Philosophy of Science // Fall 2016

Handout 5

Conventionalism in geometry: Reichenbach

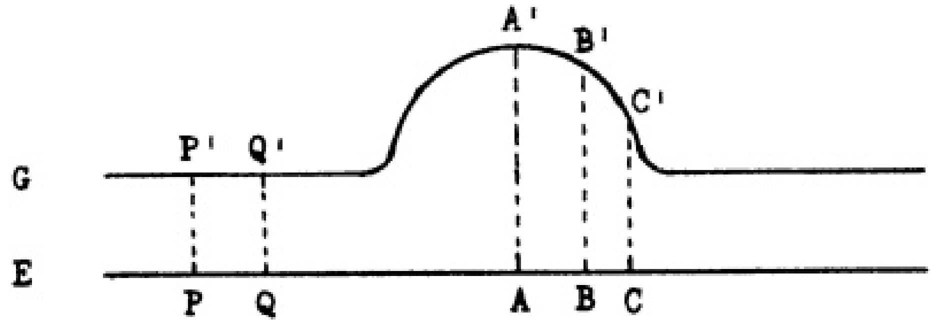
Conceptual and coordinative definitions. Conceptual definitions aim to define concepts by *reducing* it to other concepts. This is the type of definitions familiar, for example, from the Euclidean geometry. Reichenbach claims there is another family of definitions practised in physics: coordinative definitions. They aim at *coordinating* concepts with physical objects. They cannot be seen as explications of meaning. (The terminology of 'coordination' can be replaced by 'correlation' or 'correspondence'.) Basic coordinative definitions are arbitrary (though that's not the case with all such definitions).

Example 1 (Conceptual definitions). 'A *bachelor* is unmarried man.' 'A *line* is length without breadth.' (Euclid, *Elements*, Book I, Def. ii) 'A *triangle* is a figure formed by three right lines joined end to end.' (*Elements*, Book I, Def. xx)

Example 2 (Coordinative definitions). 'A *unit* is a distance which, when transported along another distance, supplies the measure of this distance.' 'The length of *one meter* is the length of the rod in Paris.'

The role of measuring rods. Once a coordinative definition is in place, we have a (by now familiar) problem of measuring lengths at different locations. We must have assurances that no unduly deformations occur along the way. But our tests can only rule out local deformations: if only one rod is deformed, we will verify this by using *another* rod. This will not be verifiable in the case of global deformations whereby every object in the universe contracts or expands in exactly the same proportion.

Universal force. Consider Reichenbach's illustration:



We have two surfaces G and E: one is with a hump, and the other is a (Euclidean) plane. Suppose a certain force acts on the surface E: every object there becomes in length equal to the shadow projected from the surface G. Suppose further that this force acts on different materials in the same way and that there is no protection from its influence. What kind of geometry would the E-people attribute to their surface?

Convention and cognition. The thought experiment shows the need for conventions in addition to observations. It is an observable fact that our rods are equal in length locally (in the same place). When they are transported, it becomes an assumption that the length is preserved. That is, whether $AB = BC$ is not a matter of cognition and verification, but of coordinative definition. That is, two physical objects at two distinct locations are *defined* as having the same length.

Question 3. Reichenbach further says that the concept of equality of length is *not* thereby defined. Is this true? Why?

Possibility of falsification. Our choice of one single rod as a measuring standard depends on the physical behaviour of the rods. There could be a world where there the uniformity in behaviour were violated. Then we would have liked to avoid the definition of length in terms of one standard Parisian rod. (The modern metrical standard is different, but we let us keep using the Parisian standard for simplicity.) So we could have set up measuring rods in every location. And then, when the rods were compared locally, their lengths would not have matched. That, however, would not have refuted our original coordinative definition.

Criteria of choice. It turns out, therefore, that our scientific theory relies, in its foundation, on coordinative definitions. They are left at our discretion. There is no sense in which a definition can be true or false. So how can we choose which definition to use? Our choice is pragmatic. A better definition is logically simpler. It also requires fewer adjustments in other fields of enquiry. A consequence here is that the scientific theory itself can no longer be declared true or false, if these notions are taken in the sense of 'corresponding to reality'.

Solidity. Another matter to be resolved by coordinative definitions is *shape*. There is a good reason to distinguish changes through displacement and changes through deformation. The first ones can be corrected by changes in position, but the latter cannot—unless we manage to isolate smaller parts of a deformed body and attribute to them changes of displacement. In the transportation of measuring rods it is assumed that they do not change shape. Indeed, without this assumption there would be no geometry.

Measuring rods, therefore, are taken as *solid*. What assurance can have of this fact? Again, we can verify their solidity if they are under the influence of differential forces. But there will be no assurance if they are influenced by universal forces.

Technical and logical impossibilities. Reichenbach then addresses the problem of subjectivity. The objection, as usual, is that we cannot determine changes (in rod's shape or length) because of technical or cognitive limitations. But there is a way to determine them *objectively*. Answer: there is no way to say whether the Parisian rod is *really* one meter long. Secondly, if the problem were technical, approximations were possible. But there is no sense in which the geometry of the surface E above is approximately Euclidean, or approximately non-Euclidean.

Remark 4 (For philosophers?). Call the rod 'Harry'. Consider the statement 'Harry is one meter long.' Is it a priori? necessary? analytic?

Relativity of geometry. Perhaps some people would maintain that the geometry of our world is Euclidean. Not that there are many such people left in academic circles now compared to 1928! Perhaps some Kantians might be desperate because of the special role assigned by Kant to the Euclidean geometry. The answer is that our measurements show that the geometry of our world could be Euclidean if we allow the presence of a certain *universal* force (that is, gravity). But alternatively, we can ignore the presence of that force and instead use non-Euclidean measurements. In any case, there is no ground for maintaining the a priori character of geometry.

Testability. Perhaps it might further be objected that the Euclidean geometry is to be preferred because it is simpler. But this is a grave mistake. Formal simplicity of the mathematical theory 'Euclidean geometry' is no warrant for its acceptance as a *physical* geometry. We apply pragmatic criteria to the combination $G + F$ of geometry and a physical theory of the universal force. The assumption $F \neq 0$ may result in fairly complex calculations. In general: what is testable is the set of actual measurements together with coordinative definitions (that would imply a choice of geometry).

An important consequence is *holism*: results of measurements can be accepted or rejected only given the background theory going all the way to coordinative definitions.

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