Scientific Reasoning Can Be Circular

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Is scientific reasoning circular? Circular reasoning occurs when an argument's premise(s) and conclusion imply each other with equal logical force, instead of the premise(s) being more believable than the conclusion. Thomas Kuhn (1970: *The Structure of Scientific Revolutions*, Chicago: Chicago University Press, p. 90; first ed. 1962) claimed that "circularity is characteristic of scientific theories." The justification of theories by observational data involves circularity because observations are theory-laden (scientists necessarily interpret data through the filter of a theory). Michael Shenefelt and Heidi White (2013: *If A, then B: How the World Discovered Logic*, New York: Columbia University Press, pp. 146-155) critique Kuhn's account and advance their own formulation of scientific reasoning that avoids circularity. After examining the dialectic, the present article discusses two possible cases of circular reasoning in science, different than the structure of Kuhn's account, showing that Shenefelt and White's circular-free account cannot cover all instances of scientific reasoning.

Shenefelt and White (p. 147) contend that on Kuhn's account scientists "believe in theories because of data and data because of theories, and consequently each becomes a premise for the other." Let T stand for the preferred theory, and A through D stand for premises describing data (note that perhaps data are not, strictly speaking, true or false until premised or interpreted). Below is the structure of Kuhn's account (Shenefelt and White, p. 153),[1] which we will call Circularity:

1. A and B and C and D.
2. If A and B and C and D, then this implies T.
3. If T, then this entails A and B and C and D.

Circularity could represent good science, for virtues of scientific theorizing like simplicity and explanatory power might redeem it, as Shenefelt and White (p. 150) recognize. Still, if Circularity is correct, it might decrease our confidence in scientific theories. (Perhaps modeling scientific reasoning as probabilistic could capture nuances that the structures above and below do not, but let us stay within the given framework.)

Shenefelt and White (p. 148) claim that "an experienced scientist treats data with caution," not assuming the data are true and therefore not treating them individually as premises. How do scientists do this and avoid circularity? Scientific reasoning starts with a *disjunctive* premise, not a conjunctive premise as in 1 (Shenefelt and White, pp. 150-152). On their proposal (Shenefelt and White, p. 150), A through D "represent the findings [data] that don't fit the rival theories and that can't all be false, though some might be." Let us call this Noncircular:

4. A or B or C or D.
5. If A or B or C or D, then this implies T.
6. If T, then this entails not C and not D.

In 4, the scientist does not know or assume which disjuncts are false; she just has *data*, but if at least one datum is true, the entire disjunction is true. Thus, T is

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[1] Shenefelt and White (pp. 151-153) present diagrams with vertical arrows to illustrate Kuhn's account of scientific reasoning, and their own; the essential points are represented below in 1-3 and 4-6.

inferred and the disjuncts C and D, inconsistent with T, are negated in 6. Because 4 is more believable than T (4 is true if at least one of the disjuncts is true), Noncircular avoids the problem of circularity (Shenefelt and White, p. 152). The data point to T, whose acceptance rules out some data as anomalous. In this way, scientists are careful to not assume that all the data are true, although they assume at least some of the data are true.[2] Therefore, Noncircular shows how scientists avoid circular reasoning.

At least, in *most* cases circularity is avoided. Two situations can occur in which scientific reasoning involves circularity, generated when one piece of data gets privileged. First, consider Lonely Datum, when there is only a single piece of data, preventing the formation of a disjunction. Yet, scientific reasoning *can* proceed as follows:

7. A.

8. If A, then this implies T.

9. If T, then this entails A.

Suppose a scientist testing the gravitational strength on a new planet only has the opportunity, due to time constraints, to drop one object. It falls at the predicted rate and the scientist records the datum, A, supporting the preferred theory of gravitational strength. In this case the theory then implies the truth of the datum. The result could be anomalous, but the scientist has *some* warrant for inferring T, although the reasoning process is circular. Therefore, Noncircular does not hold in all cases. Admittedly, scientists are "reluctant to trust any one datum alone" (Shenefelt and White, p. 149), so cases like Lonely Datum don't represent typical

[2] Analogously, a jury infers that the accused is guilty because probably *some* of the witnesses are speaking truthfully, while not assuming that they all are doing so (Shenefelt and White, p. 155).

science. However, even an experienced scientist might, reluctantly, need to make such an inference.

Second, consider Outstanding Datum. If a scientist has more reason to believe in one datum, e.g., because it is more credible than the other available data, then she is more likely to move circularly to the theory that explains that one outstanding datum, as follows:

10. B* [or A or C or D].

11. If B*, then this implies T.

12. If T, then this entails B*.

I introduce two devices: the symbol * represents that B stands out epistemically, and the brackets around A, C, and D indicate that those data are set aside as epistemically insignificant. Claim 10 is a disjunction in which, for a variety of possible reasons, B receives cognitive emphasis. The scientist might initially include all the data as logically relevant in 10, but quickly recognize that only one datum, B*, was credibly produced. In this manner, the reasoning teeters on being circular differently than on Kuhn's account. But the cognitive effect is on par with Circularity as the scientist moves from 10 to 12.

Shenefelt and White neither absolutely exclude possibilities like Lonely Datum and Outstanding Datum, nor claim that their model is meant to cover all cases of scientific reasoning. Their primary concern is "normal scientific argument" (Shenefelt and White, p. 155). Therefore, they *could* accept these cases as rare but possible forms of reasoning at the edges of science. The point was to highlight abnormal situations which do not fit their model.[3]

[3] Thanks to two anonymous referees for helpful comments.