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## **Time and the Mind Body Problem: a Quantum Perspective**

### **1. The Problem**

Insofar as we perceive the human body (our own and others) as we do any physical object, it is legitimate to study it with the methods of biophysics, and even of physics. In this respect, the Mind/Body problem is part of the Mind/Matter problem.

It happens that in today's physics, namely in Quantum Mechanics, the status of what an object is is problematic. My objective here is to show that, as a consequence, the point of view of the so called cognitive sciences is perhaps to be turned up side down. I will investigate whether it is pertinent, or not, to see the Mind as an "emanation from" the material body.

But, first of all, is there anything like "Mind" at all? We live in a technical epoch where computers and drugs have the pretension to explain every mental state in terms of mechanical tropisms. It is thus not useless, for the sake of the human condition, to recall why a *Weltanschauung* with no Subject cannot explain the totality of everyone's experience. There are several ways to conduct such a demonstration, resting for example on the absence of demonstrative foundations of the mathematical concepts used by the scientific theories themselves. I will rather take my argument from the analysis of Time. The decisive point is that there is nothing in physics allowing one to speak of anything like the "now." The only way to express the now lies in the symbolic dimension of meaning in language. It is customary for physicists to think of language in terms of communication and exchange of information. But the dimension of meaning is excluded from such a view. Thus,

if one does not accept the immaterial notion of “meaning,” one is forced to exclude anything like the “now” or the present instant.

One could worry about the possibility or the necessity of exploring the Mind/Body problem. This necessity is imposed by the empirical fact that we are, in one way or another, entangled with a body partially described by the methodology of physics and chemistry (leading for instance to the pharmacological care of our body). In Freudian Metapsychology, the Mind/Body link is ensured by drive. It is the “psychic representative of somatic excitations.” But Quantum Theory has revolutionized our views of the soma which has no more objective properties on its own. It has therefore become urgent to revisit the Mind/Body problem in the light of quantum concepts. The interesting outcome of a quantum perspective is that, as we shall see, it offers a hypothesis for the way by which a mental representation changes the state of the body.

Several authors in the past, for instance Peirce, Heidegger, and Derrida, have shown that the Mind is intimately involved with time. A rigorous investigation of the Mind/Matter problem thus requires some insight into the concept of time. I will therefore make use of some results of recent elaborations of this notion, in close connection with Quantum Mechanics.

## **2. A Brief Account on Quantum Mechanics and its Problems**

Many authors are confused by the formulation of QM in plain language. These formulations, if they are taken “à la lettre,” are often misleading. For instance, everyone can understand a sentence such as “the uncertainty of the position of an electron is  $\Delta x$ .” But, taken rigorously, it is incorrect, as we shall see. It is therefore necessary to state first in a correct manner what QM exactly says.

### *2.1 The General Framework of QM*

The conceptual framework of QM can be divided into two parts. It must be noted that it is almost impossible to explain it

correctly in plain language, unless one makes use of metaphors. These metaphors are most often fallacious, so that I choose to make use, as simply as possible, of the language in which physical concepts have been built.

*Construction and “Natural Evolution” of an Object*

The usual textbooks on Quantum Mechanics start with the primitive notion of “system:” it is the object under study. But, in fact, an object in Quantum Physics is different from objects of everyday experience: it is constructed from sets of experiments. An experiment is the visible outcome, expressed in a quantitative way with numbers, of a more or less complex setup made of technical devices (e.g. a laser source, polarizing filters and photocounters). The behavior of these setups allows one to construct an abstract object like a “photon” (or “quantum of light”). Once the object, or system, is identified, there is attached to it a mathematical object called “space of representations.”<sup>1</sup> To a particular configuration of the system is attached an element of this space. This element is called “state vector” or “wave function” or simply the “state” of the system and is designated by  $\psi$ .

—Rule **R1**:

When the system evolves on its own, i.e. is not subject to an observation,  $\psi$  changes with time according to some evolution rule, called the Schrödinger equation, or **S**-evolution. The rule **R1** is deterministic and at this level there is no “free will of the atom.”

*Observation*

But it is not sufficient to know the mathematical object  $\psi$  by which the system is represented in the theory. Indeed,  $\psi$  is an abstract object, while in the real life of a lab, in their experiments, physicists only manipulate macroscopic set-ups and numbers, representing what is usually called “physical quantities.” By physical quantity, I mean an actual set up in a particular configuration, for instance the position of an index on a ruler. Here we have a first level of “free will:” the physicist is free to choose which “observable” he is going to measure or (equivalently) to observe. It is therefore necessary to have rules

saying how to compute the numbers representing the result of a given measurement from the knowledge of  $\psi$ . There are three such rules:

— Rule **R2.1**

It is a procedure (never mind the details) giving the set of possible outcomes of a measurement. An essential characteristic of the Quantum Theory is that the possible result of a measurement is generally not unique; there is a set of several possibilities (finite or infinite) called the “spectrum” of that quantity for that system. Let  $a_1, a_2, \dots$  be this spectrum (for instance, the different positions of the index of a ruler).

— Rule **R2.2**

The potential, *a priori*, outcome is not unique, but the actual outcome of an actual measurement is unique. There is a question here: “how is a particular outcome chosen?” “How can we predict it?” The answer is that the outcome is random; we can only predict the statistical probability of it. The probability  $p_i$  that the outcome is  $a_i$ , can be computed, according to rule *R2.2*, from  $\psi$  and  $a_i$ . If the probability  $p_i$  is exactly 1 (i.e. 100%) for some  $i_0$ , the outcome is certain and can only be  $a_{i_0}$  and the system is said to be in the state  $\psi = (a_{i_0})$ . We have now a second level of “free will” in the sense that the outcome is not deterministically predictable.

—Rule **R2.3**

Just after a measurement has been performed, a new measurement of the same quantity will give the same result  $a_i$  with certainty. Thus after a measurement with an outcome  $a_i$ , the state is  $(a_i)$ . In other words, as a result of the measurement, the system has **suddenly jumped** from the state  $\psi$  to the state  $(a_i)$ . This jump, most often called the state vector reduction **R** or the wave function collapse, is not deterministic, it has a random result. I call this reduction “evolution of **type R**.”

As we shall see, this rule is the source of all the interpretation problems of Quantum Theory.

There are therefore two types of evolution for a system: the **S**-evolution and the **R**-evolution.

Until now there is no problem with this scheme, at least apparently. But a very serious problem arises when one wants to understand more precisely what a measurement is. The

natural reaction of a physicist is to view it as a physical interaction between the system and an apparatus. This is an *a priori* reasonable attitude since a physical device is made of atoms. But then the system under study and the apparatus form together a metasystem MS which evolves freely according to the **S**-evolution, which is deterministic. But the rule **R2.3** states that it evolves according to the **R**-evolution whose outcome is only probabilistic. Therefore one is led to a contradiction between two points of view: if a measurement is seen as a “natural” physical process, its evolution is in contradiction with the rule governing measurements.

Another way to express this paradoxical aspect is that, before a measurement, a physical quantity does not “possess” any definite numerical value (for example the position of an electron). If one wants to try a complete physical (in terms of an apparatus-object physical interaction) description of the measurement, there is no longer any measurement (since there is no more an **R**-evolution). This sounds like Zeno’s paradox: as soon as one tries to catch the motion by a rational analysis, there is no more motion.

What is also paradoxical is that the choice between the **S**-evolution and the **R**-evolution does not result from a physical process, but from an arbitrary decision of the physicist who chooses to describe the situation as a measurement or as a physical object-apparatus interaction. It is because this arbitrary decision comes into the game that London and Bauer proposed as early as 1938 that the state vector collapse, or **R**-evolution, is not a physical process but takes place only in the “observer’s consciousness.” I use quotation marks since it is not clear what consciousness is. It was the introduction of an idealistic wolf into a materialistic sheepfold.

This introduction of an (apparently) idealistic element into physics has shocked many physicists. They generally either do not want to discuss these matters, or try (a minority of them) to change the axioms of the theory.

## *2.2 Some Proposed Solutions to the Measurement Problem*

The above contradiction between **S**-evolution and **R**-evolution is, in my opinion, the most crucial problem of

physics. It has triggered many attempts for a solution since the '30s. Let me briefly mention, without unnecessary details, the most elaborate.

1. "Hidden Parameters"

The idea is that the randomness of the **R**-evolution is only apparent. There are supposed parameters, presently unreachable like the position of the atoms of a gas for a nineteenth-century physicist, whose evolution governs the underlying dynamics of the system-apparatus metasystem. It is only because these parameters have a random statistical distribution, irreproducible from one experiment to another, like the random, but deterministic, motion of atoms in a gas, that the **R**-evolution is, apparently, unpredictable. This proposal has lived for several decades and was a serious alternative to standard QM. In 1966, John Bell did show that for a very large class of hidden parameters (namely *local* hidden parameters), this kind of theory leads, in specific cases, to predictions in contradiction to those of QM. An experiment (on the light emission by atoms) was conducted in 1983 by Alain Aspect to test whether the new theory or QM was correct. The result was that QM is correct, thus excluding this kind of solution to the measurement problem.

2. "No Observation" Interpretation

According to this interpretation, there is no need for an **R**-evolution and the rule **R2.3** does not hold. All the possible outcomes of an experiment (Rule **R2.1**) are simultaneously realized and there is a set of simultaneous, different observers, each one seeing one of the outcomes. This interpretation, proposed by Everett, is usually called the "many world" interpretation, although it is really a "many observers" interpretation. It has no internal logical contradiction, but it does not explain a piece of empirical evidence: there is always only one *actual* observer. There is a parallelism with time: in physics, there is no privileged instant such as "now" on the time line, in contradiction with the empirical evidence of the actual existence of "now." The reason for these contradictions between the theory and empirical evidence is that there is no way to express "actuality" or "existence" in a formal, mathematical way. It is a matter of the foundations of writing: an equation is

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a written sign which, as such, is timeless, while actuality, being an actualization, is temporal, in the sense of Heidegger's *Urtemporalität*.

### 3. Decoherence

The “decoherence program” has tried to make use of the fact that macroscopic objects (and thus apparatuses) are assemblies of elementary systems (atoms) which behave incoherently: their wavelike behavior is statistically erased by destructive interferences of these waves. But this decoherence does not explain why in a given experiment there is only one outcome among many *a priori* possibilities. In this respect, it fails to explain the behavior of an apparatus as an assembly of elementary quantal constituents (like atoms).

Thus neither of these solutions is satisfactory and we are led to find something else in order to understand what the **R**-evolution is.

### 3. The *Semiotic Reduction of the State Vector*

Let us go back to the basic formulation of the quantum scheme and to the actual practice of physicists.

The rule **R2.1** gives a prescription for the possible outcomes of a measurement. We must ask ourselves what, in the real life of a lab, a measurement does. More precisely, when, according to which criteria, after which event, did a measurement really take place? A careful phenomenological examination of this process leads to the conclusion that a measurement is performed when its inscription has taken place. This inscription can be either written or oral. In fact it could take place in any symbolic system. In other words, the only “interaction” involved in a measurement is the intervention afforded by a signifier: it is only when a physical system is described in words that a measurement can take place. In this view, the classical level exists on its own, and the program of decoherence, namely to attain the goal of understanding the quantum origin of macroscopic appearances is, by matter of principle, hopeless. I therefore take as given, as a starting point, that a



measurement is nothing else than its inscription. J. Von Neumann, one of the founders of QM, did in fact express a similar view: “Indeed experience only makes statements of this type ‘an observer has made a certain (subjective) observation,’ and never any like this ‘a physical quantity has a certain value’” (1932, 420). To quote N. Bohr (1949), “By the word ‘experiment,’ we simply refer to a situation where we can *tell* others what we have done and what we have learned” (208; italics mine). In fact, the word “subjective” is unnecessary here. It is sufficient that an observer *states*, or *declares* what he has observed. In fact in this statement, in this *act* of statement I should say, the observer as a subject disappears behind his statement, and the latter thus acquires an objective, or more precisely intersubjective, status. Thus, in real practice, an observation, or a measurement, is identical to its declaration. It is intersubjective in the sense that a declaration is always shared by the interlocutors. The communication scheme, according to which 1) I first have in mind something I want to communicate, and 2) in a second time what was in my mind is after the communication transferred in the mind of my audience, is in my opinion wrong. The real situation is more atemporal. Time in the mental world is not adequately represented by the real variable  $t$ , it involves “afterwardness,” having thus a non linear character (which can be formalized rigorously [Schneider 1994 and references therein]) and an instant is not a point. In the framework of this mental time, I get an idea in my mind only afterwards, when my interlocutor has received it. Finally, phenomenologically speaking, an observation, as a declaration, only exists in the impersonal universe of discourse.

One can make the following analogy with linguistics or with mathematics. These sciences study statements (of natural language or of mathematics) for themselves, and never either for the psychological motivations or detailed physical mechanisms (acoustical for instance) underlying their production.

The question of understanding how individual subjects are articulated, or linked, to the universe of discourse is another problem which I will not discuss here and which requires more elaborated notions such as various identifica-

tions, incorporation and introjection, dual unity (Ferenczi, Melanie Klein, Nicolas Abraham, Aulagnier).

To summarize, I adopt the hypothesis that

**The R-evolution is a Speech Act**

in the sense of Austin (1962), that is, the act of production of a symbol, and not a physical (i.e. independent from an observer) phenomenon since physical phenomena strictly depend on **S**-evolutions. In the present case, this symbol is a mathematical writing, or, to be more precise, the reading of a written formula. Like any writing, it is not a static trail. As a verb, a writing is a gesture, the gesture of a production of a symbol. A symbol is homogeneous to its own production, it *is* its own production. This production takes place in the transcendental time of the emergence of an instant. It can be demonstrated (Schneider 1994) that a transcendental instant necessarily has a certain chronological duration  $\Delta T$ , in terms of our watches. This discretization of transcendental time was already discussed, in different terms, by several authors. Heidegger, for instance, names it “spannung” and “entstreckung” of the present. I do not say “in terms of physical time.” Indeed, it is misleading to identify the mathematical variable  $t$  used by physicists with time in the phenomenological sense of this word. The  $t$  variable, at least for values very much shorter than  $\Delta T$  (“very short times”), is never directly apprehended as time, but as some number deduced from seizable quantities such as a length  $L$  which is converted afterwards into  $t$  through relationships such as  $t = L/v$  (where  $v$  is a velocity).

This theory of a transcendental time has no way to predict *a priori* the value of the quantum  $\Delta T$ . It is an empirical fact, in reality unexplained (even by psycho-physiology), that  $\Delta T$  is approximately 0.1 sec.

The combination of the existence of the “lapse”  $\Delta T$  attached to any signifier and of the hypothesis that a measurement is the production of a signifier (belonging to the world of physical quantities) leads to a definite prediction: a measurement in Quantum Physics cannot be shorter than  $\Delta T$ .

After a reduction **R** has taken place, it is not objectively stalled for ever. If a second observer asks the first one what is the result of his measurement, the answer of the first observer

produces a new statement and thus a second reduction **R**. This evanescence of the reductions **R** is perhaps similar to the evanescence of the present: once an instant has been “presentified,” it is immediately superseded by another.

This model of a semiotic state vector reduction provides moreover an explanation of an embarrassing fact, namely that it is not compatible with relativity theory (because it is instantaneous everywhere or, equivalently, taking place with an infinite speed). This incompatibility is well explained by the semiotic state vector reduction: the semiotic state vector reduction being a phenomenon of discourse, it takes places in the universe of interlocution which provides a privileged, unique, frame of reference. Such a privileged frame does not exist in the physical world, according to the theory of relativity, where all frames are equivalent.

**4. The Mind/Body Problem:  
Toward a Quantum Psychology  
(A Model for an Action of  
Mental Representations on the Physical Body)**

In the past, a few authors, physicists and others, have elaborated some thinking on the relationship between QM and the Mind/Matter problem. Some physicists have built quantum models of the Mind/Body relation. A useful partial account can be found in Stapp (1993 and 1997). For instance, Costa de Beauregard (1966) has proposed that mental representations can change the probabilities in rule **R2.2**. More recently, Hameroff (1995) and Penrose (1989) have tried to 1) make an objective description of the **R**-evolution and 2) propose that this **R**-evolution *is* consciousness. In the humanities, some philosophers, psychologists or psychoanalysts and sociologists have used the QM analogy as a model of the subject-object interaction or relationship (transference in the case of a psychoanalytical viewpoint). (See for instance S. Viderman, J. Laplanche, and S. Felman.) This analogy should be investigated carefully since the status of this interaction is slightly different in QM and in the human world.

The idea of a semiotic state vector reduction is essentially that the reduction  $\mathbf{R}$  is the production of a signifier. This production creates the result of the measurement (instead of recording passively a matter of fact like in Classical Physics) and changes the state of the system, according to the rule  $\mathbf{R}$  2.3. Since we have up to now dealt with physical measurements, the signifiers which are produced belong to the universe of physical concepts.

But the symbolic register has more dimensions than just conceptual ones. It is much larger and includes signifiers (being possibly unconscious) having esthetical, affective, ethical, etc. values. I make this statement in parallel with the notion of drive in Freudian Metapsychology where, for instance, I understand the destiny of the epistemophilic drive (as a sublimation) as the production of a signifier having a conceptual value. Like the drive, any signifier takes its source from our soma. But what is the soma in QM? Before QM, it was an objective object. In QM, we have two heterogeneous notions, as we have seen in section two:

- The object under study (described by its state vector).
- The properties or attributes given to the object by our perception of it.

Which one is our body? The state of the object, or its properties, or both? I take the view that:

- As a physical object, the body is a system in the Quantum Mechanical sense (an assembly of atoms) with no qualities.
- As a phenomenal object, it is a system plus its attributes given to it by our relationship to it.

If our relationship is a measurement, we get physical attributes; if it is an affective relationship, we get symptoms.

For the physicist, the properties are descriptions of the system in terms of physical concepts (or signifiers). But for the phenomenological approach of each one of us, with our

phantasmatic (sometimes unconscious) representations of our body, it has appearances (“properties”) such as: beauty, eroticization of bodily zones, partial identifications, etc., for which physical concepts are inadequate.

Let me give some specific examples.

### 1. “Voluntary” Action

When I decide to raise my hand, there is a global representation of this action in my mind. This representation does not have the form of a detailed physical description such as “the muscular fibers of this arm will contract at such or such strength,” etc. There are global signifiers “motion of my arm from position A to position B.” In the present model, we have:

—The arm as a quantum system with no particular property.

—Each slight motion is then the result of the “state vector reduction” associated with the production of signifiers such as the above.

The accumulation of these slight motions gives the global motion of the arm.

### 2. *Blushing of the Face*

Let us consider a signifier with an affective value. As an (affective) representation, and thus production of an (affective) signifier, it can, as an **R**-evolution applied to the system “blood circuits of the face,” change the apparent vascularization of the face, the latter appearing thus as blushing.

A similar model can be invoked for hysterical somatization or for psychosomatic phenomena (such as some allergies) when the signifier is unconscious or preconscious. It is irrelevant here to point out the distinction between hysteria and psychosomatic affections. It is true that in the case of hysteria there is no visible physiological affection, but at the end, the entire body behaves differently as when there is no symptom.

How could such a model be tested? One should be able to find two different signifiers S1 and S2 which are incompatible in the quantum sense, i.e. such that after an outcome for S1

the outcome for S2 is unpredictable. A question arises here. Since psychological signifiers always refer to our body which is a macroscopic system, can they be constructed as “collective variables?”

A noticeable consequence is that there is no more “psychophysical parallelism.” Indeed, the mental world is represented by the measurement operators (and more exactly their proper values), while the physical body is represented by the state vector. There is no parallelism between them.

The new hypotheses outlined above can serve as first steps for future developments:

—Read the classical important texts in metapsychology on the Mind/Body relation through the lens of Quantum Physics.

—Investigate the “collective” observables (such as “morphology” and other qualitative features) given to the system.

—Investigate whether Quantum Physics can be extended to observables whose result are not expressed in numerical terms. This is important for the foundation of a truly quantum psychology.

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## Appendix

### *Indeterminism, Causality, Complementarity*

Quantum Mechanics has given rise to many comments in the field of humanities, most of them misleading. Non-causality, complementarity, and wave particle dualism are often referred to in unclear terms. These vague notions are not really used in the technical works of physicists (even if they use them for the layman). What is it really about?

*Indeterminism* only means that, before a measurement, one can generally not predict its outcome. This word refers only to the measurement and not to the behavior of quantum objects

on their own, which is entirely deterministic (being governed by the **S**-evolution).

*Complementarity* has, somehow, a precise mathematical formulation, namely the Heisenberg uncertainty relation  $\Delta A \Delta B \geq h$ . But it is necessary to interpret the latter correctly.

This relation bears exclusively on “ensembles,” identical copies of a given system, not on individual systems.  $\Delta A$  (or  $\Delta B$ ) is not to be interpreted as the “uncertainty” of the knowledge of the quantity A (or B). The word uncertainty does not have in Physics the same meaning as in ordinary language; in ordinary language it means that an entity has a given value but that we do not know what that value is. In Quantum Physics, a physical quantity A, as a concept, does not possess a given value A on its own; only the *result* of the measurement of that quantity exists.  $\Delta A$  is then only the statistical dispersion, around a mean value, of all the different measurements when repeated on many copies of the same system (in the same state). The smaller  $\Delta A$  is, the better the precision on the mean value of A.

“Complementarity” then means nothing else than that the statistical dispersions  $\Delta A$  and  $\Delta B$  cannot both be infinitely small for the same state of the system under consideration. The expression “the value of A” has no ontological meaning and the statement “A has the value A” has no meaning in QM. The only meaningful sentence is “the measurement of A has given, or is predicted to give, a result A.” This emphasis on measurement rests on the same grounds as those of Relativity Theory which forbids one to refer ontologically to the position or to the instant of an event: only their measurements have a meaning.

The *wave-particle dualism* rests on a fact discovered by Louis de Broglie in 1923–1924: if a system is in a state  $\psi$  such that measurement of its impulse has an exactly predictable outcome P, then the mathematical expression of  $\psi$  is a wave with a wavelength  $\lambda = h/P$  (This is not a new postulate, it is a consequence of the rule **R2.1**; h is Planck’s constant). In this case,  $\psi$  has a spatially infinite extension and the measurement of the position can give, with equal probability, a result anywhere in space. In that sense, *and only in that sense*, the system has no assignable position. If the precision on P

vanishes, so does, as a consequence of  $\lambda = h/P$ , the precision on  $\lambda$  and the wave-like nature (or, more exactly, appearance) of  $\psi$  fades out. As a particular case of  $\Delta A \cdot \Delta B \geq h$ , one has here  $\Delta x \cdot \Delta P \geq h$  (where  $x$  is the position of the object under study). Thus, as the imprecision  $\Delta P$  on  $P$  (to be more exact the statistical dispersion on repeated measurements) increases, the imprecision  $\Delta x$  on  $x$  decreases. At the limit where  $\Delta P$  becomes infinitely large, the prediction of the results on position measurements becomes infinitely precise, a way to see the object as “punctual” or corpuscular. The “wave-particle duality” is thus not ontological, but is the fact that, on a given system, the predictions on the position *measurements* and the impulse *measurements* cannot be both infinitely precise.

*Non-causality.* The “natural” evolution of a system (without measurement) is described by the Schrödinger equation and is absolutely deterministic. The non-causality, or the impossibility of making a prediction, bears only on the outcome of measurements, and is possible because measurements do not follow the Schrödinger equation.

*Observer-system interaction.* It is often said that complementarity, or indeterminism, comes from the uncontrollable influence of the observer on the observed system. This is not completely wrong, but, at the same time, also not completely correct. What is the “influence” of the observer on the system? It is natural (especially for a physicist) to view this influence as a material interaction between the system  $S$  and the observer (or its apparatus)  $O$ . But then this interaction would be described by a Schrödinger equation bearing on the meta-system  $S + O$ . Since the Schrödinger evolution of  $S + O$  is deterministic, the invoked “influence” is in turn deterministic and thus not “uncontrollable:” there is no possibility of explaining by this way the uncertainty  $\Delta A$  on the measurement of  $A$ . The observer’s influence on the system resides only in the unpredictable, wave-packet collapse (which, in the context of the present study, is of semiotic nature). For the semiotic state vector reduction, there is only an interaction between symbols and the system represented by  $\psi$ . This interaction can tentatively serve as a prototype for the Mind/Body relation.



### Notes

I am grateful to Alan Bass for his help with the English style.

1. For experts, it is a Hilbert Space.
2. Namely  $P_i = F(\psi, a)$  where  $F$  is, never mind the details, a simple function having some given standard form.

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