject that has utilitarian value, or that excites popular interest, is for that reason solely, a fit subject for instruction in the schools. Ultra-conservatism has too often insisted in keeping in the curriculum those studies that have long since ceased to be vital; on the other hand we are equally in danger, particularly at the present moment, of going to the other and equally fatal extreme. There are so many special interests that just now seem to be clamoring for recognition, practical, humanitarian, aesthetic, that our school programmes are in danger of being over-crowded with a variety of subjects which

cannot well take the place in point of mental training of those which have for years been firmly established in the curriculum. The very multiplicity of the subjects that have enriched our programmes offers a distraction and furnishes a training in dispersed rather than concentrated attention, a training which is not needed and should not be desired. The trend of popular opinion is such that the new must come in, and I am far from maintaining that this opinion is not on the whole sound; but let us see to it that this new element is assigned its proper place and given its just value. In this time of rapid change we need sanity in educational doctrine and practice as scarcely ever before.