NONLOCALITY AND ESP

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ABSTRACT

The novel physical phenomenon of quantum nonlocality is briefly described. A model of ESP based on this phenomenon is outlined and used to derive some testable predictions

1. QUANTUM NONLOCALITY

Suppose that two microphysical objects, for example, two electrons, interact for a short period of time and then separate to a large distance. Quantum theory predicts that, even when the distance between them is so great that all interaction by known forces effectively ceases, they do not become completely independent. Their states remain correlated, so that the behaviour of one may instantaneously affect the behaviour of the other. This phenomenon is variously referred to as 'nonseparability' (d'Espagnat, 1976, 1979) or 'nonlocality' (Bohm and Hiley, 1975; Villars, 1981).

It can be proved that the predicted correlations between the states of the separated electrons cannot be explained in terms of any internal parameters associated with each electron separately, which become correlated when the electrons interact and preserve this correlation when they separate (Bell, 1964; an informal account of the proof is given in, d'Espagnat, 1979). Furthermore, the instantaneousness of the correlations implies that an explanation in terms of the transmission of influence at finite speed from one electron to the other is impossible.

These long-range immediate correlations between microphysical objects are a very general and elementary consequence of the axioms of quantum theory. It is therefore extremely unlikely, given the outstanding success of this theory in explaining a wide range of complex natural phenomena, that they would not be found to actually occur in nature. Nevertheless, in recent years, the predicted correlations have been tested in numerous specially designed experiments which have generally confirmed the quantum predictions (a review of these experiments is given in, d'Espagnat, 1979). Some of the most recent experiments have been specifically designed to eliminate the possibility of signals being transmitted between the correlated systems at speeds less than or equal to the speed of light (Aspect et al, 1981, 1982a, 1982b). These have also confirmed the predicted correlations. Thus, there is considerable experimental evidence, both direct and indirect, confirming that the predicted correlations do in fact occur.

Locality, also called 'Einstein separability' (d'Espagnat, 1979) or 'simple location' (Whitehead, 1925), is the property of being completely contained in a particular spatial region, instantaneously independent of events in all other distant regions. Completely localised entities can only influence one another by direct contact, as in a collision, or as a result of an influence propagated at finite speed between them. The phenomenon of nonseparability following interaction shows clearly that microphysical objects are nonlocal entities; their behaviour in a particular region of space may be immediately dependent on the behaviour of other objects in distant regions.

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In addition to nonseparability following interaction, quantum theory may imply at least one other form of nonlocal connection between microphysical objects. Thus, Pauli's exclusion principle seems to imply immediate correlations between the states of similar fermions (e.g. electrons) even when there has been no previous interaction between them (see, Margenau, 1944, and, Villars, 1983, for a more detailed discussion of this topic). It is possible that, as our understanding progresses, other forms of nonlocality will be discovered, or even, perhaps, simply recognised as being already implicit in our existing knowledge.

Accounts of quantum nonlocality in the literature of parapsychology often suggest that it is a specific feature of quantum measurements (see, for example, Eysenck and Sargent, 1982). However, the quantum formalism shows that the nonlocal, immediate correlations exist independently of whether or not the correlated systems are observed. Of course, the correlations can only be observed by performing measurements, but they are not specifically created by the measurements.

It follows that the acceptance of quantum nonlocality is independent of any particular view of the controversial 'problem of measurement' in quantum physics (see, Lawden, 1980, for an account of this problem and its possible relevance to parapsychology). Quantum nonlocality is widely accepted amongst physicists and relatively uncontroversial (though, for sceptical views, see, Popper, 1982, and, Schlegel, 1980). It therefore seems a relatively safe foundation on which to speculate concerning the physical basis of ESP.

2. ESP Model

The human brain and nervous system are composed, ultimately, of microphysical objects (i.e. individual molecules, atoms and atomic particles). As indicated above, these are nonlocal entities, capable of being immediately influenced by events in distant regions. Hence, it is possible for immediate correlations to exist between microphysical objects in the nervous system and other microphysical objects in the distant environment. Thus, the nervous system contains within itself, in its constituent microphysical objects, a potential source of ESP information.

The form of immediate correlation between microphysical objects in the nervous system and in the distant environment that is responsible for ESP may be one of those known to contemporary physics. However, it is also possible that the relevant correlations are of a kind as yet unknown. As suggested in Section 1, new forms of immediate correlation may emerge from further progress in physics, in particular, in the high energy physics of fundamental particles. It is also not inconceivable that an increasingly detailed knowledge, from parapsychology itself, of the physical conditions required for ESP may suggest novel forms of physical correlation.

In order to make the proposed ESP model more definite and yield testable predictions, it will be assumed that nonseparability following interaction, as described in Section 1, is the form of nonlocality responsible for ESP. Of course, microphysical objects in the nervous system of the subject will not have interacted directly with microphysical objects in the target. Hence, the required correlations between their states must be established indirectly by chains of physical interactions having common, or link, interactions in the past.

Consider the situation represented schematically in Fig 1. At time t_o, microphysical objects m_o and M_o interact and then separate (m_o may be, for example, a photon scattered by an atom, M_o, on the surface of an object). After the interaction, m_o interacts with m_1, which subsequently intereacts with m_2, etc., until eventually m_n interacts with m_T, a microphysical object belonging to the target. A similar chain of interactions links M_o to M_S, a microphysical object belonging to the subject. The nonseparability of m_o and M_o following the initial interaction and the subsequent nonseparability following interaction of all the members of the chains m_o–m_T and M_o–M_S ensures that, at time t_1, M_S and m_T are immediately interconnected.

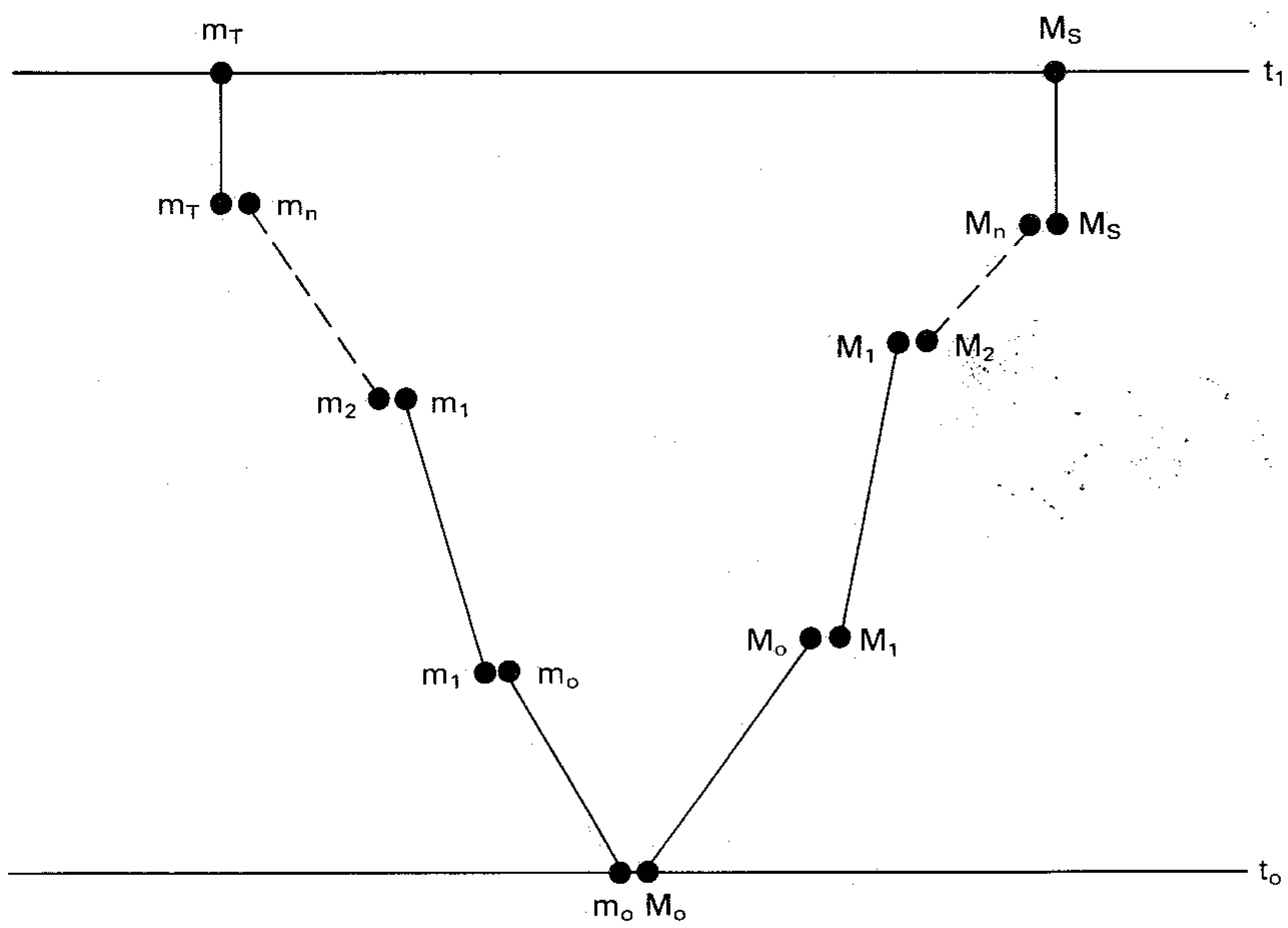

Fig. 1. Chains of physical interaction establishing immediate correlations between microphysical objects m_T and M_S at time t_1 as a result of the common, link interaction between m_o and M_o at time t_o.

The immediate connections of microphysical objects are particle–particle contacts. Thus, the microphysical objects in the nervous system do not respond to distant macro-objects and events directly, but rather, to their constituent microphysical objects individually. Hence, in order to realise this potential source of information some kind of sensory mechanism must exist capable of converting the microlevel behaviour of the source particles into perceptions of distant objects and events.

This mechanism could be a special sense, employing special forms of neural organisation that have evolved specifically for the purpose. Thus, special receptor cells may exist somewhere in the nervous system capable of generating nerve impulses from the behaviour of some of the nervous system's constituent microphysical objects. These nerve impulses might first be mapped onto a special area of the cerebral cortex of the brain, analogous to the primary visual cortex. Many anatomically distinct regions of the cerebral cortex exist, whose functional significance is unknown, which could serve this purpose (see, Hubel, 1979, for an account of the limitations of our current knowledge of the brain). After preliminary analysis in the cortex, the ESP information could be processed in a succession of other special areas of the brain before eventually giving rise to perceptions of distant macro-objects and events.

Alternatively, the ESP mechanism could be a residual function of one of the ordinary senses. Suppose, for example, that the output from the visual receptor cells in the retina is influenced by aspects of the behaviour of the incident photons, or of other microphysical objects within the cells themselves, which are immediately correlated with the behaviour of other microphysical objects in the distant environment. In that case, as well as carrying the information required for normal vision, the output from the visual receptors would also carry the information required for ESP. Thus, ESP information could be carried as a kind of 'noise' in the visual system. This 'noise' could be analysed in a similar way to normal visual information by the higher stages of the visual system, which might consequently yield, as well as normal visual perceptions, 'extrasensory' perceptions.

In order for the ESP mechanism to be effective, it seems reasonable to suppose that a large number of microphysical objects in the nervous system of the subject must be correlated with microphysical objects in the target. Hence, a large number of linked chains of physical interaction, of the kind represented in Fig 1, must exist. A large number of such chains of interaction may easily form if the subject and target are brought together for a period. For example, if the subject simply looks at the target for a short time, photons which have interacted with atoms on the surface of the target will interact with molecules in the subject's retina forming a large number of correlating chains of interaction.

It also seems reasonable to assume that the ESP effect will be stronger if the average number of interactions in the chains, and the average time elapsed since the link interactions, are as low as possible. Minimising these factors may reduce the disturbing influence of correlations with microphysical objects in the chains of interaction other than those belonging to the target.

Thus, the proposed model predicts that ESP will be stronger if the subject and target have been in contact in the recent past. This suggests the following specific predictions:

i The success rate in a standard clairvoyance test using Rhine cards ought to be higher if the subject has examined the cards before the test.

ii Telepathy tests ought to be more successful if the subjects have met together immediately before the tests.

iii Remote viewing experiments should be more successful if the subject has previously visited all the target sites.

According to the proposed model, in principle, ESP is possible over any order of distance. The underlying correlations between microphysical objects in the subject and target, which are responsible for ESP, are preserved no matter how far they have separated. However, the preceding discussion suggests that, though possible over any distance, ESP will generally be more successful over shorter distances.

It follows from the proposed model that ESP is possible regardless of any screening introduced between the subject and the target. Even if the screening were capable of preventing all known forms of physical interaction between them, ESP would still be possible. According to the model, the precondition for ESP is the existence of link interactions in the past, in the sense explained above. If these occur before the screening is introduced, ESP will still be possible.

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