April 17, 1998 LBNL-41715

Counterfactual Conditionals and Elements of Reality *

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Abstract

Shimony claims that my proof of nonlocality has a mortal lacuna, which he would like to fill by introducing Einstein-Podolsky-Rosen elements of physical reality. The claim is examined. It appears to lack cogency within the framework of quantum thinking.

*This work was supported by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics, Division of High Energy Physics of the U.S. Department of Energy under Contract DE-AC03-76SF00098.

Disclaimer

Shimony (1998) accepts the validity my counterfactual reasoning, but argues that, contrary to my claims, the argument must be grounded in some elements of reality of the kind introduced by Einstein, Podolsky, and Rosen, but rejected by Bohr (1935).

The issue centers on my statement

SR: If experiment R2 was performed in region R and the outcome + appeared the observers in R then if, instead, experiment R1 had been performed in region R the outcome – would have appeared to the observers in R.

This statement appears in my proposed locality postulate

LOC2: If SR is true under the condition that the experimenter in L at some later time will freely choose to perform experiment L2, then SR must be true also if that later free choice will be to perform L1 instead of L2.

Shimony quotes my defense of this locality condition:

" Notice that everything mentioned in SR is an observable phenomenon in region R. ...But a statement about what would happen in R, under certain conditions defined there, that is known to be true under the condition that the later free in L is L2, cannot be rendered false by changing that later free choice, provided the idea is upheld that observable effects can propagate only into the forward light cone."

He then says: "It seems to me that this defense would be valid if it were indeed true that 'everything mentioned in SR is an observable phenomenon in region R' ".

He grants that SR does not *explicitly* mention any region but R, but avers that this is not enough.

He claims that if I do not accept the realities justified by the EPR criterion of physical reality then I have "no option but to ground the objective status of the counterfactual conditional upon the quantum mechanical correlations (ii) and (iii) between outcomes of experiments in L and R."

But where does this need "to ground the objective status" come from?

In line with the precepts of the Copenhagen interpretation I ground my counterfactual arguments not in possible physical worlds, as is normally done by philosophers who tacitly assume a classical-type realistic ontology, but in possible observations of observers: SR asserts simply that if outcome + appears to the observers in region R under one option of the free choice by the experimenter in region R, then outcome – would appear to those observers under the other option of that experimenter in region R. The objectivity in quantum thinking is the weak objectivity of the intersubjective agreement of what appears to all observers who are observing the preparation of a given experiment and its outcome: it is not the strong objectivity of some putative objective reality that lies behind our experiences.

As is normally the case in logical arguments the question of whether a statement such as SR is in fact true or false in the actual world, or whether it can be proved true under certain conditions, is separated from the issue of what the statement means. For example, we know what it means, in plane or spherical geometry, to say that the sum of angles of a triangle is 180 degrees, before establishing whether or not that statement is true within the geometry being considered.

Proving the truth of SR under the condition that L2 is performed in region L certainly does require mentioning something about region L. But that proof pertains to the truth of the premise of LOC2, not to its conclusion. However, the *meaning* of SR itself is grounded in the possible observations of observers stationed in R: it does not mention, explicitly, or refer implicitly, to anything in L. The validity of LOC2 does not arise from the manner in which the truth of its premise (that SR is true under condition L2) was derived, or even if that premise is actually true or not: it arises from the locality notion that because the *meaning* of SR is the assertion of a possible relationship between possible experiences of observers in region R, the truth of this statement cannot, without *some sort* of backward-in-time influence, be definitely true if at some later time an experimenter makes one free choice, but not be true if that later free choice goes the other way.

Shimony's argument for his position is this: "... it is hard to see how one can attach meaning to the words of a statement without some semantical instructions that indirectly if not directly refer to conditions of observation. In the case of the statement SR the only relevant observations are those of correlations between experimental outcomes in L and R."

Well, it is true that the only relevant observations are observations of preparations and outcomes of possible experiments in L and R. But only those in R enter into the *meaning* to SR. It is normal, and I think inherent, in counterfactual reasoning to refer to possibilities as well as actualities, and Bohr's interpretation of quantum theory makes it a theory for computing the probabilities associated with different mutually exclusive alternative possibilities: it adheres to the view of science as being about various possilities that all conform to some general laws, even though only one of these possibilities is actual.

In view of this ubiquity of talk about possibilities in counterfactual reasoning, Shimony's remarks about the need "to ground the objective status of the counterfactual conditional" do not appear to create, within the framework of quantum thinking, any cogent logical barrier against my direct way of interpreting the logical structure of my proof.

Shimony also says that relation asserted in SR is not "an observable phenomenon in region R". But I did not says that it was. I said rather that "everything mentioned in SR was an observable phenomenon in R." Perhaps it would have been clearer if I had replaced "observable" with "possible": my intention was to stress that these things were all phenomena (i.e., experiences) that *could* appear to observers in region R.

This examination shows, I believe, that Shimony's remarks about the need to "ground the objective status of the counterfactual conditional" and about "semantical instructions" fail to constitute any clear or cogent argument for the existence of a "mortal lacuna" in my proof. Yet those two points are the only arguments that Shimony advances against my proof.

As regards the position that Bohr(1935) adopted in his answer to the paper of Einstein, Podolsky, and Rosen, it should be recalled that Bohr based his answer to EPR on a *rejection* of EPR's claim that the choice of the experimenter in one region had no influence on the reality in the other region: Bohr insisted that while "there is...no question of a mechanical influence"... "there is essentially the question of an *influence on the very conditions which define the possible types of predictions regarding the future behaviour of the system.*" This position is completely concordant with my proof, regarded as a proof of the failure of LOC2. For a failure of LOC2, unlike a failure of LOC1, would not involve a mechanical influence of the free choice in L upon what really happens in R: it would involve essentially an influence of the free choice in L upon the truth of a statement that in one case, but not the other, can be deduced from several 100My proof shows, perhaps more convincingly and incisively than Bohr's often challenged argument, that the validity of the predictions of quantum theory does entail the kind of partial breakdown that Bohr required of the EPR idea that there is no faster-than-light influence of any kind.

References

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