

## Guest editorial

### The persisting vision of David Hartley (1705–1757)

*“The sensations remain in the mind for a short time after the sensible objects are removed. This is sufficiently evident in things visible and audible; one may infer it by analogy in other senses.”* (Hartley 1959, page 2, original italics)

David Hartley (figure 1), who was born three hundred years ago, sought to unite the physical and psychological worlds by means of a speculative neurophysiology. His sources of inspiration were Newton’s theory of vibrations, Locke’s principle of association, and a host of perceptual phenomena. He also drew heavily on Berkeley’s sensory-motor theory of vision.



**Figure 1.** David Hartley (1705–1757) after a frontispiece engraving by William Blake in Hartley (1791).

Hartley proposed that sensations enter into the nervous system as vibrations (matter in motion) which give rise to localised vibrations in the brain: *“External Objects impressed upon the Senses occasion, first in the Nerves on which they are impressed, and then in the Brain, Vibrations of the small, and, as one may say, infinitesimal, medullary Particles”* (1749, page 11, original italics). It was vital for his theory that these vibrations could persist after the external object had been removed, so that they could function as the physical substrate for our ideas. Hence the importance of the phenomena alluded to in the quotation at the head of this editorial. Hartley described three visual phenomena that provided evidence for what was Proposition 3 in his theory.

The first was Newton's description of a whirling ember being visible as a circle, given in the second edition of his *Opticks* (Newton 1718). Hartley paraphrased Newton's account with emphasis on the parts important to his own theory:

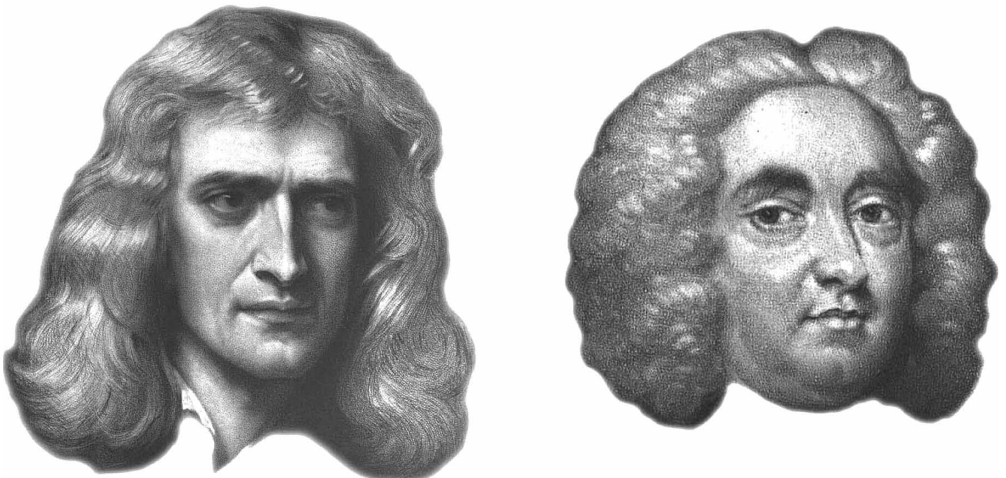
“If a burning Coal be nimbly moved round in a Circle, with Gyration continually repeated, the whole Circle will appear like a Fire; the Reason of which is, that the Sensation of the Coal, in the several Places of that Circle, *remains impressed on the Sensorium*, until the Coal return again to the same Place. And so in a quick Consecution of the Colours’ (*viz.* Red, Yellow, Green, Blue, and Purple, mentioned in the Experiment, whence this Passage is taken) ‘the Impression of every Colour *remains on the Sensorium*, until a Revolution of all the Colours be completed, and the first Colour return again. The Impressions therefore of all the successive Colours, *are at once in the Sensorium*— and beget a Sensation of White.’” (Hartley 1749, page 9, italics added by Hartley)

Thus the small vibrations or vibratiuncles could continue after the source of stimulation was no longer present. The second phenomenon was the visibility of an afterimage following prolonged observation of a candle flame. Later in the book, Hartley gave a slightly fuller description of afterimages: “Upon shutting one’s Eyes after they have been fixed upon a luminous Object, as a Candle, a Fire, a Window, it is common to have a faint Image of the Object remain in the Eye for a few Moments. This follows from the gradual Declension of the Vibrations excited” (Hartley 1749, page 199). The third phenomenon was Newton’s account of seeing “a Circle of Colours like those in the Feathers of a Peacock’s Tail” (1718, page 137) when pressure was applied by a finger to the corner of the eye. Hartley elaborated on this:

“Flashes of Light, and other luminous Appearances, are occasioned by Strokes upon the Eye, rubbing it, Faintings, &c. Now it is very easy to conceive, that violent Agitations in the small Particles of the Optic Nerve should arise from such Causes; and consequently that such Deceptions of Sight, as one may call them, should be produced, if we admit the Doctrine of Vibrations... The most remarkable of these luminous Appearances is that which resembles the Eye of a Peacock’s Feather, and which offers itself upon shutting and rubbing the Eye in a Morning.” (1749, page 198)

Although such persisting images were not restricted to vision, the examples given for other senses were meagre.

The first edition of Newton’s *Opticks* had been published the year before Hartley was born, and he was very much a child of the Newtonian age (see Allen 1999). Isaac Newton (figure 2, left) sought to provide a mechanistic account for physical nature;



**Figure 2.** Left, Isaac Newton (1642–1727) and right, George Berkeley (1685–1753), both after engravings in Wood (1880).

Hartley applied the same ideas to biological life in general and to that of humanity in particular. He realised that the principles set forth in Newton's *Queries* in his *Opticks* and in his *Principia* could serve, not only as a framework for interpreting physical events, but also for explaining the neurophysiological basis of perception and thought. In the final paragraph of *Principia* Newton wrote:

"... all sensation is excited, and the members of animal bodies move at the command of the will, namely, by the vibrations of this Spirit, mutually propagated along the solid filaments of the nerves, from the outward organs of sense to the brain, and from the brain into the muscles. But these are things that cannot be explained in few words, nor are we furnished with that sufficiency of experiments which is required to an accurate determination and demonstration of the laws by which this electric and elastic Spirit operates." (Newton 1803, page 314)

Hartley's theory was expressed in his book *Observations on Man, his Frame, his Duty, and his Expectations. In Two Parts*, published in 1749. It is the first volume, concerned with the human frame, that is of most interest here. It provides the basis for his theory of vibrations and associations and applies them to perception and thought:

"My chief Design in the following Chapter, is, briefly, to explain, establish and apply the Doctrine of *Vibrations* and *Associations*. The First of these Doctrines is taken from the Hints concerning the Performance of Sensation and Motion, which Sir *Isaac Newton* has given at the End of his *Principia*, and in the *Questions* annexed to his *Optics*; the Last, from what Mr. *Locke*, and other ingenious Persons since his Time." (Hartley 1749, page 5)

Hartley was born at Illingworth, near Halifax, Yorkshire, on June 21, 1705. He seems to have developed an interest in the mind at an early age, since his daughter later reminisced:

"I am inclined to think that ... the intention of writing a book upon the nature of man was conceived in his mind, when he was a *very little boy*. He was not a boasting man, nor ever spoke an untruth; but in many conversations that I have had with him about his book, he has told me, that when he was so little as to be swinging backwards and forwards upon a gate, (and, I should suppose, not above nine or ten years old,) he was meditating upon the nature of his own mind; wishing to find out how man was made; to what purpose, and for what future end." (Warner 1817, pages 92–93, original italics)

He received his secondary education at Bradford Grammar School, then studied mathematics, classics, and divinity at Cambridge University, becoming a fellow of Jesus College from 1727 until his marriage three years later. He was expected to follow in his father's footsteps and become an Anglican clergyman. His refusal to sign the Thirty-nine Articles resulted in him abandoning this plan and, without any specific medical training, he became a physician, practicing at Newark, Bury St Edmunds, London and finally Bath. By the account of his son, he became a good and caring physician: "He exercised the healing art with anxious and equal fidelity to the poor and to the rich. He visited, with affectionate sympathy, the humblest recesses of poverty and sickness, as well as the stately beds of pampered distemper and premature decrepitude" (Hartley 1791, page ii). His steady mastery of medicine informed the theory of human nature he was to write, and in *Observations* he provided a survey of contemporary knowledge regarding perception. However, he reflected upon this rather than adding to it by means of experimental enquiries.

Hartley's ideas on perception and motion were presented in skeletal form a few years before they were fleshed out in *Observations*. They were published in Latin as an addendum to the second edition of his treatise on a treatment for kidney and bladder stones proposed by Joanna Stephens (Hartley 1746). The *Various Conjectures on the Perception, Motion, and Generation of Ideas* were not translated into English until over

two hundred years later (Hartley 1959). In both the *Conjectures* and in the *Observations* Hartley outlined his basic argument which assumed that memory images could be conceived as smaller-scale vibrations (vibratiuncles) in the same regions of the brain as the original sensory experience: “These Vibrations are backwards and forwards of the small Particles; of the same kind with the Oscillations of Pendulums, and the Tremblings of the Particles of sounding Bodies” (1749, page 11). Since these vibrations could become associated by contiguity, they could link up to represent compound ideas (see Allen 1999; Wilkes and Wade 1997).

Another influence on Hartley was George Berkeley (figure 2, right) whose *Essay Towards a New Theory of Vision* was published in 1709. Like Berkeley, and many philosophers before him, Hartley held that touch was the fundamental source of information to integrate the senses. This was evident from the order in which the senses were surveyed in *Observations*; feeling was first, followed by taste, smell, sight, and hearing. If there is conflict between touch and sight “we always depend upon Touch” (1749, page 138). This was considered to be so, in large part, because touch was not thought to be as readily deceived as vision: “we call Touch the Reality, Light the Representative” (page 138). This point is delightfully amplified in the context of pictures deceiving the eye:

“Thus, the Picture of a Knife, drawn so well as to deceive his Eye, would not when applied to another Body, produce the same Change of visible Impressions, as a real Knife does, when it separates the Parts of the Body thro’ which it passes. But the Touch is not liable to these Deceptions. As it is therefore the fundamental Source of Information in respect of the essential Properties of Matter, it may be considered as our first and principal Key to the Knowledge of the external World!” (page 138)

It is a strange irony that Hartley’s system was built upon an illusion of vision (visual persistence) and yet he used other visual illusions to subjugate vision to touch! Nonetheless, he was well aware of the power of visual images in forming and retaining memories: “It is probable, that Fables, Parables, Similes, Allegory, &c. please, strike and instruct, chiefly on account of the visible Imagery, which they raise up in the Fancy. They are also much more easily remembered on the same Account” (1749, page 214). Hartley adopted a Berkeleyan view of how visual size, distance and orientation are determined:

“Where the Picture on the *Retina* is of a just Size, and also the previous Judgment concerning Distance just, our Estimate of tangible Magnitude by Sight will be just likewise. But if the Picture on the *Retina* be magnified or diminished by Glasses, or our previous Judgment concerning the Distance be erroneous, our Estimate of tangible Magnitude will be erroneous in like manner.... The principal Criterion of Distance is the Magnitude of the Picture, which some known Object makes on the *Retina*. But the five following associated Circumstances seem to have also some Influence on our Judgments concerning Distance, in certain Cases, and under certain Limitation: The Number of Objects which intervene, the Degree of Distinctness in which minute Parts are seen, the Degree of Bigness, the Inclination of the Optic Axes, and the Conformation of the Eye.... The Position of Objects is judged intirely by the Part of the *Retina* on which the Rays fall, if we be in an erect Posture ourselves. If we be not, we allow for our Deviation from it, or make Reference to something judged to be in an erect Posture. If we fail in these, Errors concerning the Position of visible Objects must happen. Our calling Bodies *erect*, when the Rays proceeding from their Tops fall upon the lower parts of the *Retina*, and *vice versa*, is merely from Association of the same Kind with those by which the Senses of other Words are determined.” (Hartley 1749, pages 200–204, original italics)

Hartley’s influence on subsequent psychology was principally through his systematic application of the principles of association (see Allen 1999; Buckingham and Finger 1997). It influenced Erasmus Darwin (1731–1802) in his psychology and medicine as expressed in *Zoonomia* (Darwin 1794, 1796). Hartley’s theory of vibrations has been neglected in

comparison. When Joseph Priestley (1733–1804) reprinted an abridged version of the *Observations* as *Hartley's Theory of Mind* (Priestley 1775) the theory of vibrations was omitted. C U M Smith (1987) has suggested that “the Hartleyan vibration theory was too far ahead of its time to have a direct influence on the progress of neurophysiology” (page 132), but its indirect influence was profound.

The impact of Hartley's *Observations* on perception has been more long-lasting, primarily through his sensory-motor theory. Indeed, he described a range of phenomena that were taken to support this close integration between sensation and action. They tended to be in the areas of the development of binocular single vision. For example, he remarked that “new born Children move their Eyes in a congruous Manner; that the Motions are chiefly to the Right and Left, scarce upwards and downwards at all” (page 216), but then speculated on the causes of squinting:

“The Circumstances which occasion Squinting in young Children, agree well with the Theory proposed here. Thus, if a Child be laid so into his Cradle, as that one Eye shall be covered, the external Influences of Light cannot operate upon it. And if this be often repeated, especially while the Association which confirms the Congruity of the Motions is weak, the Eye which is covered will obey the Influences which descend from the Brain, and turn upwards and inwards for the most part. What turns the Scale in favour of this Position, remains to be inquired... The persons who squint, preserving the Sight of the squinting Eye, are obliged to move their Eyes in a congruous manner.” (pages 218 and 221)

If the onset of strabismus occurs in adulthood then double vision results, but “this ceases, and he gains the Power of seeing single again, provided the Distortion remains fixed to a certain Degree. For the Association between Points of the two *Retina's*, which corresponded formerly, grows weaker by degrees; a new one also between Points that now correspond, takes place, and grows stronger perpetually” (1749, pages 205–206). In these respects, Hartley based his assessment on the writings of Robert Smith (1689–1768; 1738) and James Jurin (1684–1750; 1738) as well as Berkeley.

Hartley founded his theory on the phenomenon of visual persistence but the ideas of vibrations in the nerves did not themselves persist. The concept was important because it reflected a change in the view of nerve function from the flow of the animal spirit through hollow tubes to mechanical vibrations within solid nerves. Interest in the electrical properties of torpedo fish was growing in Hartley's day, and he mentioned the numbness produced by touching them:

“For the Oscillations of this Fish's Back may neither be isochronous in themselves, nor suitable to those which existed previously in the Hand; and yet they may be so strong, as not only to check and overpower those in the Part which touches the Fish, but also to propagate themselves along the Skin, and up the Nerves, to the Brachial Ganglion, and even to the Spinal Marrow and Brain; whence the Person would first feel the stupefaction ascend along the Arm to the Shoulder, and then fall into a Giddiness, and general Confusion, as is affirmed to happen sometimes. Some Effects of Concussions of the Brain, and perhaps Spinal Marrow, also of being tossed in a Ship, of riding backwards in a Coach, and other violent and unusual Agitations of the Body, seem to bear a Relation to the present Subject.” (Hartley 1749, page 133)

Unfortunately, Hartley continued “it would be too minute to pursue these things” (page 133). Some, like John Walsh (1725–1795; 1773), did pursue them and by the end of the eighteenth century, the possibility of electrical action within the nerves was being entertained by Luigi Galvani (1737–1798) and others (see Piccolino 1997).

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