

# Helmholtz: part 2

## Geometry: epistemology, metaphysics, semantics

1. Epistemology: what is the source of justification for our beliefs about geometry?
2. Metaphysics: does physical reality have intrinsic geometric structure?
3. Semantics: what do we mean when we make geometric claims?

## Epistemology of geometry

1. Empiricism: best fit (could be wrong)
  - (a) Objection: how is the reference of terms fixed?
  - (b) Stronger objection(?): to check for fit, one must use geometry
    - Compare: justification of induction
    - Compare: justification of deduction
2. Holistic empiricism: a geometry  $G$  is correct if it is a part of the overall best theory  $T$
3. Kant: the phenomena is “pre-processed” by the rules of geometry that our perceptual apparatus applies (couldn’t be wrong)
4. Strict conventionalism: geometrical axioms are analytic (true by definition), and so empty of content (couldn’t be wrong)

## Helmholtz’s arguments

1. “...in testing rigid bodies for the invariance of their form, the correctness of their planes and straight lines, in fact we must use the very same geometrical propositions we sought to prove” (p 47)
2. “... the system of spatial measurement must presuppose the same condition on which alone it is meaningful to assert congruence.” (p 49)
3. “Postulates 2 and 4 must evidently be presupposed if congruence is to be meaningful at all.” (p 50)
4. Geometric axioms make claims about physical reality only when connected with mechanical principles
5. The lesson(s) of the convex mirror

6. “But if we can imagine such spaces of other sorts, it cannot be maintained that the axioms of geometry are necessary consequences of an a priori transcendental form of intuition, as Kant thought.” (p 63)
  - (a) What “other sorts” of spaces is Helmholtz thinking of? Why does he think we can imagine such spaces?
  - (b) What is an a priori transcendental form of intuition?
7. “...space [*der Raum*] ...does not at all correspond with the most general conception of an aggregate of three dimensions.” (p 61)
 

What does Helmholtz think is “the most general conception of an aggregate of three dimensions”?
8. On the origin and meaning of geometrical axioms
9. Against the transcendental (Kantian apriori) character of Euclid’s axioms
10. Physical presuppositions for the applicability of geometry
 

“Thus all our geometric measurements depend on our instruments being really, as we consider them, invariable in form.” (p 63)

“Every comparative estimate of magnitudes or measurement of their spatial relations proceeds therefore upon a supposition as to the behaviour of certain physical things, either the human body or other instruments employed.” (pp 63–64)
11. Geometry cannot be kept pure
 

“... the axioms of geometry are not propositions pertaining only to the pure doctrine of space.” (p 67)

“We cannot however decide by pure geometry and without mechanical considerations whether the coinciding bodies may not both have varied in the same sense.” (p 67)

“As soon as certain principles of mechanics are conjoined with the axioms of geometry we obtain a system of propositions which has real import, and which can be verified or overturned by empirical observations.” (p 68)