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The Psychology of David Hartley and the Root Metaphor of Mechanism: A Study in the History of Psychology

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The present paper examines the effects of the scientific revolution upon the history of psychology with special emphasis upon the work of Hartley. Hartley's *Observations on Man* (1749) is generally recognized as the synthesis and origin of psychological associationism although this awareness has not brought about a due examination of his system and its influence upon psychology. The reasons for this will be discussed, as well as the more general impact of Hartley's system upon psychology, with special reference to Pepper's root metaphor theory.

The history of psychology is commonly presented as a series of events which brought psychological thought away from philosophical speculation into the realm of natural science. Contemporary accounts of the history of psychology often separate philosophical and experimental periods in a manner which suggests that psychology's problems originated in philosophy and remained unmanageable until the advent of modern, scientific psychology (e.g., Boring, 1950; Kantor, 1969; Lundin, 1972; Schultz, 1969). The effect is to divorce experimental psychology from its philosophical heritage. Reading history backwards to an experimental starting point and clumping the rest together as "pre-experimental" loses both historical fact and historical perspective. The story of psychology thus told tends to lose sight of important problems which existed, and continue to exist, and gives us an unnaturally smooth, uncomplicated picture of the relation of the present to the past.

The loss of historical perspective is nowhere more obvious than in the failure of most psychological historians to deal adequately with psychology as participating in the Scientific Revolution of the 16th-18th centuries. It was during this period that those intellectual giants, Galileo, Descartes and Newton, challenged the Aristotelian-Scholastic analysis of natural phenomena and introduced a new way of dealing with science. The new natural philosophy involved a significant shift in the assumptions held about the nature of reality and the nature of scientific explanation. The new approach was typified by an emphasis on mathematical demonstration, efficient causality, and the corpuscular theory of matter. The assumptions adopted had broad implications for psychology, and a distinct change in the individual's relation to the natural

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world was one of the most basic consequences. It can be argued, in fact, that the categories then established are still operative, and help to explain the predominant trends in modern psychology. This neglect of our intellectual heritage needs to be corrected. Young, for example, argues as follows:

> Modern psychology grew, in fact, from a synthesis of views of Locke and Newton within the dualistic framework set by Descartes. But it is not the historians of psychology who have seen this. Rather it has been made clear by the writings of the scholars just mentioned [Balz and Burtt] and by Crombie, Vartanian, Halevy and Albee, among others, whose writings have been largely ignored by historians of psychology. The problems of modern psychology grew out of and are continuous with those of the classical Scientific Revolution. Indeed their origin should be traced to the natural philosophers from Kepler to Newton and the price they paid in order to achieve a world which could be exploited by the physico-chemical sciences. In return for a physical universe of matter and motion—of extended substances—which could be treated by geometrical, mathematical means, they pushed their main problems into the concept of mind. Those that remained were accomodated by the concept of the Deity and the ether. Thus, Descartes, Locke, Newton, and Hartley provide the essential framework within which scientific, philosophic, and psychological problems must be seen. (1966, p. 20)

Young suggests an obviously tremendous assignment, and if his evaluation of current histories is correct—as I think it is—broad, general historical surveys are not what we now need in psychology, but instead, careful analyses based on primary source material.

One period in the history of psychology which has close, immediate ties with the larger Scientific Revolution is the generation of psychological thinkers who first inherited and adopted the new categories of the natural sciences. The impact of Galileo, Descartes and Newton seems especially clear among those English philosopher-psychologists who founded and contributed to the tradition of British empiricism and associationism. This would include Thomas Hobbes, John Locke, George Berkeley, David Hume, and David Hartley, along with others from the Scottish School of "common sense," such as Thomas Reid, Dugald Stewart and Thomas Brown. At a later time, empiricism and associationism are represented in the work of James and John Stuart Mill, Alexander Bain and Herbert Spencer. To deal with all these thoroughly would plunge us into an enormous literature of commentary by philosophers and historians. But there is a more economical way of dealing with the effect of the Scientific Revolution upon the history of psychology. It rests on the thesis that David Hartley holds special significance as the author of the first distinctly psychological treatise which incorporates the main assumptions of that revolution. Hartley's *Observations on Man* (1749) is generally recognized as the synthesis and origin of psychological associationism, even though the awareness has not brought about a due examination of the system and its influence (see Boring, 1950; Kantor, 1969; Klein, 1970; Lowry, 1971; Schultz, 1969; Watson, 1971). Young states:

> The principles for which Hartley argued became accepted as the basic assumptions of physiological psychology in the nineteenth century, and they have thus not changed fundamentally since 1749. The developments which were based upon this theory form the most important aspects of the application of the scientific revolution to the neural, behavioural, and social sciences. Nevertheless, there has been *no* full-scale study of Hartley's work and influence. (1966, pp. 23-24)

Many twentieth century psychologists share Hartley's fundamental suppositions about the nature of science and the study of individuals and, like Hartley, fail to realize that these assumptions represent just one way of viewing psychology. There is not really a qualitative difference between the direction Hartley was pointing for psychology and what has actually occurred.

Historical analysis of the assumptions which grew from the Scientific Revolution into Hartley's psychology needs explicit criteria for evaluating the kinds of assumptions involved. An excellent set of standards germane to the entire investigation exists in the literature on metaphor in Stephen Pepper's (1942) book *World Hypotheses*. Pepper focuses on our attempts to structure and organize the voluminous and complex cognitive data which we find in the world around us, and he presents the concept of *root metaphor* as a means of analysing the adequacy of these attempts. Pepper believes that it is impossible to deal with cognitive information without making a basic hypothesis about the nature of the world, and that four root metaphors have been particularly successful in organizing the data. These four relatively adequate root metaphors have been used by thinkers throughout history to make sense of their world and to produce both precise and inclusive hypotheses to guide them. One of the root metaphors Pepper outlines is the root metaphor of mechanism, which incorporates the categories and assumptions adopted by the natural philosophers in the Scientific Revolution.

The root metaphor of mechanism is based on the metaphor of the machine but is not limited to the analogy of a man-made mechanical device usually thought of as a machine. Rather it involves an analysis of the kinds of assumptions which must be made about the world if the operation of a hypothetical machine is taken as the prototype of nature. For example, the root metaphor of mechanism begins with the assumptions that real things have a particular location in time and space, that primary qualitites (like size, shape, motion, weight or mass, number) are the only real characteristics which differentiate the particulars, and that mathematical relationships, or laws, operate among the particulars. The particulars, their primary qualitities and their laws are all that are necessary to offer a meaningful description of the efficient function of the mechanism. These three categories form the primary categories of the root metaphor of mechanism. Once the primary categories have been delineated, there are other characteristics of a machine which are related to the primary categories but which are unnecessary to a description of its operation. There are, for instance, secondary qualities (such as color, odor,

taste and temperature) which cluster around the primary qualities in specific ways. The secondary qualities may also be related lawfully to each other, and where they exist, these are the secondary laws of the root metaphor of mechanism. The primary and secondary categories are separate but both are necessary to maintain the integrity of the root metaphor. The features of the primary categories are known through cognitive evidence derived from the materials within the secondary categories, and the existence of the secondary categories as distinct entities depends upon the prior extraction of the primary categories. The task for a mechanist is to relate these two aspects of natural phenomena without sacrificing the basic assumptions which created them.

Every root metaphor has strengths and weaknesses, and from the standpoint of psychology, every root metaphor produces a different view of the individual. The root metaphor of organicism, for example, emphasizes integration and organic process and produces a very different image of the person than mechanism which focuses on analysis and reduction to physical particulars. The individual image resulting from the root metaphor of mechanism is one which stresses the basic reality of the primary categories and results in reduction, materialism and determinism which characterize much of current psychology (Watson, 1965). Historically, the mechanistic assumptions which psychology derived from the Scientific Revolution are a primary source of the development of psychology away from a central focus on mental life and toward the emphasis on behavior. The historical antecedents of Hartley's psychology are found in the root metaphor of mechanism originating in the Scientific Revolution. It is the mutual acceptance of this particular world hypothesis by Hartley and many psychologists today which makes him a significant representative of our psychological heritage.

The Psychology of David Hartley

The work of David Hartley (1705-1759) represents a unique opportunity to examine the application of the root metaphor of mechanism to the study of human behavior. The preparation of his major work, *Observations on Man* (1749), spanned an eighteen year period (1731-1749) during which Hartley had ample time to be influenced by the new, empirical science.[1] At Cambridge he was influenced by the mathematical arguments of men like Robert Smith and Nicholas Saunderson, and he was a friend of the experimental physiolo-

[1]In 1746 Hartley published a Latin tract which was almost directly reproduced as the first 22 propositions in *Observations*. See David Hartley, *Various Conjectures on the Perception, Motion, and Generation of Ideas* (1746), trans. by R.E.A. Plamer, introduction and notes by Martin Kallich. (Los Angeles: Augustan Reprint Society, No. 77-8, William Andrews Clark Memorial Library, University of California, Los Angeles, 1959). For a discussion of Hartley's early tract, see Benjamin Rand, "The Early Development of Hartley's Doctrine of Association," *Psychological Review*, 1923, 30, 306-320.

gist Stephen Hales.[2] Hartley's career turned from the ministry to medicine, and as a physician in London he further pursued religious and scientific studies. He was elected a Fellow of the Royal Society and interacted with individuals such as Bentley, Butler, Hooke, Law, Jebb, Clarke, and Stillingfleet (see Oldfield and Oldfield, 1951). Hartley wrote at a time when the past successes and future promise of the new science had gained great momentum, as evidenced by a number of important publications in the middle years of the 18th century. La Mettrie's *L'Homme Machine* was published in 1748 and Condillac's *Traité des Sensations* appeared in 1754. In England, Hume's *Enquiry Concerning Human Understanding* and Hartley's *Observations on Man* arrived as independent testimonies of the effects of the new science. As Halévy writes of this period:

> This was the beginning of the Utilitarian century, the century of the Industrial Revolution, of the economists and of the great inventors. The crisis had been brewing for fifty years: two names contemporaneous with the Revolution of 1688 symbolise the new era: 'Locke and Newton,' names which have become proverbially associated both in England and on the Continent. (1952, pp. 5-6)

One of the most potent messages of the new science was that universal laws (discovered in the primary categories and extended to the secondary) make nature and individuals intelligible. The underlying causes which produce observable effects need not be known as long as the chain of efficient causes stemming from the laws result in constant effects. It is thus possible to gain power over nature through the knowledge of natural laws and to actively apply these laws to human analysis, moral and political areas, and religious study. Hartley's application of the root metaphor of mechanism was one of the most important achievements in directing a naturalistic analysis of human behavior and in contributing to an atmosphere of progress, knowledge and revolution. His work reflected the feeling that it was enough,

> to apply the Newtonian method with a view to determining the smallest number of general simple laws, which, once discovered, will enable all the detail of phenomena to be explained by a synthetic and deductive method. It follows that it is possible to construct a practical science on the basis of this knowledge, and to extend our power to the same extent as we extend our faculty of foresight. (Halévy, 1952, pp. 5-6)

Hartley identified his efforts with the successes of Newton and Locke, and he readily acknowledged them as his intellectual masters. He hoped for a positive natural science of human behavior which would contribute to the progress of culture and the accumulation of useful knowledge. Hartley was a pious and

[2]Robert Smith (1689-1768), mathematician and astronomer at Cambridge, successor to Roger Cotes (Plumian Professorship) and R. Bentley (Master of Trinity); Nicholas Saunderson (1682-1737), Lucasian Professor of Mathematics, Cambridge, 1771; Stephen Hales (1677-1761), Newtonian physiologist and author of *Vegetable Staticks* (1727) and *Haemastaticks* (1733).

rational thinker, and his naturalism did not produce a skeptical philosophy, like Hume's, which questioned the individual's ability to know the external world and his or her relationship to it. Hartley's optimism was related to his religious faith and his belief that the application of the new categories to the study of human behavior would lead to proper moral decisions and to the revelation of God. In fact, the major intent of his psychological analysis was to contribute to a rational and scientific solution to the problems of faith and morality. Hartley's unqualified acceptance of the assumptions of mechanism and his faith in the progress of religious and moral fulfillment based on scientific principles combined to create an uncritical and naive quality in his work. Willey (1961) comments on this blend of scientific ardor and religious certainty:

> Hartley was a man of unusual originality and penetration, and he writes with the zest of one who knows he is engaged in pioneering work, but who feels, at the same time, that he is building up morality and religion on unshakable foundations. In this respect Hartley is clearly in the apostolical succession of English physico-theologians from Bacon, through Boyle, Locke, and Newton, to Joseph Priestley . . . . That peculiarly English phenomenon, the holy alliance between science and religion, persisted (in spite of Hume) till near the close of the century. It is Hartley's distinction that he evolves his religion, not from the starry heavens, but from a study of human psychology. Hartley was both necessitarian and Christian, materialist and religious . . . . (pp. 136-137)

Hartley and the Root Metaphor of Mechanism

Hartley's participation in the root metaphor of mechanism can be recognized by examining the extent to which he shares the aims, methods and assumptions of the new science of nature. There are numerous indications that he willingly accepts the characteristics of the natural world put forward by Newton and Locke. He believes that nature is fundamentally constant and continuous in all its effects (Hartley, 1749), and that its phenomena could be reduced to a few, simple, general laws. In fact, it is "the great Business in all Branches of Knowledge . . . to reduce, unite, and simplify our Evidences, so as that the one resulting Proof, by being of a higher Order, shall be more than equal in Force to all the current ones of the inferior Orders" (Hartley, 1749, pp. 344-345). Natural laws are statable in quantitative, mathematical terms. The extent to which mathematical demonstrations might some day encompass a broad range of subjects appeals to Hartley and he believes it possible,

> that future Generations should put all Kinds of Evidences and Inquiries into mathematical Forms; and, as it were, reduce *Aristotle's* ten Categories, and Bishop *Wilkins's* forty *Summa Genera*, to the Head of Quantity alone, so as to make Mathematics and Logic, Natural History, and Civil History, Natural Philosophy, and Philosophy of all other Kinds, coincide *omni ex parte*. (1749, p. 351)

Since Natural Philosophy for Hartley includes mechanics, optics, chemistry,

astronomy, medicine and psychology, it seems clear that he considers the theory of the human mind amenable to mathematical demonstration.[3]

The physical world in Hartley's view is composed of multitudes of particles located in time and space. His belief in the atomistic composition of matter is evident throughout his work and is the basis of his explanations of natural phenomena, including human phenomena. He accepts transdictive inferences to unseen particles as a valid part of scientific analysis, based upon the true nature of the material world. Because of the continuity in nature, the visible world presents a direct clue to the discovery of invisible things:

> The analogous Natures of all the Things about us, are a great Assistance in decyphering their Properties, Powers, Laws, etc., inasmuch as what is minute or obscure in one may be explained and illustrated by the analogous Particular in another, where it is large and clear. And thus all Things become Comments on each other in an endless Reciprocation. (1749, p. 343)

Hartley is willing to admit that neither the proper methods of investigation nor the "Detail of the Phaenomena sufficiently copious and regular" exist to allow determination of the exact nature or number of unseen particles (1749, p. 364). Such doubts, however, do not prevent him from supposing that all orders of particles, "perpetually flying off from all Bodies with great Velocity," are responsible for gravity (attractive force), repulsive forces, light, chemical activity and heat (1749, pp. 25, 352-353, 364-365). In all of nature, then, the primary particles are the basic building blocks, so that "larger Particles arise from, and are compounded of, those of the next less in Size, and so on; just as the whole Gravity of the Moon is compounded of the Gravity of all its Parts" (1749, p. 365).

It is not only the corpuscular theory of matter but also the form and method that Hartley adopts from the new science, especially from Newton. The *Observations* is written in a literary form of propositions, demonstrations, corollaries and scholiums patterned after the *Principia* and *Opticks*, and Hartley specifically states his allegiance to Newton's methodology:

> The proper Method of Philosophizing seems to be, to discover and establish the general Laws of Action, affecting the Subject under Consideration, from certain select, well-defined, and well-attested Phaenomena, and then to explain and predict the other Phaenomena by these Laws. This is the Method of Analysis and Synthesis recommended and followed by Sir Isaac Newton. (1749, p. 6)

Like Newton, Hartley also disclaims the use of fictitious hypotheses. Only

[3]For Hartley (1749) natural philosophy is the "Application of the Arts of Mathematics and Logic to the Phaenomena of Natural and Civil History . . . in order to decypher the Laws by which the external World is governed and thereby to predict or produce such Phaenomena as we are interested in" (p. 354). According to Oldfield and Oldfield (1951, p. 371), Hartley's was the first published work in English to use the term 'psychology' in the modern sense.

those hypotheses which are "most comfortable to" and "suit" the phenomena should be used (1749, pp. 341, 345-347). Further, he is not a "system-maker" because he did not "first form a System, and then suit the Facts to it" (1749, p. 11). Hartley, however, is unable to maintain as rigid a Newtonian posture as he might like. He admits that he will not be able to execute the proper methods with accuracy in his subject area because of the "great Intricacy, Extensiveness, and Novelty of the Subject" (1749, p. 6). He also fails to uphold Newton's standards regarding the importance of deriving an hypothesis from the phenomena rather than stressing its explanatory power. Hartley even suggests that the explanatory scope of a theory is a legitimate argument for its validity, regardless of the direct evidence—a statement more Cartesian than Newtonian in nature:

> Let us suppose the Existence of the Aether, with these its properties, to be destitute of all direct Evidence, still, if it serves to explain and account for a great Variety of Phaenomena, it will have an indirect Evidence in its favour by this means. Thus we admit the Key of a Cypher to be a true one, when it explains the Cypher completely: and the Decypherer judges himself to approach the true Key, in proportion as he advances in the Explanation of the Cypher; and this without any direct evidence at all. (1749, p. 15-16)

Hartley's enthusiastic acceptance of the new mechanistic categories and his desire to participate in the victories of the new science are evident in the following statement. The phenomena of nature,

> are carried on by Attractions and Repulsions; and . . . these may be expected to take place in the small descending Orders of Particles, as well as in gross Bodies, and in the biggest component Particles.
> . . . . [T]hese Principles of Attraction and Repulsion of the several kinds, and of Vibrations, are dependent upon, and involved within each other, since this also is agreeable to the Tenor of Nature, as it is observed in the Body, in the Mind, in Science in general . . . . Each Part, Faculty, Principle, etc. when considered and pursued sufficiently, seems to extend itself into the Boundaries of the others, and, as it were, to inclose and comprehend them all.
> . . . . And it would be no Objection . . . that we could not explain, in any definite Manner, how these things are effected, nor put any Limits to the Sizes of decreasing Corpuscles, or their active Powers in respect to each other. Nor would this be to reason in a Circle, more than we argue, that the Heart and Brain, or the Body and the Mind, depend upon each other for their Functions; which are undeniable Truths, however unable we may be to give a full and ultimate Explanation of them . . . . [F]uture Ages may analyse all the Actions of Bodies upon each other, up to a few simple Principles, by making such Suppositions as the Phaenomena shall suggest, and then trying and modelling them by the Phaenomena. At least this is what one is led to hope, from the many simple and easy Solutions of very complex Problems, which have been produced within the last two Centuries. (1749, p. 110)

Hartley's assumptions also extend to the use of efficient causality as the basis of all natural operations, including the production of ideas. He does not ban the idea of final causality as it relates to the idea and revelation of God, but he makes it clear that the investigation for efficient causes should never be

shadowed by final causes. Final causality is relevant to the extent that it merges with efficient causes, but as an explicit source of explanation, final causality is not incorporated into any of Hartley's arguments relating to psychology. It is the physical, corporeal world of particles that produces sensations and ideas in individuals. For Hartley the only source of ideation is the sensory world and the impact of particles upon the body which transfers motion to man: "External Objects, being corporeal, can act upon the Nerves and Brain, which are also corporeal, by nothing but impressing Motion of them (1749, p. 12). The laws that apply to the material particles apply to the human body, since it is composed of the same matter, and to the production of ideas. All the processes of human mentality and activity are absorbed into efficient causes and the relations between particulars located in time and space.

The result of Hartley's focus on matter, motion, and efficient causality is that his explanations of psychological phenomena are telescoped into the view that the numerous and varied kinds of human experience can be accounted for by differences in the intensity (degree), frequency (kind), location (place) and line of direction of matter in motion. The secondary qualities, for example, "are only Modifications of the primary ones" (1749, Part II, p. 60). It is the modifications of matter which produce the appearances of colors in us, and in the vibrations of matter which cause odors and flavors, "one may reasonably suppose, that each sapid and odorous Body excites Vibrations of the same Frequency as those which take place in it before it is tasted or smelt" (1749, p. 42). Hartley offers no explanation of primary and secondary qualities apart from his examination of the qualities of bodies which pertain to each of the senses. Tangible qualities, for example, include "Moisture, Dryness, Softness, with Fluidity, Hardness, Smoothness, Roughness, Motion, Rest, Distance, and Figure" (1749, p. 136). The ideas of qualities like motion, figure and distance are primarily due to vibrations arising from the pressure of matter and corresponding muscular contractions, though comparable ideas gained visually are also crucial. In every case, the qualities of bodies are reduced to the varieties of vibrations of matter transferred to the senses and nerves. Hartley evidently believes that the patterns of all qualities, both primary and secondary, exist in the particles of matter even when they are not sensed, and that the ideas of primary qualities are caused in the same way as the ideas of secondary ones.

It is inherent in the root metaphor of mechanism that one must "get hold" of a phenomenon before it is real, and there is uneasiness about everything that cannot be expressed as a "particular" in a certain time and place. Thus even those aspects of nature which cannot be directly located are assumed to be potentially capable of observation as real "things," if they were only larger or less complex. It is also true for Hartley that if something is not thus "located" and preceded by a direct cause, it has little place in his psychology. Halévy comments on the effects of this philosophy:

> It is an inherent tendency of this philosophy in some sense to materialize thought in order to find for the invisible and intangible psychological phenomenon, some palpable equivalent which can get hold of the methodical observations of the enquirer. The nervous element, for example, may be considered as the sign, or as the cause, or even as the substance of the psychological phenomenon. (1952, p. 439)

It is thus the empiricism, reductionism, atomism, and naturalism, stemming from the categories of the root metaphor of mechanism, which Hartley accepts as his starting point and which he does not question. They are, for him, the true foundations of natural philosophy.

The Doctrine of Vibrations and the Doctrine of Association

Hartley based his psychology on two explanatory concepts: the Doctrine of Vibration and the Doctrine of Association. He considered these as the only principles necessary for an understanding of the entire range of human experience, including sensations, ideas, feelings, and motor activity, or behavior. The Doctrine of Vibrations was developed from Newton's Aether hypothesis and from "Hints concerning the Performance of Sensation and Motion" at the end of the *Principia* and in the *Queries of the Opticks* (Hartley, 1749, pp. 5, 14, 111). Hartley argues that vibratory motion is consistent not only with phenomena in the physical world, such as gravity and electricity, but also with human sensory experience. In fact, he assumes that physical vibrations carried through the nervous system are reliably correlated with, or are parallel to, mental sensations and ideas. Thus:

> if that Species of Motion which we term Vibrations, can be shown, by probable Arguments, to attend upon all Sensations, Ideas, and Motions, and to be proportional to them, then we are at Liberty to make Vibrations the Exponent of Sensations, Ideas, and Motions, or these the Exponents of Vibrations . . . however impossible it may be to discover in what Way Vibrations cause, or are connected with Sensations, or Ideas; i.e. tho' Vibrations be of a corporeal, Sensations and Ideas of a mental Nature. (1749, pp. 33-34)

Further, for Hartley's psychophysical parallelism it does not matter "whether the Motions in the medullary Substance [of the brain] be the physical Cause of the Sensations, according to the System of the Schools; or the occasional Cause, according to Malebranche; or only an Adjunct, according to Leibnitz" (1749, p. 511).

The doctrine of Vibrations relates to the production of both sensations and ideas which are two aspects of mental experience for Hartley. Sensations are internal feelings resulting from direct, external impressions, and ideas are all other internal feelings (1749, p. vii). All ideas are composed of the simple ideas of sensations which are "Copies and Offsprings of the impressions made on the Eye and Ear, in which the same Orders were observed respectively" (1749,

pp. 56-57). The ideas of sensation appear to differ from the sensations because they are fainter copies of the originals. They otherwise resemble the sensations in intensity, time, and place. As Hartley supposes: "Sensations, by being often repeated, leave certain Vestiges, Types, or Images, of themselves, which may be called, Simple Ideas of Sensation" (1749, p. 56). Just as sensations are related to vibrations, so ideas are related to minute vibrations, or vibratiuncles. The vibratiuncles are the vestiges of vibrations, fainter copies, which represent the physical counterparts of mental ideas. The permanency of both vibratiuncles and ideas of sensation depend upon the assumption that repeated stimulations eventually result in permanent impressions. Hartley defends this claim in relation to sensations and ideas:

> Sensations remain for a short time after the Impression is removed; and these remaining Sensations grow feebler and feebler, till they vanish. They are therefore . . . of about the same Strength with Ideas. And it seems reasonable to expect, that, if a single Sensation can leave a perceptible Effect, Trace, or Vestige, for a short time, a sufficient Repetition of a Sensation may leave a perceptible Effect of the same kind, but of a more permanent Nature, i.e., an Idea, which shall recur occasionally, at long Distances of Time, from the Impression of the corresponding Sensation . . . . (1749, p. 57)

The individual particles of sensations and ideas function like their physical counterparts, vibrations and vibratiuncles, in that they cohere into progressively larger and more complex units. In the material world the particles are held together by attractive and repulsive forces operating because of the mechanical effects of the Aether. In the world of human experience, simple sensations and ideas come together because of the "Power of Association," which Hartley turns into a comprehensive law of mental life. He writes:

> The influence of Association over our Ideas, Opinions, and Affections, is so great and obvious, as scarcely to have escaped the notice of any Writer who has treated of these, though the word *Association*, in the particular sense here affixed to it, was first brought into use by Mr. Locke. But all that has been delivered by the Ancients and Moderns, concerning the Power of Habit, Custom, Example, Education, Authority, Party-prejudice, the Manner of Learning the manual and liberal Arts, etc., goes upon this Doctrine as its Foundation, and may be considered as the Detail of it, in various Circumstances. (Hartley, 1749, p. 65)

While it is true that the recognition of associational processes was at least as old as Aristotle, "all that has been delivered by the Ancients and Moderns" was the *fact* of association and not the broad *doctrine* of association (cited in Drever, 1968, p. 18). In fact, for both Locke and Aristotle, it is the active powers of the mind which predominate over any passive, mechanical process of association. It is Hartley who reverses the trend.

Hartley's view of the nature of association resulted from his acceptance of the root metaphor of mechanism. Contiguous associations, simultaneous or successive, are the means by which mental and physical particulars are

mechanically held together and organized. Thus:

> Any Sensation A, B, C, etc., by being associated with one another a sufficient Number of Times, gets such Power over the corresponding Ideas, a, b, c, etc., that any one of the Sensations A, when impressed alone, shall be able to excite in the Mind, b, c, etc., the Ideas of the rest.
>
> Sensations may be said to be associated together, when their Impressions are either made precisely at the same Instant of Time, or in the contiguous successive Instants. We may therefore distinguish Association into two sorts, the Synchronous, and the Successive. (Hartley, 1749, p. 65)

It is the elementary ideas of sensation which come together to form a whole idea of a complex object. For example, the idea of a horse is made up of a multitude of discrete simple ideas of sensation. The idea of a horse is not possible until the simple ideas (such as head, legs, body and tail) are sufficiently associated. Once this has occurred, the law of association states that the presentation of any part of the idea (such as the head) will cause the whole idea to occur. The conditions under which associations take place are limited to connections in time and space; in other words, to the single law of contiguity.

Contiguity is the exclusive law of association because it is Hartley's goal to prove that associations occur not only in the mental sphere, but at the level of material particles as well. Thus it follows that:

> Any Vibrations, A, B, C, etc., by being associated together a sufficient Number of Times, get such a Power over a, b, c, etc., the corresponding miniature Vibrations, that any of the Vibrations A, when impressed alone, shall be able to excite b, c, etc., the Miniatures of the rest. (Hartley, 1749, p. 67)

Contiguity is also critical for Hartley because it refers to events which occur together in time and space and which differ only in terms of frequency, intensity, location and line of direction. It is important for him to limit associations to contiguity in order to remain consistent with the categories of the root metaphor of mechanism which he is anxious to do.

The Implications of Hartley's Psychology

The adoption of the root metaphor of mechanism, on behalf of the new scientific view of the natural world, the desire to be precise, empirical, quantitative, physical and analytical, and the application of a new set of assumptions to the study of man culminate in Hartley's work. It should be noted, however, that this interpretation applies to Part I of the *Observations* and not to Part II which deals with religious and moral issues, such as the truth of the Christian religion, the nature of God, and the conception of good and evil. Hartley hoped to build a rational, scientific foundation in Part I for the improvement of spiritual and moral enlightenment in Part II. But in spite of his

own optimistic hopes and religious commitment, there is little in Part II which depends on Part I (Willey, 1961). The implications of his psychological program can be gained from an evaluation of his contributions to future psychologists: his psychophysiology, associationism, and emphasis on the data of behavior.

Hartley is justifiably recognized as a pioneer in psychophysiology. Descartes also initiated the study of the bodily correlates of mental life, though Hartley's work is both more complete and more systematic. Hartley began from what he believed to be the facts of sensation and ideation and then proposed a physiology which reflected these facts (Klein, 1970). His medical experience and keen observations took him a long way, but as it turned out, the Doctrine of Vibrations was inadequate and too speculative, even for his contemporaries (Coleridge, 1817/1868).[4] In spite of the failings of his particular theory, however, Hartley's efforts ultimately prevailed. He was also able to recognize a number of important aspects of brain and nervous function which give his work a particularly modern tone. For example, his analysis supports the concept of the localization of brain function (vibrations located in different parts of the brain) as well as the opposite tendency for sensations to diffuse throughout the medullary substance (Oldfield and Oldfield, 1951). He also comes very close to stating the idea of specific nerve energies as developed by Johannes Mueller. If the nature and frequency of vibrations in the nerves could be discovered,

> it might also a little unfold to us the different internal Structures of the several Nerves, and of the Parts of the Brain that correspond thereto. For it seems probable to me, that each Nerve and Region is originally fitted to receive, and, as one may say, sympathize with such Vibrations as are likely to be impressed upon them in the various Incidents of Life; and not that the auditory Nerve could perform the Office of the Optic, if put into its Place, or *vice verse* . . . . (Hartley, 1749, p. 42)

Elementarism is surely encouraged by this view, for if each nerve transmits a single sensation then experience must be a plurality of discrete sensations (Hamlyn, 1961).

Elementarism was just one of the implications of Hartley's psychophysiology. The overall effect of his assumptions about the nature of the material world, when translated to his beliefs about body and mind, was to materialize, atomize, and mechanize mental life more extensively than ever before. For Hartley did not maintain the notion of an active consciousness either as immaterial or as possessing inherent ideas of reflection. Samuel Taylor Coleridge was one of the first, if not the only, to offer a critique of Hartley's psychology (Coleridge, 1817/1868). He felt that any conjectural physiology is detrimental to an adequate understanding of the association of ideas; but he

[4]Coleridge says that Haller has shown that the doctrine of vibrations attributes properties to the nerves and brain which are incompatible with their nature.

also recognized that Hartley's account of ideas could not be divorced from his neurology: "For all other parts of his system . . . once removed from their mechanical basis, not only lose their main support, but the very motive which led to their adoption (Coleridge, 1817/1868, p. 227). In other words, as long as Hartley is committed to explaining ideas according to the laws of matter and motion, his physiology is essential to his system. Coleridge was also critical of Hartley's argument that association can occur in vibrating particles. Why, for example, should material nerves acquire a disposition to a particular vibration any more than a weather-vane acquires a "habit of turning to the east, from the wind having been so long in that quarter" (Coleridge, 1817/1868, p. 227).

It is in relation to Hartley's associationism that he has received the most attention, for his physiological theories were frequently ignored.[5] However, the assumptions which pervaded his physiology also limited the ways in which the association of ideas was conceived. For example, Hartley reduced the laws of association to the single law of contiguity (successive and simultaneous associations), and this was because of his physicalism. As Coleridge remarks:

> For to what law can the action of material atoms be subject, but that of proximity in place? And to what law can their motions be subjected, but that of time? Again, from this results inevitably, that the will, the reason, the judgment, and the understanding, instead of being the determining causes of association, must needs be represented as its creatures, and among its mechanical effects. (1817/1868, p. 228)

Hartley's acceptance of the categories of the root metaphor of mechanism also sustained the basic assumption that experience is built up from discrete sensations which are the fundamental realities of perception. The implications of this belief are that all ideas can be reduced to elementary parts, and ultimately to the physical "parts" of the natural world. The result of this philosophy, Coleridge concludes, is that:

> The sum total of my moral and intellectual intercourse, dissolved into its elements, is reduced to extension, motion, degrees of velocity, and these diminished *copies* of configurative motion, which form what we call notion, and notion of notions. (1817/1868, p. 233)

Under these conditions, the relational qualities among ideas, the development of meaning and the perceived qualitative differences between ideas, are aspects of experience which are deemphasized. Further, as Coleridge says, if the will and reason are the products of mechanical causes, "*any* part of any impression might recall any part of any other, without a cause present to determine what it should be. For to bring in the will, or reason, as causes of their own cause, that is, as at once causes and effects, can satisfy only those who . . . having first

[5]For example, by Joseph Priestley, James Mill and Erasmus Darwin.

demanded organization, as the sole cause and ground of intellect, will then cooly demand the pre-existence of intellect, as the cause and ground-work of organization" (1817/1868, p. 229).

There is one other area in which Hartley's associationism prepared the way for the future. He extended the doctrine of association not only to all ideas but to motions and movement as well. Hartley conceived of the individual as a creature who begins life responding passively to external stimulation. It is possible that he thought of the natural vibrations as inborn movement potential, but as soon as a movement occurs it quickly comes under the control of associated sensations, ideas and other motions. The association of bodily movements as an explanation of voluntary behavior and habits was instrumental in creating the later emphasis on the data of behavior. For if external associations can account for all a person does, it is not difficult to forget internal associations of ideas and to claim that the ideas themselves have little or nothing to do with the way a person acts.

In the future, Hartley's physiology, associationism and religious views would not be maintained in their integrity. First, the religious parts were split off as irrelevant to the rest of the work. This in itself is a significant sign of the direction psychology was heading. The association of ideas, without the physiology, was important to some, like Joseph Priestley and James Mill. In this case the doctrine of association was identified with ideas, and Hartley's application of association to motion and behavior was ignored. For others, however, Hartley's associational motor theory was retained as the object of interest, especially for those who maintained physiological interests, such as Erasmus Darwin and Johannes Mueller. Through Darwin and Mueller, Hartley's analysis of the association of motions was sustained until it was rejoined with sensationistic associationism in the work of Alexander Bain, almost a hundred years later. Bain's reintroduction of the primacy of motion along with associationism began the trend which led to the modern application of the root metaphor of mechanism in behaviorism. Hartley, however, had already spoken to the methods, assumptions, and direction that psychological study would travel. In this regard, the assumptions of the root metaphor of mechanism had reached their culmination in Hartley.

An awareness of the role of metaphor enhances an historical analysis of mechanistic assumptions which grew from the Scientific Revolution into psychology. The study of these assumptions in the psychology of Hartley highlights their transition into psychology and calls attention to the ways in which root metaphors can be taken for granted. The dominant root metaphor of mechanism in contemporary psychology, while it may help psychology to gain favor with physicists and biologists, has limited the kinds of data, methods, terms and aims deemed acceptable in the study of man. The fact that the mechanism metaphor has been widely accepted does not invalidate the need to examine its origins and effects on psychology. If the historical review

of the development of a particular root metaphor reveals that it has become myth, the realization should offer greater opportunity for other hypotheses. In particular, the historical investigation of the root metaphor of mechanism should heighten our awareness of its existence and cause us to question its relevance to psychology. It should also call attention to the fact that history itself is written from the outlook of certain assumptions, and that knowledge of present assumptions can help achieve valuable historical perspective.

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