Other dimensions, other worlds

In "The Postulates of the Science of Space," a lecture delivered in 1874 and published the following year in *The Contemporary Review*, Clifford begins by humbly paying homage to a book that "has been for nearly twenty-two centuries the encouragement and guide of that scientific thought which is one thing with the progress of man from a worse to a better state."[1] This vital book is Euclid's *Elements*, the foundational text of geometry as well as "the inspiration and the aspiration of scientific thought," since "the aim of every scientific student of every subject was to bring his knowledge of that subject into a form as perfect as that which geometry had attained."[2] But what begins as a tribute to Euclid soon turns into a eulogy of sorts, though one without a note of sadness. By the 1870s the foundational premises of Euclidean geometry had convincingly been challenged by a number of prominent mathematicians, and Clifford elatedly describes the break from the Euclidean paradigm as a new Copernican revolution: "[T]he transcendent importance of these two changes is that they are changes in the conception of the Cosmos."[3] Dubbing the Russian mathematician Nicolai Lobachevskii the new Copernicus of geometry, Clifford explains that what the shift from Euclidean to non-Euclidean concepts of space means is that space which we cannot observe is space about which we can say nothing: "knowledge of Immensity and Eternity is replaced by knowledge of Here and Now." Geometry may still be the model and inspiration for all exact sciences, but its purview is not unlimited. "The geometer of to-day," Clifford writes, "knows nothing about the nature of actually existing space at an infinite distance; he knows nothing about the properties of this present space in a past or a future eternity."[4]

Yet Clifford arguably does not go far enough. For non-Euclidean geometry declines to make definitive pronouncements, not only about eternity and infinity, but also about the nature of the space inhabited by our bodies. This position was crystallized in the 1880s when mathematicians such as Henri Poincaré argued that, whether Euclidean or

non-Euclidean, geometry does not (or should not) concern itself with space as it actually is, but simply with the consistency of its theorems and axioms. "[T]he word 'existence' has not the same meaning when it refers to a mathematical entity as when it refers to a material object," Poincaré explains. Unlike physical objects, "[a] mathematical entity exists provided there is no contradiction implied in its definition, either in itself, or with the propositions previously admitted."[5] Moreover, what Clifford did not anticipate is that non-Euclidean geometry, much like the ether, would occasion not an implosion of knowledge to Here and Now but instead an explosion of speculations about spaces and dimensions other than those we know – and which, it was argued, were the key to accessing the world of spirits. Before we proceed to spirits, though, we should acquaint ourselves with some of the basic ideas of non-Euclidean geometry.

Lobachevskii's seminal contribution was to demonstrate that Euclid's infamous fifth postulate, involving parallel lines, cannot be proved within the Euclidean system, and, furthermore, that an alternate, entirely consistent geometry can be developed alongside the Euclidean one. The fifth postulate states: "That, if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than two right angles."[6] In the somewhat simpler terms of the Playfair axiom: "*Through a given point only one parallel can be drawn to a given straight line* or, *Two straight lines which intersect one another cannot both be parallel to one and the same straight line*."[7] Another formulation, derived from the Playfair axiom, is that the sum of the angles in a triangle is invariably equal to 180°, or the sum of two right angles.[8] In his article "On the Principles of Geometry," published in 1829 in the *Kazan Messenger*, Lobachevskii demonstrated that, presuming the fifth postulate inoperative, an infinite number of straight lines can be drawn passing through a point outside a given line and that all the lines thus derived will be parallel to each other. Differently put: an infinite number of intersecting lines can be drawn parallel to a given line, one consequence being that the sum of the angles in a triangle is less than 180°.

Clifford cites Lobachevskii as the inventor of non-Euclidean geometry, yet the Hungarian mathematician János Bolyai had independently obtained the same results in 1829, although he did not publish them until 1832 (his "The Science of Absolute Space"[9] appeared as an appendix to his father Wolfgang's mathematical treatise *Tentamen*). Historians consider Lobachevskii and Bolyai to have invented non-Euclidean geometry

simultaneously, though Lobachevskii may have the greater claim to first place as he published his work before Bolyai. The famous German mathematician Carl Friedrich Gauss would have beaten both Lobachevskii and Bolyai, however, had he dared to go public with his own non-Euclidean geometry, which he had developed as early as 1824. When Wolfgang mailed Gauss an advance copy of the *Appendix*, Gauss wrote back to congratulate the son, albeit somewhat peevishly: "If I begin with the statement that I dare not praise such a work, you will of course be startled for a moment: but I cannot do otherwise; to praise it would amount to praising myself; for the entire content of the work, the path which your son has taken, the results to which he is led, coincide almost exactly with my own meditations which have occupied my mind for from thirty to thirty-five years." Gauss ends the letter by magnanimously stating that he is "overjoyed that it happens to be the son of my old friend who outstrips me in such a remarkable way."[10]

Mathematicians had for centuries treated the parallel postulate as an embarrassing complication in what is otherwise an elegant, consistent system; Jean Le Rond d'Alembert exasperatedly called it "l'écueil et le scandale des élémens de Géométrie."[11] All attempts to prove the postulate had failed, yet this was not regarded as an indication that there was something questionable about the rest of the *Elements* or even that the postulate, frustratingly resistant to proof, might be false.[12] "Though there never were a circle or triangle in nature," David Hume asserted in *An Enquiry Concerning Human Understanding* (1748), "the truths, demonstrated by EUCLID, would for ever retain their certainty and evidence."[13] But the postulate, as Hans Reichenbach observes, is fundamentally suspect: "At first glance the axiom appears to be self-evident. There is, however, something unsatisfactory about it, because it contains a statement about infinity; the assertion that the two [parallel] lines do not intersect within a finite distance transcends all possible experience."[14] Proof for the parallel postulate cannot be derived from experience because parallel lines cannot be followed into infinity to make sure that they keep their distance from each other. There is always the possibility that, if we were to pursue them far enough, they will at some point start converging or diverging. Euclid's space is flat and infinite: the kind of space in which a straight line will continue on its trajectory into infinity. Lobachevskii and Bolyai showed that space may in fact be curved – or that mathematically constructed spaces and physical space need not be identical. In any case, a space of constant negative curvature (shaped like a saddle, and on which movement in any direction is uninterrupted) can be constructed in which the parallel postulate is false but the others remain valid.

The next pivotal contribution came from the German mathematician Georg Friedrich Bernhard Riemann, who showed that Lobachevskii's hyperbolic space of constant negative curvature is not the only alternative to Euclid's parabolic geometry of zero curvature space. In "Über die Hypothesen, welche der Geometrie zu Grunde liegen," a lecture delivered in 1854 at the University of Göttingen as his *Habilitationsschrift* and published in 1867, Riemann made the crucial distinction between finite/infinite and bound/boundless space, and formulated an elliptic geometry of constant positive curvature in which space is finite yet boundless. Shaped like a sphere, in contrast to the pseudo-spherical constructions of Lobachevskii and Bolyai, such space is said to be finite because the surface of the sphere does not extend into infinity; it is boundless, however, because an object moving along the surface of the sphere will never reach the end of the surface. Whereas in Lobachevskii's and Bolyai's negative curvature space an infinite number of parallel lines are possible and the sum of the angles in a triangle is less than 180°, in Riemannian space there are no parallel lines and the sum of the angles is greater than 180°. With Riemann it became clear that instead of one non-Euclidean geometry there were at least two equally viable alternatives, both of which suggested that the *Elements* needed reconsideration and that the very notion of a geometric axiom is deeply problematic.

Non-Euclidean geometry was not a resounding success in Britain, in part because of the language barrier but mostly because Euclid was unanimously regarded as infallible.[15] A major step forward was made in 1873 when Clifford published his translation of Riemann's article in *Nature*[16] and the following year delivered a series of lectures on Riemann at the Royal Institution. More influential in spreading the word on Riemann were the articles that Helmholtz published in British scientific journals in the 1870s. Helmholtz found non-Euclidean geometries serviceable to promoting his empiricist agenda and disproving intuitionism.[17] In "The Origin and Meaning of Geometrical Axioms," an 1876 article for *Mind* (originally a lecture delivered in Heidelberg in 1870 and published that year in *The Academy*),[18] Helmholtz argues that Kant was mistaken in claiming that geometric axioms are synthetic *a priori*. In the *Critique of Pure Reason* Kant had argued that "*mathematical propositions, properly so called, are always judgments* a priori*, and not empirical, because they carry along with them necessity, which can never be deduced from experience.*"[19] Helmholtz is suspicious of such assumptions because we cannot be sure whether what we seem to grasp intuitively might not in fact be derived from experience.

The parallel postulate, which "has called forth a great number of seeming demonstrations" ("OM," p. 302),[20] is a case in point:

The main difficulty in these inquiries is and always has been the readiness with which results of everyday experience become mixed up as apparent necessities of thought [*scheinbare Denknothwendigkeiten*] with the logical processes, so long as Euclid's method of constructive intuition is exclusively followed in geometry. In particular it is extremely difficult, on this method, to be quite sure that in the steps prescribed for the demonstration we have not involuntarily and unconsciously [*unwillkürlich und unwissentlich*] drawn in some most general results of experience, which the power of executing certain parts of the operation has already taught us practically. ("OM," p. 302)

Euclid's method is founded on the assumption of the congruence of geometrical figures: "The foundation of all proof by Euclid's method consists in establishing the congruence of lines, angles, plane figures, solids, &c. To make the congruence evident, the geometrical figures are supposed to be applied to one another, of course without changing their form and dimensions." But "this assumption of the free translation of fixed figures with unchanged form to every part of space," Helmholtz maintains, is not a matter of *a priori* necessity, as it can be shown that "every proof by congruence rests upon a fact which is obtained from experience only" ("OM," p. 303) rather than from an intuitive understanding of space.

Helmholtz illustrates his argument with an analogy that would quickly inspire both scientists and spiritualists to speculate on other kinds of space as well as other dimensions – and the intelligent beings who may inhabit them:

Let us, as we logically may, suppose reasoning beings of only two dimensions to live and move on the surface of some solid body. We will assume that they have not the power of perceiving anything outside this surface, but that upon it they have perceptions similar to ours. If such beings worked out a geometry, they would of course assign only two dimensions to their space. They would ascertain that a point in moving describes a line, and that a line in moving describes a surface. But they could as little represent to themselves [*eine Vorstellung machen können*] what further spatial construction would be generated by a surface moving out of itself, as we can represent what would be generated by a solid moving out of the space we know. ("OM," p. 303)

If such beings inhabited an infinite plane, "their geometry would be exactly the same as our planimetry." They would hold it as axiomatic "that only one straight line is possible between two points, that through a third point lying without this line only one line can be drawn parallel

to it, that the ends of a straight line never meet though it is produced to infinity, and so on." If we presume, on the other hand, that their world is not flat but a sphere, such as Riemann's space of positive curvature, one axiom of their geometry would be that no parallel lines can be drawn and that the "shortest or straightest line between two points … [is] an arc of the great circle passing through them" ("OM," p. 304), i.e. a geodetic line. This and all other axioms would not be the result of intuitive judgments but of experience, although the axioms might appear to possess universal validity and necessity. Moving now from flat or curved two-dimensional space to our space of three dimensions, we can see how the same mistake is made when we suppose that the axioms of Euclidean geometry are the result of an intuitive grasp of space, and how, rather than being universal and necessary, "geometrical axioms must vary according to the kind of space inhabited" ("OM," p. 305). Non-Euclidean geometry is a welcome contribution to the philosophy of science and general epistemology because it shows us that "if we can imagine such spaces of other sorts" (if such spaces are conceivable, *vorstellbar*), as is clearly the case, then "it cannot be maintained that the axioms of geometry are necessary consequences of an *a priori* transcendental form of intuition, as Kant thought" ("OM," p. 314).[21]

Yet if we can imagine and construct mathematical models of spherical and pseudo-spherical alternatives to Euclid's flat space, this does not mean that we are also able to imagine a space of four dimensions – just as the inhabitants of a plane cannot imagine a space in which objects have length, width, and breadth. What the inhabitants of each space can represent (*vorstellen*) to themselves is confined by what they can experience. As a hard-line empiricist, it is critical for Helmholtz to distinguish the imaginable spaces of Lobachevskii and Riemann (which demonstrate that the Euclidean axioms are experientially derived) from the unimaginable, unrepresentable space of four dimensions:

By the much abused expressions "to represent" ["*sich vorstellen*"] or "to be able to think how something happens" ["*sich denken können, wie etwas geschieht*"] I understand – and I do not see how anything else can be understood by it without loss of all meaning – the power of imagining the whole series of sensible impressions [*sinnlichen Eindrücke*] that would be had in such a case. Now as no sensible impression is known relating to such an unheard-of event as the movement to a fourth dimension would be to us, or as a movement to our third dimension would be to the inhabitants of a surface, such a "representation" ["*Vorstellung*"] is as impossible as the "representation" of colours would be to one born blind, though a description of them in general terms might be given to him. ("OM," p. 304)

Just as a blind person cannot form a *Vorstellung* of colors, no matter how vividly we describe them to him or her, so too are we constitutionally blind to a fourth dimension of space. Helmholtz is adamant about this and underscores the impossibility of our visualizing more than three dimensions:

Inhabiting a space of three dimensions and endowed with organs of sense for their perception, we can represent to ourselves the various cases in which beings on a surface might have to develop their perception of space; for we have only to limit our own perceptions to a narrower field. It is easy to think away [*wegdenken*] perceptions that we have; but it is very difficult to imagine [*sinnlich vorstellen*] perceptions to which there is nothing analogous in our experience. When, therefore, we pass to space of three dimensions we are stopped in our power of representation [*Vorstellungsvermögen*] by the structure of our organs and the experience got through them which correspond only to the space in which we live. ("OM," p. 308).

Thus Helmholtz seems to want to have it both ways with the imagination (*Vorstellungskraft*), and power of imagination (*Vorstellungsvermögen*), which is at once summoned to tear down nativist and intuitionist arguments, and severely restricted to a combinatory exercise in which we reshuffle the building blocks of experience to form mental representations of alternate spatial models. The imagination is powerful enough to enable us to conceive, in perceptual terms, what it would be like to inhabit a space of only two dimensions, and "represent to ourselves the look of a pseudospherical world" ("OM," p. 318), but, because conditioned by experience and limited by the physiology of our sense organs, it cannot take us into a four-dimensional world. Since a fourth dimension "is not merely a modification of what we have but something perfectly new, we find ourselves by reason of our bodily organisation quite unable to represent a fourth dimension" ("OM," p. 319).[22]

Scientists regularly use vivid analogies to illustrate and clarify complex propositions. In the case of Helmholtz's plane and sphere dwellers, the analogy did much more in the long run than simply package a complicated idea in a way that made it understandable to non-specialists.[23] Despite his warning about confusing the imaginable and the unimaginable, in popular culture the multi-world analogy operated as bonding agent between non-Euclidean and what are called *n*-dimensional geometries (of more than three dimensions), and spurred interest in considering ways to apprehend the fourth dimension. For who is to say what is or is not imaginable (*vorstellbar*)? Not only is imaginability a matter of individual capabilities, but the concept, as Helmholtz deploys it, hinges on a

dubious, exclusionary definition: the ability mentally to construct a "series of sensible impressions" ("OM," p. 304). But to imagine something can also mean to speak about it in some fashion, to speculate on the nature and properties of a thing, without necessarily forming a mental image of it. In this regard, the fourth dimension – as well as a fifth, sixth, and so on – is very much imaginable.

Not only is the fourth dimension imaginable in this alternate sense of the word, but, as Poincaré for one believed, one might actually be able to get a glimpse of four-dimensional objects. We should first note that Poincaré's major contribution to geometry was to cut its Gordian knot: which mathematical space, the Euclidean or one of the non-Euclidean versions, corresponds to the space we inhabit? Starting from the premise that "every deductive science, and geometry in particular, must rest upon a certain number of indemonstrable axioms,"[24] Poincaré argues that the question of veracity is meaningless, as the axioms of geometry are neither *a priori* synthetic judgments, as Kant had believed, nor, as Helmholtz maintained, derived from experience. In an 1887 article, "Sur les hypothèses fondamentales de la géométrie," Poincaré reasons:

One may now ask what these hypotheses [axioms] are. Are they experimental facts, analytic judgments or synthetic *a priori* judgments? We must respond negatively to these three questions. If these hypotheses were experimental facts, geometry would be subject to unceasing revision and would not be an exact science; if they were synthetic *a priori* judgments or, even more, analytic judgments, it would be impossible to remove one and establish a system on its negation.[25]

This removal and negation had occurred via non-Euclidean geometry, so that what are called geometric axioms are best understood as *conventions*. This is not to say, however, that a set of axioms is chosen randomly: "the observation of certain physical phenomena … accounts for the choice of certain hypotheses among all possible ones." Still, "the group chosen is only more convenient than the others and one cannot say that Euclidean geometry is true and the geometry of Lobachevsky is false any more than one could say that cartesian coordinates are true and polar coordinates are false."[26] As he later phrased it in "Les Géométries non euclidiennes" (1891), to ask "Is Euclidean geometry true?" is to pose a meaningless question. "We might as well ask if the metric system is true, and if the old weights and measures are false … One geometry cannot be more true than another; it can only be more convenient."[27]

Poincaré's "Sur les hypothèses fondamentales de la géométrie" and "Les Géométries non euclidiennes" were collected in *La Science et l'hypothèse* (1902), which also includes a more daring and controversial piece, "L'Espace

et la géometrie," first published in 1895. Here Poincaré recycles Helmholtz's multi-dimensional analogy but hints that perceiving four-dimensional objects is indeed possible if we put our minds – and eyes – to it:

> Let us begin with a little paradox. Beings whose minds were made as ours, and with senses like ours, but without any preliminary education, might receive from a suitably-chosen external world impressions which would lead them to construct a geometry other than that of Euclid, and to localise the phenomena of this external world in a non-Euclidean space, or even in space of four dimensions. As for us, whose education has been made by our actual world, if we were suddenly transported into this new world, we should have no difficulty in referring phenomena to our Euclidean space. Perhaps somebody may appear on the scene some day who will devote his life to it, and be able to represent to himself the fourth dimension.[28]

Perception, Poincaré maintains, can be enhanced by training: "Just as we have pictured to ourselves a non-Euclidean world, so we may picture a world of four dimensions."[29] His mathematical conventionalism and perceptual relativism rest on the assumption that there is a substantial difference between geometric and perceptual space. Geometric space is considered to be continuous, infinite, three-dimensional, homogeneous, and isotropic; perceptual space, he maintains, has none of these properties. For instance, perceptual space is two-dimensional. The "image formed on the back of the retina" is continuous, but "possess[es] only two dimensions, which already distinguishes purely visual from what may be called geometrical space." Similarly, perceptual space is not homogeneous, given that the yellow spot, the area of greatest visual acuity, "can in no way be regarded as identical with a point on the edge of the retina"[30] where vision is blurry. When we look at something, Poincaré further explains, the eyeball performs a great number of muscular movements that rapidly imprint on the retina a series of images, each slightly different from the next in terms of perspective. These images are almost instantaneously collated and superimposed to produce a three-dimensional picture. Thus although the surface of the retina has only two dimensions and the images captured by it are two-dimensional as well, ocular accommodation and convergence enable us to see three-dimensionally. These operations are performed in accordance with certain laws that "form a group, which has the same structure as that of the movements of invariable solids."[31] But these laws are not the ultimate arbiters of what we can imagine and perceive:

> There is nothing … to prevent us from imagining that these operations are combined according to any law we choose – for instance, by forming a group with the same structure as that of the movements of an invariable four-dimensional solid.

In this there is nothing that we cannot represent to ourselves, and, moreover, these sensations are those which a being would experience who has a retina of two dimensions, and who may be displaced in space of four dimensions. In this sense we may say that we can represent to ourselves the fourth dimension.[32]

Mathematical conventions, as well as conventional ways of seeing or knowing, can be altered, as there is no innate or necessary correspondence between our perceptual space and the geometric spaces we construct through conventions and experience.

Poincaré's refutation of Helmholtz's empiricist take on geometric axioms was part of a broader discussion on four-dimensional seeing. Literary authors were quick to explore this possibility. In Edwin A. Abbott's *Flatland: A Romance of Many Dimensions* (1884) an inhabitant of two-dimensional space discusses geometry with a Sphere and reasons that there must exist "some yet more spacious Space, some more dimensionable Dimensionality" which a Sphere, closer to it than a Flatlander, can perceive "with the inner eye of thought."[33] The fourth dimension is conceived as time in Herbert George Wells's *The Time Machine* (1895). The Time Traveller explains:

Clearly … any real body must have extension in *four* dimensions: it must have Length, Breadth, Thickness and – Duration. But through a natural infirmity of the flesh … we incline to overlook this fact. There are really four dimensions, three of which we call the three planes of Space, and a fourth, Time … You know how on a flat surface, which has only two dimensions, we can represent a figure of a three-dimensional solid, and similarly they [i.e. mathematicians] think that by models of three dimensions they could represent one of four – if they could master the perspective of the thing.[34]

To do so one would mentally need to superimpose a series of time-bound images and construct a chrono-composite: "For instance, here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensioned being, which is a fixed and unalterable thing."[35] As Wells must have known, Victorian photographers were adept at making composite images by means of multiple exposure. Yet time is not what most nineteenth-century mathematicians had in mind when they spoke of the fourth dimension, which they conceptualized in spatial rather than temporal terms.[36]

  The ability to imagine three-dimensional non-Euclidean spaces was arguably enhanced in the late 1860s when the Italian mathematician Eugenio Beltrami constructed visual models of spherical and pseudospherical spaces, which heightened the interest of contemporary mathematicians

in non-Euclidean geometry.[37] But as Reichenbach has argued, such images show us too little; they merely map out non-Euclidean geometry upon Euclidean space, so that we fail to see the extra dimension purportedly represented in them. We can, however, "emancipate ourselves from Euclidean congruence," he argues in the manner of Poincaré, by "training the eyes to adjust to the behavior of solid bodies"[38] under non-Euclidean rules of congruence. But representing four-dimensional objects is far more challenging. As Linda Dalrymple Henderson explains, such an object (called a hypersolid) "is bounded by three-dimensional solids, just as the three-dimensional solids we know are bounded by two-dimensional planes. Such a complex figure must necessarily be viewed in sections either by passing it through our space so that new three-dimensional sections continually appear or by turning it on an axis and taking successive three-dimensional views of it."[39] Yet understanding what must be done to see four-dimensionally does not enable us to actually do so. A breakthrough of sorts was made by the American mathematician Washington Irving Stringham, whose 1880 article "Regular Figures in *n*-Dimensional Space"[40] includes visual models of hypersolids, but these glaringly lack the illusionism we encounter in two-dimensional perspectival representations of three-dimensional figures.

The challenge of figuring out how to "master the perspective of the thing," as Wells's Time Traveller puts it, was vital to arousing public interest in hyperspace (i.e. space of more than three dimensions). In *The Fourth Dimension Simply Explained* (1910), a collection of 22 essays selected from 245 submissions for a science-prize competition, statements about picturability and visibility range from the Helmholtzian position that we are constitutionally forever barred from seeing in four dimensions – "The idea [of another dimension] is to us incomprehensible," asserts one writer; "even if a fourth dimension exists, it must forever remain unknown to us in our natural condition"[41] – to bolder variants of Poincaré's speculations on breaking free from perceptual conventions. Another widely discussed question was whether the fourth dimension concealed not just something but *someone* from our sight, namely spirits. Dismissals were in order. "[T]he idea of a fourth dimension has been made ridiculous," the same writer continues, "by the suggestion that spirits probably dwell in that dimension and can appear to us and disappear at pleasure, thus offering an explanation for the so-called phenomena of spiritualism."[42] Yet there is nothing ridiculous about this suggestion, another contributor maintains, if we recognize that our mental vision is actually four-dimensional: "we can do in thought" what a four-dimensional being "could do in fact." A

simple experiment proves the theory. "For imagine a solid cube before your mind's eye. You can look direct at the front of it. You can look equally straight at its back or at any side, without either moving your own imagined position or the cube's position. This is four-dimensional."[43] In fact, there may be more to our four-dimensionality than mental vision: "If our mental vision be four-dimensional, then our mental or spiritual self may be four-dimensional. If séance-wonders are four-dimensional, they may represent the powers of spiritual beings. If time is but the way in which we perceive the fourth dimension, then our spiritual selves, being four-dimensional, may be above time, outside of time – eternal."[44]

Such reasoning challenges Clifford's claim that the knowable universe had imploded via the non-Euclidean revolution to "knowledge of Here and Now,"[45] and part of the reason why the new geometries were often received with hostility in Britain is that they could so easily be abducted by spiritualists looking to buttress their arguments with the latest scientific theory. Riemann and Helmholtz were severely criticized for uprooting geometry from its Kantian foundations and opening the door to fantastic speculations. In an 1896 article for *The Philosophical Review*, the American psychologist, philosopher, and mathematician James Hervey Hyslop warns against

a great deal of crazy metaphysics which might support itself upon the authority of men like Helmholtz and Riemann. Occultism simply revels in the doctrine of a fourth dimension, and is absolved from the duty of proving it *in se* by the authority of presumably sane scientific men; and while it may be sufficient simply to laugh at the pretensions of the occultist, and while it only dignifies his speculations seriously to consider them, there are some at least quasi-genuine phenomena which throw the reins to madhouse theories, when both parties soberly discuss the claims for a fourth dimension and remain wholly ignorant of the logical principles, which not only vitiate the argument for the existence, or even possibility, of this "dimension," but make the talk about it mere child's play.[46]

Hyslop admits that "it is not necessary to deny the fact of other than the known properties of existence, nor to deny that there is more than is dreamt of in any of our philosophies," but cautions that modifying "geometry and mathematics, so that they … are made to share the precarious fortunes of metaphysics" is not a good idea because "our science would lose its much boasted certitude by the change, and would very soon turn into a fool's paradise."[47]

Although Hyslop does not name names, it is more than likely that the "madhouse theories" that worry him are those of the German physicist and astronomer Johann Carl Friedrich Zöllner and the English

mathematician Charles Howard Hinton, both of whom were regularly cited by late-Victorian popularizers of non-Euclidean geometry as no less authoritative on dimensional matters than Riemann and Helmholtz.[48] Zöllner's experiments with the celebrated American medium Henry Slade are documented in his *Transcendental Physics* (first published in German in 1878 as the third volume of his *Wissenschaftliche Abhandlungen* and translated into English in 1880), where Zöllner makes an effort to show the compatibility of clairvoyance with the new geometries. The experiment that convinced him that clairvoyance is indeed empirically demonstrable involved inviting Slade to a séance and presenting him with two sealed cardboard boxes. One box was circular and contained a five-Mark piece; the other, rectangular, held two smaller coins. Seated at a table with the boxes in front of him and furnished with a writing slate and two pencils, Slade first concentrated on the circular box and reported seeing the numbers 5 and 1876 (the denomination of the coin and the year it was minted), after which the coin apparently dropped through the bottom of the box, penetrated the table's twenty millimeters of oak wood, and landed on the slate which the medium was holding under the table. In Zöllner's estimation, Slade's ability to see inside the box without touching it "established the existence of a direct perception of objects, not effected in the ordinary way of our sense-perceptions."[49] Slade's performance with the first box presented "incontrovertible proof … of the reality of so-called *clairvoyance*."[50] While clairvoyance may be inexplicable from the perspective of traditional science, it

admits a very easy and natural explanation by help of the fourth dimension. From the direction of the fourth dimension, the, to us, three-dimensionally enclosed space must be regarded as appearing open, and indeed in an interval from the place of our body so much the greater, the higher the soul is raised to the fourth dimension. At the same time, with the increasing elevation to this fourth dimension there is a widening of the overlooked space of three dimensions, just as by elevation above the surface of the earth there is, according to geometrical laws, a widening of the overlooked two-dimensional expanse.[51]

Slade communicated the contents of the rectangular box by writing on the slate, after which the coins dropped onto it. But when Zöllner picked up the box and shook it, he heard rattling. Puzzled, he opened the box. The results were better than he could have hoped. Not only had the coins been removed, but the two pencils had taken their place. Differently than with the circular box, Slade was unable to communicate the contents of the rectangular box without using the slate. Rather than being discouraged by this discrepancy, Zöllner turned it to his advantage: "The contents of

this rectangular box must therefore have existed as imaged in another, not a three-dimensionally incorporated intelligence, before that represented image could be transmitted to us by the aid of writing. Hereby is proved, as it seems to me, in a very cogent manner the existence of intelligent beings, invisible to us, and of their active participation in our experiments."[52] In the case of the first box, "Slade's soul was … so far raised in the fourth dimension that the contents of the box in front of him were visible in particular detail" to Slade himself. "In the second case, one of those intelligent beings of the fourth dimension looked down upon us from such a height that the contents of the rectangular box were visible to him, and he could describe its contents upon the slate by means of the pencil."[53] Such experiments provide "proofs of the reality of a fourth dimension" and "the transport of material bodies from a space enclosed on every side,"[54] while the fourth dimension in turn explains how something like clairvoyance is possible – a suspiciously neat arrangement, a skeptic might say: two dubious theories dovetail to validate one another.

Zöllner begins to sound a bit like Poincaré when he launches into a discussion of the laws of perspective and the adjustment that occurs when we move from three-dimensional "cubical vision" to four-dimensional "quadratic vision."[55]

The ascertainment of these laws of perspective for space intuition widened by a dimension would first of all be the task of *geometry*, just as the elements of Euclid must have been known and have become the common property of physicists and astronomers before the spatial significance of celestial phenomena could be thought. That intuitional images, or representations of objects of sight clothed with all the attributes of sense, arise, change and disappear in our soul without the intervention of the physical sight is proved by dreams, hallucinations, and illusions.[56]

Zöllner admits that, for the time being, we know nothing of the means by which such representations are created "and can therefore only advance hypotheses about them." He is confident, however, that "the essential criterion for the fact that the latter [intuitional] class of representations have real objects in an external world corresponding to them, is the *geometrical* criterion; that is, the possibility for our understanding to refer a part of the changes and differences of those representations to the geometrical laws of remoteness and position."[57] Translated into less imposing language, Zöllner's point is that just as elevation in three-dimensional space gives us a broader visual scope, so too are mediums such as Slade, and "other individuals under other conditions in the clairvoyant state,"[58] able to see more from a higher vantage point in the fourth dimension – to peek inside closed boxes, for instance.

In an 1878 article for *The Quarterly Journal of Science*, entitled "On Space of Four Dimensions" (reprinted in the English edition of *Transcendental Physics*), Zöllner argues that "our contemplation of a three-dimensioned space has been developed by means of the law of causality, which has been implanted in us *a priori*,"[59] and suggests that Kant's intuitionism is not entirely at odds with Helmholtz's empiricism:

> [O]ur present conception of space, familiar to us by habit, has been derived from experience, *i.e.*, from empirical facts by means of the causal principle existing *a priori* in our intellect. This in particular is to be said of the three dimensions of our present conception of space. If from our childhood phenomena had been of daily occurrence, requiring a space of four or more dimensions for an explanation which should be free from contradiction, *i.e.*, conformable to reason, we should be able to form a conception of space of four or more dimensions. It follows that the *real* existence of a four-dimensional space can only be decided by *experience*, *i.e.*, by observation of *facts*.[60]

No such experiences being available to us, our conception of space is limited to three dimensions. "A great step has been made," however, "by acknowledging that the *possibility* of a four-dimensional development of space can be understood by our intellect, although … no corresponding image of it can be conceived by the mind."[61]

But clairvoyants such as Slade are endowed with greater perceptual powers and can see what others cannot. That objects perceived by "quadratic vision" tend to be hazy, transparent, and seem to lose solidity is in accordance with the rules of geometric perspective, but also in accordance with Berkeley's *Treatise Concerning the Principles of Human Knowledge* (1710). Berkeley's distinction between vivid ideas derived from sense perception and vague ideas produced by the imagination is compatible, Zöllner believes, with his own argument regarding the difference between high-definition corporeal vision and fuzzy "intuitional images" apprehended "in our soul."[62] Berkeley enables Zöllner to raise his discussion of the mechanisms of perception from Helmholtz's secular dimension onto a theological plane. "The ideas of sense," Berkeley writes and Zöllner quotes, "are more strong, lively, and distinct, than those of the imagination … and are not excited at random, as those which are the effects of human wills often are, but in a regular train or series – the admirable connection whereof sufficiently testifies the wisdom and benevolence of its author."[63]

Whereas Zöllner tried to come up with empirical evidence for clairvoyance, the fourth dimension, and the existence of intelligent spirits,[64] Hinton took a more theoretical route. His two series of *Scientific Romances* (1884–5;

1896), containing popular essays dealing chiefly with the fourth dimension, were a touchstone for later attempts to bridge the divide between materialism and spiritualism by means of geometry. Hinton's work is representative of the leap in late nineteenth-century hyperspace philosophy from an endorsement of Helmholtzian restrictions on perception and the imagination to predictions of opening unseen multi-dimensional vistas. In "What is the Fourth Dimension?" (which opens the first series and was originally published in 1880 in the *Dublin University Magazine*), Hinton revisits Helmholtz's multi-dimensional analogy and argues that the inhabitants of lower dimensions can neither perceive nor form mental images of higher dimensions of space. Yet this does not mean that we cannot conceptualize an object with an extra dimension, as Helmholtz insisted, but that in doing so we must "rely, not on a process of touching or vision, such as informs us of the properties of bodies in the space we know, but on a process of thought," or what Hinton terms the "exercise of the abstract imagination."[65] For instance, it is possible to form a "mental construction" of a so-called four-square, a four-dimensional object with sixteen points, twenty-four surfaces, and thirty-two lines, bounded by eight cubes. Yet we should not expect to be able to visualize the object in the familiar sense of the word and must "divest ourselves of the habit of visual or tangible illustration."[66] Differentiating between mental *conceptions* and mental *images*, Hinton maintains that "speculations of this kind … have considerable value; for they enable us to express in intelligible terms things of which we can form no image. They supply us, as it were, with scaffolding, which the mind can make use of in building up its conceptions."[67] Four-dimensional objects are *imaginable* but not *picturable*.

In "Many Dimensions" (1885), Hinton replaces mental constructions of four-dimensional objects with something very different: "the feeling of being in four-dimensional (or more dimensional) space."[68] Affective rather than cognitive, "the inward apprehension of space" affords a mystical communion with something larger instead of being simply a challenging mental exercise, as it is for Poincaré. When he argues that "we would pass beyond the knowledge of the things about us in the world" if we made an effort "to acquire a sense and living apprehension of four-dimensional space,"[69] Hinton is careful to specify that by *sense* and *apprehension* he means something other than what a physiologist would. Space, he argues, is not to be mastered intellectually, but to be worshiped. Like God, space is infinite and omnipresent, and can be comprehended by human intellect only by wrapping it in the artificial and arbitrary "garments of magnitude and vesture of many dimensions." Space, again like God, surpasses

understanding and makes customary modes of apprehension inadequate. This deification of space, the hallmark of Hinton's work on the fourth dimension, is anti-ocularcentric as well as anti-logocentric, in that it abandons both outer and inner senses in favor of a transcendental, mystical affect of the soul: "[T]he divinity moves, and the raiment and robes fall to the ground, leaving the divinity herself, revealed, but invisible; not seen, but somehow felt to be there."[70] The move from sense perception and rational comprehension to spiritual affect is essential for the conversion that Hinton encourages his readers to make "from the most complete materialism to something very different," namely "the elevation of our notion of space to its true place," where "the antagonism between our present materialistic and our present idealistic views of life falls away."[71]

Hinton, it should be remarked, was not alone in calling for a deification of space. Echoing Wooldridge's "rationalist's faith," in *The Dimensional Idea as an Aid to Religion* (1907) W. F. Tyler seeks "an *hypothesis that conceivably explains consonantly with our reason* the conditions in which we find ourselves," and that at the same time would "form the basis of a new religion founded on reason and not on mysticism." The foundations for this new, reasonable religion are readily available in "the dimensional idea," specifically in the notion that "[i]mmediately above us is a fourth dimensional existence, in which the whole of each of us, past, present, and future is an existing thing."[72] "The infinite-dimensional existence," Tyler declares, "I conceive to be God, of Whom, therefore, in an infinitely small degree we are a 'part,' *but of Whose nature and attributes, it is hopelessly impossible to gain any conception whatever*." This, he explains, "is not so much a new religion in addition to existing ones as a new religious idea, capable of being grafted on to any existing religion, and forming the esoteric basis of the ideas of cultured exponents."[73]

But the anti-ocularcentrism of *Scientific Romances* does not carry over into another work by Hinton on the same subject, *A New Era of Thought* (1888). Hinton begins in the familiar mode, arguing for "liberating our minds from the limitations imposed on it [sic] by the particular conditions under which we are placed."[74] What were previously feelings are now "spiritual intuitions," which Hinton describes as "thoughts and imaginations, not observations of external facts."[75] Yet his clarification of this and other similarly vague statements relies on ocularcentric language; "the right direction to look," he writes, "is, not away from matter to spiritual existences, but towards the discovery of conceptions of higher matter."[76] "The first thing to be done," he instructs the reader, "is to organize our higher-space perception, and then look." "We have been subject

to a limitation of the most absurd character. Let us open our eyes and see the facts."[77] This figurative use of *looking* and *seeing* morphs into literal usage, and Hinton eventually abandons affect and intuition to settle on something more concrete. To establish communication with "the high intelligences by whom we are surrounded," we must learn "to develop our power of perception." This time Hinton specifically refers to a non-corporeal alternative to the bodily eye: "The power of seeing with our bodily eye is limited to the three-dimensional section. But I have shown that the inner eye is not thus limited; that we can organize our power of seeing in higher space, and that we can form conceptions of realities in this higher space, just as we can with our ordinary space."[78] To have a conception of higher space means to perceive it with the inner eye – a hidden, underdeveloped sense long overdue for some exercise.

Such exercises, however, are not to be undertaken simply in order to satisfy our curiosity about what else we may see if we extend ourselves into the fourth dimension. "It is necessary," Hinton argues, "to develop our perceptions of higher space, so that we can apprehend with our minds the relationship we have to beings higher than ourselves."[79] Heightened apprehension is critical, for it enables us to answer the fundamental questions about love and duty: "The question is, Whom are we to serve?" It cannot be ourselves (for this would be self-centered and selfish), and it cannot be other individuals, since "their claims are conflicting, and as often as not there is more need of a master than of a servant."[80] Nor do our fellow human beings always inspire in us feelings of sympathy and duty. The correct answer is that we must serve "the undiscerned higher beings, of which we are a part."[81] "[T]o love them," Hinton reasons, "we must know them," and to know them we must educate ourselves to perceive them. In brief: seeing is knowing is loving. The "perception of higher beings in higher space"[82] is not some kind of dimensional game but a moral imperative which we must follow if our lives are to have any real meaning or purpose.

"Spiritualists literally had an alternative worldview through their distinctive and extensively described theories of spiritual or inner vision," remarks Sarah A. Willburn in her study of Victorian spiritualism and mediumship. She observes that these theories, together with various séance practices, "called into question the very meaning of vision and changed the spiritualist's concepts of visible culture while creating an invisible culture for the practitioner."[83] It is important to recognize that this new invisible culture of spiritualists and mediums was part of a larger discourse on invisibility and alternate modes of perception. Hinton's appeal to these sense

modalities, for instance, has its antecedents not just in spiritualist works such as Crowe's *The Night-Side of Nature* and the Romantic concern with the visionary powers of the imagination, but also in the lectures and writings of nineteenth-century scientists who offered to their audiences visual models of invisible objects and processes, and appealed to their imagination to help picture the imperceptible.

A good example is Tyndall. In an 1870 lecture entitled "Scientific Use of the Imagination," Tyndall tries to impress upon his audience "some of the more occult features and operations of Light and Colour," to transport them "beyond the boundary of mere observation, into a region where things are intellectually discerned, and to show … [them] there the hidden mechanism of optical action." "[W]e cannot transcend experience," Tyndall concedes in Helmholtzian fashion, yet the imagination gives us the capacity to "carry it a long way from its origin. We can magnify, diminish, qualify, and combine experiences, so as to render them fit for purposes entirely new. In explaining sensible phenomena, we habitually form mental images of the ultra-sensible."[84] This is what enabled scientists to discover the luminiferous ether, Tyndall explains. But the imagination is not just an aid in grasping complex concepts; it is a prime mover in the progress of science: "without the exercise of this power, our knowledge of nature would be a mere tabulation of co-existences and sequences" rather than, as it ought to be, an endeavor in "binding the parts of nature to an organic whole."[85] The imagination is "a power of expansion" and "a power of creation" that has, in the case of the ether, "led us into a world not less real than that of the senses, and of which the world of sense itself is the suggestion and, to a great extent, the outcome."[86]

Tyndall's use of the word *occult* to designate those properties of light and color that surpass empirical observation evokes its etymological roots *in occultis* (that which is secret, hidden, undetectable by the senses), but also has mystical resonances – as does *imagination*, a word that most scientists avoid, Tyndall observes, "because of its ultra-scientific connotations."[87] It is possible, he suggests, that Goethe and Young were both correct in their assertions about the nature of light, and that religion and the theory of evolution are not as incompatible as they seem. One can imagine such opposites attracting and dovetailing at "the outer rim of speculative science," for example in "the idea of primeval union between spirit and matter."[88] The imagination is critical in such endeavors. Its function is to synthesize empirical data and help us make leaps and gain insights – for instance, to open vistas to "a higher region" (*PIS* I, p. 708), as Whewell calls it, where materialist science must confess to its limitations.

Light has occult features – imperceptible qualities, certainly, but also possibly "occult *qualitates*"[89] in the mystical sense of the phrase – but so too does vision. In the Preface to the sixth (1880) edition of *Heat a Mode of Motion*, Tyndall writes that in the pages to follow he has

> tried to show the tendency displayed throughout history, by the most profound investigators, to pass from the world of the senses to a world where vision becomes spiritual, where principles are elaborated, and from which the explorer emerges with conceptions and conclusions, to be approved or rejected as they coincide, or refuse to coincide, with sensible things. By his observations and reflections in the domain of fact the scientific philosopher is led irresistibly into the domain of theory, his final repose depending on the establishment of absolute harmony between both domains.[90]

The journey of scientific discovery forms a circle, or more precisely a coil along which the discoverer moves from the sensuous world to the non-sensuous one and back again, rotating between two kinds of vision. To make a discovery, say one concerning occulted relations between natural phenomena, it is necessary to elevate oneself to a world distinct from "the world of the senses," a world "where vision becomes spiritual" and "principles are elaborated." For the loop of discovery to be completed, the visionary must return to the sensuous realm, where the insights of spiritual vision are tested against "sensible things." Thus behind the linear history of science – or the linear narrative of this history – is a story of oscillations: "vision becomes spiritual," then corporeal, then spiritual again, and so on.

We should be careful, however, not to confuse Tyndall with Zöllner, Hinton, and other spiritualist proponents of inner vision. For while his spiritual vision has affinities with clairvoyance, Tyndall regarded spiritualism as a hoax. "Surely no baser delusion ever obtained dominance over the weak mind of man,"[91] he decided after attending a séance. His position on religion is more complicated. In the famous "Belfast Address" of 1874, Tyndall declares it to be the primary objective of science to "wrest from theology, the entire domain of cosmological theory. All schemes and systems which thus infringe upon the domain of science must, in so far as they do this, submit to its control, and relinquish all thought of controlling it."[92] Tyndall subscribed to the basic tenet of scientific naturalism, namely that, "[r]educed to the common denominators of evolving matter and energy, all natural phenomena could be explained mechanically and interpreted without reference to God, supernatural agencies, or independent mind."[93] Yet as Bernard Lightman shows, such a conviction did not necessitate atheism or hostility toward religion. Tyndall was an agnostic, in the particular sense of someone who holds "that God is unknowable

owing to the inherent limitations of the human mind."[94] As Lightman explains in his study of prominent Victorian agnostics, including Tyndall, Clifford, Spencer, and Huxley: "The agnostics were prepared to fight to the death to defend the right of scientists to remain strictly on the material level when analyzing physical phenomena, since materialistic terminology had proven in the past to help people control nature better than obscure spiritualistic terminology. But equally important to the agnostics was the recognition that the scientist erred who tried to convert his materialistic description of nature into an actual ontological doctrine."[95] In "Scientific Use of the Imagination" Tyndall reassures his audience that science is not the enemy of religion. For instance, they have nothing to fear from the theory of evolution:

Fear not the Evolution hypothesis. Steady yourselves, in its presence, upon that faith in the ultimate triumph of truth which was expressed by old Gamaliel when he said: "If it be of God, ye cannot overthrow it; if it be of man, it will come to nought." Under the fierce light of scientific enquiry, it is sure to be dissipated if it possess not a core of truth. Trust me, its existence as a hypothesis is quite compatible with the simultaneous existence of all those virtues to which the term "Christian" has been applied. It does not solve – it does not profess to solve – the ultimate mystery of this universe. It leaves, in fact, that mystery untouched.[96]

Tyndall urges his audience to regard matter and spirit as "equally worthy, and equally wonderful; to consider them, in fact, as two opposite faces of the self-same mystery."[97] Theology must not infringe on science, but science should not presume that it will ever be able to answer all our questions. His contempt for spiritualist séances aside, what Tyndall shared with contemporary spiritualists was an impatience with intellectuals who fail to recognize "the limits beyond which science ceases to be strong."[98]

It would seem that Wooldridge's "rationalist's faith," or something like it, was in some ways achieved through an epistemic hybridization. Stewart and Tait, Zöllner, and Hinton were not alone in their efforts to reorganize the terms of discourse between spiritualism and materialism by showing how the scope of scientific inquiry may be extended by making conjectures about the invisible world – the kind of conjectures, they insisted on pointing out, that scientists themselves were already making about, say, the nature of space or the etheric undulations that permeate it. If the boundary between "real" science and quasi-science needed to be policed, this was partly because the sciences had helped to erode it. According to skeptics of Hyslop's thinking, this was the beginning of the end of respectable science: spiritualism and metaphysics had begun to degrade it to a "fool's

paradise."[99] Such opinions are still heard today. Late-Victorian "vision[s] of a happy otherworld" predicated on the fourth dimension are "[s]illy and sad,"[100] comments one critic. Yet given the paradigm shifts that have punctuated the history of science and occasioned radical turns, Victorian spiritualists could fairly take the same dismissive tone in addressing scientists who refused to consider that what they held as axiomatic may at best be a useful convention, at worst a total fiction. Hyslop, it should be noted, eventually adopted a more critical view of materialism and reinvented himself as a passionate advocate of spiritualism. His *Life After Death: Problems of the Future Life and Its Nature* (1918), one of several books he authored on the subject, is an appropriate closing example in this chapter, in that it is one of the most forceful and, so far as I can tell, most cogent demonstrations of how mainstream scientific theories or laws – specifically the atomic theory, the ether theory, and the law of energy conservation – are not only not inimical to a survivalist argument but imply it as a matter of necessity.

"The belief in a soul," Hyslop writes, "is primarily based, so far as conceivability is concerned, upon the assured existence of something transcending sense and that is not matter as we ordinarily know it. Is there any such thing?"[101] The affirmative answer is provided, in the first place, by the atomic theory. Atoms, Hyslop explains, are thought to be matter, yet they

are supersensible, and it is only pure imagination that ascribes material properties to them … Even the best of physicists say that the term means only quantity of energy and they do not pretend to define their properties. It will not do to say that they have form or shape, because no atom has ever been seen by naked eye or microscope. Nor will it do to say that they have weight, because no atom has ever been weighed.

The only evidence that atoms have the properties of matter is not evidence at all but a conjecture, namely "the *a priori* assumption that the constituent elements of matter as known to sense perception have the same properties as the compounds."[102] Hyslop is careful not to suggest that he has a better understanding of atoms than a physicist; rather, he points out that, whether they choose to acknowledge it or not, scientists who endorse the atomic theory share with spiritualists a confidence in the existence of things that elude the senses: "Let the physicist give any conception to it he wishes; it is not a sensory fact and that is all we require to indicate its resemblance in one important feature of it to what has been called spirit from time immemorial; namely, that it transcended sense perception."[103]

The ether provides the next link in Hyslop's chain of reasoning, for it is the immaterial substance *par excellence*. "The essential qualities of matter," he explains, "are gravity, inertia, and impenetrability." The ether

does not fit this description on any account: it "is universally distributed through space, is not subject to gravity, is perfectly penetrable and apparently not inert … If we insist on calling it by the name 'matter' this term has so changed its meaning that what we have called its essential properties are not essential to it at all and we might call it anything we pleased." From here Hyslop reasons: "If any reality exists in this universe with the properties ascribed to the ether and these the opposite of what we understand by matter, it is not hard to conceive the existence of an energy that thinks and it may be that the ether is this energy." Again, Hyslop is wary of making indefensible claims: "Now all this does not prove the fact of spirit. It only shows that dogmatic denial of its possibility is not justified." Physical science has every right "to demand evidence for the assertion of it," but it must first "concede that the question is an open one and subject to the laws of evidence, and by spirit we do not need to go farther than to suppose some energy that thinks apart from the physical organism with which it is usually associated, or always associated as we know it normally."[104]

The notion of a thinking energy is not so *outré* if we consider the full implications of the law of energy conservation, as Hyslop is prepared to do. He observes, first, that this law proposes "the persistence of the antecedent in the consequent." The energy which in a steam-powered machine moves the piston, for instance, "is the same in kind as well as amount as that which is distributed about the machine shop and does the ultimate work." Next, if we assume, and Hyslop does, that there exists the "same sort of causal relation between mental and physical phenomena,"[105] and that consciousness is a mode of motion, we are forced to admit that the doctrine of survival stands on solid ground:

You cannot say that the effect, consciousness, is a mode of motion without assuming also that the antecedent motion is also consciousness, or your conservation of energy does not hold good. The conservation of energy that will assume a causal nexus between physical and mental phenomena, and at the same time assumes that the two terms are qualitatively the same, must admit that one of the terms is just as permanent as the other, and the doctrine of survival would be a necessity from the very nature of the case … Hence the conservation of energy interpreted as a material causation; that is, the transmission of force from subject to subject and identical in quality or quantity must yield the doctrine of survival, whether we assume a soul or not.[106]

Physicists of the materialist persuasion who deny this reasoning, Hyslop contends, fall into a logistic trap of their own making: "Hence the only escape which the physicist has, who interprets causality in terms of

conservation, is to deny a causal nexus between physical and mental phenomena, and to deny that distinctly opens the way to supposing that there is something else than physical phenomena and their accidents in the world."[107]

The "fool's paradise" of occultists turns out not to have been so foolish after all. The real fools, in fact, are on the other side. "I regard the existence of discarnate spirits as scientifically proved," Hyslop bluntly declares later in his book, "and I no longer refer to the skeptic as having any right to speak on the subject. Any man who does not accept the existence of discarnate spirits and the proof of it is either ignorant or a moral coward. I give him short shrift, and do not propose any longer to argue with him on the supposition that he knows anything about the subject."[108]