Do quantum observers have minds?

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Abstract

In collapse theories of quantum mechanics, there are observers who are in a superposition of brain states with different perceptions. This paper presents a no-go result for such quantum observers. It is shown that the following three assumptions: (1) quantum observers have minds, (2) continuity of psychophysical connection, and (3) functionalism for mental content are incompatible. Possible implications of this result are also briefly discussed.

In quantum mechanics, the physical state, which determines the result of a measuring device or the mental state of an observer, may be described by the wave function, or a decoherent branch of the wave function, or additional variables.[1] The first case includes the bare theory (Albert, 1992; Barrett, 1999) and collapse theories (Ghirardi and Bassi, 2020), where there are quantum observers whose physical states are superpositions of brain states

[1]In this paper, when I say "the wave function of an observer", I mean "the wave function of the relevant part of the brain of an observer that relates to her mental state", and when the observer is entangled with another system, it denotes the entangled state of the composite system. Certainly, it is extremely difficult to know what the wave function of an observer is, let alone its connection with the mental state of the observer. But, as we will see, what I consider below is a simple situation, in which the connection between the physical state and the mental state is assumed for each result branch of a post-measurement superposition, and the question I want to answer is only what the psychophysical connection is for the whole superposition.

with different perceptions.[2] The second case includes the many-worlds theory. The third case includes the de Broglie-Bohm theory and the modal interpretations. The question is: which one, if any, is true? (Gao, 2019)

In the following, I will derive a new no-go result for quantum observers. Concretely speaking, I will prove the incompatibility of the following three assumptions:

(A1). Quantum observers have minds: a quantum observer, whose physical state is a superposition of brain states with different perceptions, has a well-defined mental state;

(A2). Continuity of psychophysical connection: when the physical state of an observer changes continuously, her mental state also changes continuously or does not change, in other words, infinitesimal physical changes cannot lead to finite mental changes.

(A3). Functionalism for mental content: the mental content of an observer is determined by its causal relations to sensory inputs and behavioral outputs (Levin, 2021);

Consider a quantum observer M being in a post-measurement superposition:

$$\alpha \left|1\right\rangle_P \left|1\right\rangle_M + \beta \left|2\right\rangle_P \left|2\right\rangle_M , \tag{1}$$

where $\left|1\right\rangle_P$ and $\left|2\right\rangle_P$ are the wave functions of a pointer being centered in positions x_1 and x_2, respectively, $\left|1\right\rangle_M$ and $\left|2\right\rangle_M$ are the wave functions of the observer M who observes the pointer being in positions x_1 and x_2, respectively, and α and β, which are nonzero, satisfy the normalization condition $|\alpha|^2 + |\beta|^2 = 1$.

According to (A1), the quantum observer M has a well-defined mental

[2]In standard quantum mechanics, it is postulated that when a quantum system is measured by a measuring device or an observer, its wave function no longer follows the linear Schrödinger equation, but instantaneously collapses to one of the wave functions that correspond to definite measurement results. As a result, there are no observers who are in a quantum superposition of brain states with different records. However, such quantum observers exist in the bare theory and collapse theories, as well as in consciousness-collapse theories (Chalmers and McQueen, 2022). In collapse theories, due to the imperfectness of wave-function collapse, the post-measurement state of an observer is an entangled superposition of brain states with all possible records, although the modulus squared of the amplitude of one result branch is close to one in general. This leads to the well-known tails problem (McQueen, 2015). Besides, even if the dynamical collapse of the wave function is perfect, since the collapse time of a single superposed state is a random variable, whose value can range between zero and infinity, there always exist certain measurements with a small probability, for which the collapse time is much longer than the normal perception time and the observer can be in a superposition of brain states with different records.

state. According to (A2), the mental content of M must be related to the values of α and β. If this is not true, then the mental content of M will be constant for all nonzero values of α and β. But since the mental content of M are different for the cases of $\alpha = 0$ and $\alpha = 1$, which are "observing the pointer being in position x_2" and "observing the pointer being in position x_1", respectively, the continuity of psychophysical connection will be violated when α or β changes from 0 to 1.

However, such a mental state cannot be realized by functionalism for mental content. According to (A3), the mental content of M is determined by its causal relations to sensory inputs and behavioral outputs. Since quantum mechanics requires that the outputs of M cannot contain the information about (nonzero) α and β (otherwise she will be able to distinguish non-orthogonal states and further realize superluminal signaling, which is prohibited by quantum mechanics), the mental content of M should be independent of the values of α and β.

Therefore, I have derived a no-go result for quantum observers, namely that the following three assumptions: (1) quantum observers have minds, (2) continuity of psychophysical connection, and (3) functionalism for mental content are incompatible.

In order to avoid this no-go result, we must reject one or more of these assumptions. However, it seems that rejecting each assumption will pay a big price. Rejecting the first assumption will reject collapse theories, a promising alternative to standard quantum mechanics. Rejecting the third assumption will pose a serious problem for the philosophy of mind, since almost all current major theories of mental content are in one way or another functionalist (McLaughlin, Beckermann and Walter, 2009, p.9). While the second assumption seems also reasonable and cannot be readily rejected.[3] If our mental state is determined by our brain state as usually thought, then it will be natural to assume that when our brain state changes continuously, our mental state also changes continuously or does not change. It will be interesting to see which assumption is wrong and should be rejected.

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[3]This assumption is true in the identity theory of mind, which holds that states and processes of the mind are identical to states and processes of the brain (Smart, 2017). Moreover, it is also arguably true in theories of mind which hold that mental properties except phenomenal properties are physically reducible, such as Kim's (2005) physicalism.

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