Topoi (2016) 35:461–463
DOI 10.1007/s11245-016-9367-2

Introduction: The Geometry of the Visual Field—Early Modern and Contemporary Approaches

Hannes Ole Matthiessen[1]

Published online: 3 February 2016

Every schoolchild knows some basic geometrical properties of the world we inhabit. As is easily demonstrable, a triangle's internal angles sum up two right angles. The area of a circle is πr^2. These formulae hold true of the everyday objects we are acquainted with. They are useful when we want to divide an irregularly shaped parcel of land in two equal pieces, or when we wonder how much water we need to fill the new swimming pool. This geometry of physical bodies has been well understood since antiquity.

But sometimes there is a pronounced difference between the geometrical properties of a thing and the geometrical properties characteristic of our experience of it, particularly in vision. When we move relative to a rectangular table-top we may notice that the portion of the visual field which it occupies grows and shrinks, and also that its apparent shape varies—here it is a rectangle, a parallelogram, a trapezoid. If we studied the apparent shapes just as we studied the intrinsic shapes since antiquity, the result would be a geometry of the visual field.

For sure, investigations into the relation between the intrinsic geometry of things and the geometry of their appearances are not new in the intellectual history. The standard work in this area, Euclid's "Optics", is nearly as well-known as his "Elements". With the new developments in physiological optics and applied optics in the early Modern Era, the discussion vivified significantly. Among the numerous authors who dealt with questions of visual geometry one philosopher plays a distinguished role: Thomas Reid. In his attempt to refute certain claims about the incommensurability of visual and tactile spaces put forward by George Berkeley he develops a *geometry of visibles* according to which the two spaces, though commensurable, possess very different properties. Reid argues that the geometry of visibles is explainable in terms of spherical geometry—and hence very much unlike the Euclidean geometry of tactile space. He thus (arguably) develops one of the first non-Euclidean geometrical systems *and* claims that it is fit to describe figures we have before our eyes all the time. Although Reid's radical theory was discussed here and there in the nineteenth century, it received considerable attention as an intriguing piece of philosophy only towards the end of the last century.

This volume combines specimens of Reid-scholarship with empirical and philosophical treatments of questions concerning the geometrical properties of the visual field. Its aim is to show how much systematic philosophers and empirical psychologists can learn from historians of philosophy, and vice versa.

Giovanni B. Grandi undertakes a detailed survey of two central aspects of Thomas Reid's theory of vision: the claim that distance from the eye is not perceived visually and the claim that the original object of sight is the position of an object's parts with regard to the eye. He offers a detailed analysis of both theses discussing various possible readings and focusing on Reid's empirical assumptions and general methodology. Particularly, and contrary to most contemporary commentators, Grandi argues that Reid, by his own lights, is neither forced to assume the eye akin to a single point in space, nor to the perfect spherical shape of the retina. He finally suggests that we can make most sense of Reid if we understand him as employing a method of *non-precisive abstraction* in his geometrical thinking rather than as attempting to offer a full account of geometric phenomenology.

✉ Hannes Ole Matthiessen
HannesOleMatthiessen@mail.ru

[1] Institut für Philosophie, Humboldt-Universität zu Berlin, Berlin, Germany

In a similar vein, Gerald Westheimer suggests reading Thomas Reid's geometry of visibles as a sort of *Gedankenexperiment*, a way to analyse what vision would be under certain idealized conditions. He argues that for such an idealized eye—that cannot perceive the distance of an object—Reid's account is fairly accurate, but needs amendment as soon as more physiological factors are put into consideration (such as, e.g., the discrepancy between the rotation point of our eyeballs and the entrance pupil). Moreover, when it comes to questions of geometrical phenomenology (especially for the perception of large figures), research that goes far beyond Reid's fairly a priori considerations would be required.

In his contribution to this volume Lorne Falkenstein undertakes a critical assessment of some central propositions from Reid's geometry of visibles. Reid runs into trouble, according to Falkenstein, because he fails to appreciate the phenomenological difference between perceiving visual space *in a single view* and exploring it via *eye rotation.* While, e.g., a great circle of the Reidean visual sphere appears everywhere straight when seen bit by bit, its appearance in one view contains changes in direction (e.g. from *up* to *right* to *down* to *left*) and thus is not that of a straight line. As Falkenstein argues on both a priori and empirical grounds (going back to Helmholtz' conception of visual space) the problem also applies to other aspects of Reid's account. While, in a succession of visual experiences, visual space may exhibit the non-euclidean properties Reid ascribes to it, it will not do so when taken in at one glance.

Hannes Ole Matthiessen also argues that Thomas Reid's geometry of visibles does not capture all aspects of the geometry of visual experience. Even if a Reidean about phenomenal visual space might be able to deal with the phenomenal three-dimensionality of visual experience and with the difficulty of attending to visibles large enough to be noticeably non-euclidean, she would face serious difficulties in explaining the phenomenology of binocular vision and particularly of double imagery. Since Reid shows awareness of these phenomena, but fails to discuss them in the context of his geometry of visibles, Matthiessen suggests that Reid may not have been after a geometry of experience in the first place, but rather after a theory about viewpoint-relative yet mind-independent relational properties—*perspectival properties*—of objects. As such, Reid's theory may still today seem attractive.

Although his paper is not immediately concerned with Thomas Reid's geometry of visibles, Robert French offers an account of visual space that is in interesting ways similar to Reid's. He starts with the claim that photographs and visual experiences resemble each other in their two-dimensional topology. Based on the observation that certain distortions that occur in photography do not occur in visual experience French develops an account according to which visual space is holistically spherical, just as Reid thought. However, certain phenomena (i.e. the absence of close-up distortions) lead French to argue that the curvature of visual space should be understood as variable depending on the (apparent) distance of represented objects.

William Rosar's essay is also concerned with the topology of visual space. The author attempts to answer the question as to *what kind of space visual space could be* by applying Hans Reichenbach's method of coordinative definition to it by which mathematical concepts (such as "straight line") are assigned (coordinated) to physical entities (such as "ray of light in a vacuum"). In the topologically two-dimensional visual space, Rosar argues, colours and differences between colours play the role of primary qualities. As it turns out, since it satisfies the topological properties of dimensionality, orientability, continuity and connectivity, visual space has the right to be called a real space just as physical space has.

Jan Koenderink engages with another classical model of the geometry of phenomenal visual space that was proposed by Hermann von Helmholtz 100 years after Thomas Reid published his geometry of visibles. It is meant to accommodate the sometimes reported phenomenon that lines parallel to, but in significant apparent distance from, the horizon appear slightly curved when not in focus. Koenderink argues that this model is insufficient in that it predicts a certain kind of distortion for horizontal eye movements. He therefore suggests an original alternative—termed the *panoramic visual field*—that makes use of the well-known Mercator-projection.

While the authors introduced so far treat the visual field and visible figures as essentially (topologically) two-dimensional, Mark Wagner and Anthony J. Gambino discuss the geometry of three-dimensional visual space. As empirical studies on size-, distance- and shape-estimation suggest, 3-dimensional visual space (i.e. the euclidean space we inhabit as perceived by sight) appears *compressed* in the in-depth dimension: we tend to under-estimate extensions in this dimension while being accurate in perceiving extensions oriented frontally, a phenomenon referred to as the *anisotropy* of visual space. Wagner and Gambino conduct both a meta-analysis of studies from the last decades and their own empirical study to describe factors contributing to this phenomenon, such as the availability of binocular and other cues, the distance from the observer, instructions used in the experiments, and others.

Phillip John Meadows, in his contribution to this volume, argues that spatial features of visual perceptual experience provide the basis for a version of the argument from illusion that evades the classical objections that have been put forwards against its predecessors. Reflections on the geometry of visual experience are thus immediately relevant to the philosophy of perception. The essential point is that certain visual spatial properties (such as geometrical properties like "triangular", but also more basic properties like "being the left region of visual space") are special in one important respect: while an appearance as of something being red or as of something turning clockwise does not require there to be anything (a sense-datum or whatever) to be really red or turning clockwise, those spatial properties *are* instantiated qua being present in experience. Once we have triangularity, Meadows argues, we have an instance of spatiality, and thus the sense-datum inference goes through.

Many of the papers in this volume grew out of talks held at a conference—under the title of this volume—that took place in Fribourg in 2013 and was generously supported by the Fonds Nationale Suisse de la Recherche Scientifique. After the conference, an official call for papers was issued, and all papers reviewed by external experts, whom I would like to thank in this place. I am grateful to Lorne Falkenstein, Giovanni B. Grandi, Jan Koenderink and Mark Wagner for their contribution both to the conference and to this volume, as well as to Robert French, Anthony J. Gambino, Phillip John Meadows, William Rosar and Gerald Westheimer who were not present in Fribourg. I would also like to thank all the conference speakers whose papers are not included in this issue, Liliana Albertazzi, Luciano Boi, Fabrice Correia, Andrea van Doorn, Regina-Nino Mion and John Schwenkler. Special thanks to Rose-Marie Graf for helping with a lot of organisational issues, and to Fabio Paglieri and the whole Topoi-team for their consistent support.