The Exo-Endo-Perspective of Non-locality in Psycho-Physical Systems

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Abstract

According to Hans Primas many epistemological questions of the so-called measurement problem of quantum physics can be solved by the distinction of the exo- and endo-perspective of a physical system. Pascual Jordan - one of the founding fathers of quantum theory - formulated already in 1947 the idea that the subconscious level in psychology may be equivalent to - what is now called - the endo-level in quantum physics.

The model of pragmatic information (MPI), which is a candidate for a non-classical model of psychology, predicts that the behavior of a non-classical system depends on the conditions of its observation. The exchanged pragmatic information (meaningful information) ties the "observer" (e.g. a person) and the "observed" (e.g. a machine) together and creates an "organizational closed system". It is assumed that this process produces non-local correlations between the observer and the observed. The "observer effect" can be regarded as a special phenomenon of psycho-physical systems.

As a target to demonstrate this "observer effect", a quantum physical random event generator (REG) was used which was observed by human subjects who had the instruction to "influence mentally" the outcome of the observed REG.

The "observers" are characterized by a set of psychological variables which were measured by questionnaires *before* the observation-experiment. The "observed" is characterized by a set of statistical variables describing the observed random process. An "observer effect" should show up in correlations between these two sets of variables.

The results support the assumptions of the MPI that a human observer (or other self-organizing systems?) may select certain noise fluctuations from a seemingly separated system via non-local correlations if a feedback-loop generates "meaning" of the process to the observer. The process can be adequately described by the concept of "pragmatic information". It is shown that the concept of "pragmatic information" is a much better descriptor of the observation process than any other "Shannon-type" measure of information. The correlations between psychological and physical variables reflect the pragmatic information of the display and the instruction given to the subjects.

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The result of the experiment further show that external attribution of meaning is a necessary condition for the occurrence of the observer effect. It is argued that "observer effects" are no "signals" but "only" (non-local) correlations or "pseudo-signals" which do not allow to "identify" situations without resources from the environment - or to use a technical example - do not allow to built "faster-than-light-telegraphs".

From this point of view, the distinction between the "internal" and the "external" pragmatic information of an observer experiment gives a criterion for the replication of the non-local correlations. The seemingly "internal" meaning exists only "post hoc" as correlation. It is a feature of the "organizational closure" of the system which is created by the external attribution of meaning to the system. If the "internal" pragmatic information about the system available to the experimenter from a previous experiment could be "used" to code a real external signal, the non-local correlations change or disappear, leading to a result completely different from the previous experiment. From this viewpoint the well-known replication problem of psychological experiments appears in a new light.

Keywords: non-classical models of psychology, pragmatic information, non-local correlations, Cartesian cut, exo-endo-system.

1. Introduction

Endophysics is a new and growing field of theoretical physics which has been proposed by D. Finkelstein, O. Rössler, and H. Primas. Its aim is to take into account that the observer is part of the observed world. The endo- exo-distinction represent two complementary categories for the description of systems. The exo-perspective refers to the usual view from "outside", where the observer and the observed are separated (mathematically it is described by a so-called W*-algebra, for details see Primas 1992). The endo-perspective takes into account that (at least in non-classical systems) the observer is part of the system.

The terms endosystems and exosystems are defined in the following way: "A strictly closed physical system without any concept of an observer is called an endosystem. If the endosystem is divided into an observed and an observing part, we speak of an exophysical description. The world of the observers with their communication tools is called the exosystem." (Primas 1992).

It is astonishing (and to a certain extend contraintuitive) that it can be shown that the mathematical formalism (given by a so-called C*-algebra, for details see Primas 1992), which describes the endo-system is completely bidirectional deterministic which means that it is possible to describe it by "universal laws".

Primas writes: "Quantum endopysics refers to the ontic, quantum exophysics to the epistemic aspect of quantum theory. Endopysics has universal laws and describes what is supposed to be objective real, that is, what exists independently of human knowledge. Exophysics is contextual, deals with sensations, observations and measurements which reflect the objective real. An operational variant of exophysics presupposes the existence of an experimenter, of an observer, or of a measuring system. In contradistinction, in quantum endophysics there is no subject-object distinction, so that endophysics is about being, not about measuring."

It could be argued that it is not useful to introduce ontic aspects to a theoretical model which cannot be directly measured or experimentally investigated. However, the advantage of such an approach is not only that well-known problems and "paradoxes" of the interpretation of quantum theory disappear, but that the results of classical systems also fit into the model.

In Primas' own words: "Experimentally inaccessible ontic states are not meaningless but play a particularly interesting role in classical mechanics, they lead to the phenomenon of the so-called deterministic chaos, that is dynamical processes whose endophysical description is bidirectional deterministic but whose exophysical operational description is nondeterministic. ... Many of the conceptual difficulties and alleged paradoxes of quantum mechanics are due to the failure to distinguish properly between endophysical and exophysical descriptions." (It may be an interesting question to compare Primas' concept of endophysics with the notion of "the implicate order" which had been introduced by David Bohm (1980), but this is beyond the scope of this paper).

On the other hand, the way from the "universal laws" of the endo-world to the exo-world which can be experienced and measured is by no means unique. (Mathematically it is described by the so-called "Gelfand-Naimark-Segal-construction" which transforms the C*-algebra to a W*-algebra, for details see Primas 1992). Primas writes: "The endoworld does not present itself already divided. We have to divide it!". The act of measurement is an active process which separates the endo-system in "observer" and "observed". In physics it creates "dressed objects" (e.g. atoms, molecules etc.) and in general "emergent properties". Separation means cutting non-local correlations which constitute the endo-system. Exophysical objects are so to say "artificially isolated objects".

In his paper for this conference Harald Atmanspacher (1997), stresses the fruitfulness of the exo-endo-concept in the realm of physics. In this paper we apply the exo- endo distinction in a completely different domain, namely in psychology, or to be more precise in psycho-physical systems. At first sight it is not clear, why this should be useful, because many psychologist believe that psychology is a field in which only - if at all - classical physics plays a role. However, even if we adopt the questionable reductionistic point of view, assuming that psychology is only a "very complicated part of physics" it must be conceded that quantum mechanical phenomena are not restricted to the microscopic domain, as Harald Atmanspacher argues in his paper and that they may also emerge in this "very complicated part of physics".

But there is also another vein of tradition in psychology: The idea that quantum theory may have some relevance for biology and psychology was already formulated by its founders such as N. Bohr, E. Schrödinger, W. Pauli, and P. Jordan. The latter especially argued that quantum mechanics would be the last possibility to reconcile the personal experience of "free will" with the physical world view. In classical physics the whole universe works like a tremendously complicated yet fully deterministic "clockwork" which does not allow "free will". P. Jordan (1947) assumed that the quantum mechanical indeterminism of processes inside the human brain can be amplified in such a way that unpredictable reactions of a person could occur that must be interpreted as manifestations of free will. Moreover, he assumed that the process of suppression as described by Freud's model of psychodynamics shows similarities to the concept of complementarity in quantum theory.

2. How to bridge the Cartesian gap?

From an epistemological viewpoint it might be unsatisfactory, to transport theoretical concepts from the "physical part" of the "universe of discourse" to its "mental part" - so to say, across the Cartesian gap between "res extensa" and "res cogitans" - because the assumption that quantum effects play a role in biological and psychological systems involves much more difficult questions (e.g., the reductionism problem) than the correct interpretation of quantum physics. Nevertheless, from a phenomenological point of view there are several good arguments as to why highly complex systems at least may have some similarities to quantum physical systems (Lucadou, Kornwachs, 1983):

1. The axioms of quantum theory (QT) seem to be of a very general nature since they do not contain information about physics itself but merely about the way in which measured data are linked with the theory, and how the states of a system develop in time. The properties of physical observables are contained in the mathematical formulation of the corresponding operators, which, however, are not specified in the axioms.

2. There exists a formal similarity between the Schrödinger equation describing stationary quantum mechanical systems and the eigenequations describing self-referential complex systems.

3. It is known that any measurement of a sufficient complex system causes perturbations. At least for practical purpose it seems to be wishful thinking to expect that such perturbations can be suppressed deliberately. For example, any questionnaire exerts an influence on the assessment of a subject.

4. The results of different measurements A and B depend on their temporal order: $(AB - BA) \neq 0$

5. Indistinguishability of certain psychological constructs. Continuously marking of single events is not possible.

6. Some features of macroscopic complex systems seem to be governed by uncertainty relations (e.g., autonomy versus reliability of a system).

7. Some features of macroscopic complex systems exhibit stepwise rather than continuous changes, resembling quantum leaps.

8. Macroscopic complex systems can show stochastic behavior that cannot operationally be distinguished from the stochastic behavior of a quantum mechanical system.

9. In some macroscopic (complex) systems "anomalous" correlations between psychological conditions (or variables) of a human observer and variables of an independent physical process have been observed in spite of careful shielding against any known physical signal transfer which could have produced the correlation. In some cases where the correlation includes temporal displacement, any classical (local) model fails to describe the effect (Jahn

1981, Jahn & Dunne 1986, Radin & Nelson 1989)). Thus it seems plausible that these correlations are non-local in nature like the EPR-correlation.

Conditions 1. to 8. cannot be regarded as sufficient conditions for the assumption that complex (psychological) systems can be considered as "non-classical" since in any case a suitable classical model can be given to describe the effect. However the situation resembles that of atomic and molecular physics before the invention of quantum theory: the spectra of specific atoms or molecules could be calculated with an enormous degree of precision on the basis of classical models. However, the parameters of the corresponding equations had to be determined individually, post hoc, and no "explanation" for these specific values could be given. Similarly, in psychology very distinct classical models can be found for learning curves of individuals, which, however, do not allow a generalization of the adapted special system parameters.

3. Incompatibility in psychology

Since until now no universal theory of psychology exists which means that many competing (and conflicting) models are in use, incompatibility in psychology seems to be a normal situation. However, this is not meant here. In physics incompatibility means that it is not possible to measure two observables at the same time with arbitrary precision. Or to state it in a different way: The result of the measurement of two independent observables depend of their temporal order. In quantum theory this is expressed by commutation relations i.e. $(AB - BA) \neq 0$.

In psychology, such situations are also very familiar, as we have mentioned above (point 4.). However, most psychologist believe that the reason for this is a completely classical perturbation which causes the change in measurement B after having measured A and vice versa and that this perturbation can be made arbitrarily small by experimental conditions. In quantum physics this is not possible in principle. As a consequence the mathematical structure and all the well-known problems of quantum theory emerge.

In a recent article, Hans Primas (1996) has shown that such incompatible properties produce "holistic" (or "non-local") correlations within such systems, and - what is more important in our respect - that holistic correlations do also exist *between* otherwise independent systems if both contain incompatible properties (Primas, 1996):

"Between two kinematicly independent subsystems Σ^A and Σ^B holistic correlations can exist, if and only if there exist incompatible properties both in Σ^A as well as in Σ^B.

In relation to a state with the state-functional ρ there exist holistic correlations, if and only if there are at least two observables A_1,A_2 in system Σ^A and at least two observables B_1,B_2 in system Σ^B with

$$|\rho\{A_1(B_1 + B_2) + A_2(B_2 - B_1)\}| > 2".$$

If we assume that the Cartesian gap cannot be bridged by any physical interaction (so-called dualism), there may still exist non-local correlations between "the mental" and "the physical", however, only in the case that psychology contains real incompatible properties. Unfortunately, as we have mentioned above, it is difficult or even impossible to show this experimentally within psychology. But the arguments of Hans Primas indicates a way how this problem could be bypassed. Since psychological and physical systems could easily be isolated in an experimental situation, the measurement of non-local correlations between both would be a strong experimental argument, that psychology has really a quantum-mechanical or a "non-classical" structure. The existence of "genuine" *non-local correlations* is not compatible with any classical model. This is the kernel of Bell's well known theorem (Bell, 1966).

4. How can non-local correlations be measured in psycho-physical systems?

The model of pragmatic information (MPI) (see Kornwachs & Lucadou 1985, Lucadou 1995), which is a candidate for a non-classical model of psychology, predicts that the behavior of a non-classical system depends on the conditions of its observation. The exchanged pragmatic information (meaningful information) ties the "observer" (e.g. a person) and the "observed" (e.g. a machine) together and creates an "organizational closed system" (Varela 1981). It produces non-local correlations between the observer and the observed which is called "observer effect".

Naturally, the main experimental problem is, how to establish the organizational closure between the observer and the machine and to make a prediction about the relevant variables and the non-local correlations which might occur in the system due to the organizational closure. Another problem is how to guarantee that no other physical influences of the observer could be responsible for the possible correlations in the system except the assumed "non-local observer effect".

As a target to demonstrate the observer effect, we used a random event generator (REG) which was observed by human subjects who had the instruction to "influence mentally" the outcome of the observed REG.

Concerning the relevant variables, we looked for correlations between psychological trait and state variables and statistical variables of the observed REG-process. Naturally they show a correlation if the psychological variables are measured after the observation and if the observer gets strongly absorbed by the observation (organizational closure) (figure 1). In this case, the correlations remain stable for a while and cannot be distinguished from local correlations. However, if the psychological variables are measured in advance (before the observation) no classical model could account for a correlation between psychological variables and the physical variables of the observed REG-process as far as no signals are involved which overcomes the shielding.

From the point of view of an alternative model that assumes that certain unspecified signals which are emitted by the observers and which are able to overcome the shielding produce such correlations it seems of fundamental importance whether a specific physical variable (tracer) could be found which is indicative for such a signal.

5. Some details of the experiment

Since it would exceed the scope of this paper we will report here only the essential parts of the experiment. A detailed report on this experiment has been published (see Lucadou 1986).

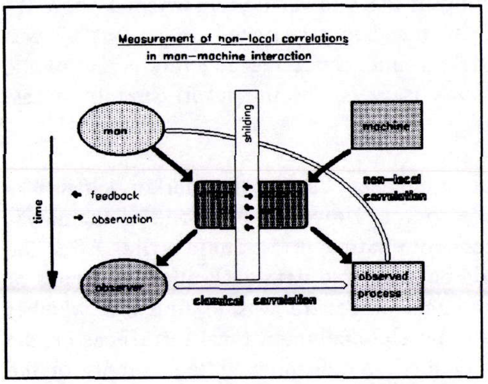

Fig. 1.

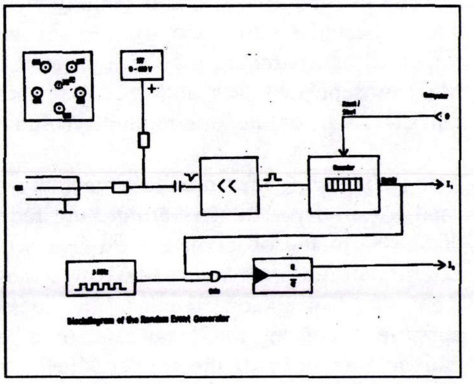

Fig. 2.

The quantum physical process used in the experiment was the radioactive decay (e-) of a SR-90 source of about 0.045 mCi centered in a circle of five Geiger-Mueller-tubes (figure 2). The observers of the process were 299 unselected subjects (mainly students). In one part of the experiment (which we describe here) they could observe the decay process "rather directly" in such a way that changes in the momentary decay rate could be observed. For this purpose a counter sampled a fixed number of events (e.g. 112) from one Geiger-Mueller tube. The resulting sampling time was used as a measure for the momentary decay rate. This momentary decay rate (sampling time Zi) was then compared with the previous one. A decrease of the momentary decay rate was indicated as a "1" and an increase as a "0". If no change of the decay rate occurred the event was omitted.

$$\begin{aligned} Z_{i-1} &> Z_i = \text{"0"} \\ Z_{i-1} &< Z_i = \text{"1"} \\ Z_{i-1} &= Z_i = \text{"no result"} \end{aligned} \qquad (1)$$

However, the latter case did not occur often due to the sufficient variance of the sampling time.

It can be shown that the result of this procedure is a Markow-chain which is completely determined by the following transition matrix:

$$p_{ij} = \begin{pmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{pmatrix} = \begin{pmatrix} 1/3 & 2/3 \\ 2/3 & 1/3 \end{pmatrix} \qquad (2)$$

It can further be shown that this matrix hold in general and does not depend on the distribution of the random process if the measured single events are stochastically independent.

The resulting Markow-chain was displayed to the observer on a vertical string of 16 red lights (LEDs) in such a way that, beginning with a string of the 8 lower lights switched on, a "1" was indicated by the next light at the top of the line being switched on and a "0" was indicated by switching off the light at the top of the line. Since the generation rate of the Markow-sequence was about 10 per second the observers got the impression of a fast randomly fluctuating "thermometer column".

This technique to measure the momentary change in the decay rate by the Markow-chain was used for all five counters around the radioactive source. However, only one of them was displayed to the observer but all five sequences were stored in a computerfile. After the experiment the five parallel Markow-chains could be compared with each other by means of their cross-correlation function. The idea behind this procedure was to find out whether possible changes in the decay rate could be due to possible common local influences on the radioactive source or the Geiger-Mueller tubes or the common high voltage supply or the subsequent electronics.

Furthermore the stored Markow-chains were objected to several detailed analysis procedures such as auto-correlation techniques and statistical tests in order to detect any deviation from the "normal" behavior which may artificially produce an "observer effect". Such artifacts, however, are rather unlikely and could only be produced if electrostatic influences, electrical transients, thermal effects or mechanical influences could overcome the shielding. In such a case, however, they should be detected by these analytical methods.

The main problem of introducing an organizational closure between the quantum-physical system and the observer was solved in the following way: The observers were instructed (in a standardized way) to observe the fluctuating light column at the display and to "push" it to the top of the row as often as possible or to keep it there as long as possible. This should be done only by "concentration", "mental powers" or "psychokinesis" or what so ever. It is known by other studies that many persons in fact believe to possess such "powers" and that the attitudes concerning these beliefs are emotionally loaded very much (another part of the study was to find out more detailed information about such belief systems). It was assumed that the personal interest or emotional involvement of the self-selected (!) subjects in such questions would generate a motivational factor that should be sufficient to produce an organizational closure. However, since the subjects may consciously or unconsciously react quite different to such an "odd" instruction it cannot be assumed that they would consistently "produce" an identical observer effect.

Moreover, quite different observer effects could be expected depending on the specific structure of each self-organizing system. This means that it is plausible to assume that the observer effect depends on personality characteristics of the observer. From this point of view it was decided to use personality questionnaires as independent psychological variables. Of course, the subjects had to fill out the questionnaires before the experimental session took place to avoid that the feedback information on the random process might influence the way the subjects filled out their questionnaires. Thus the questionnaires can be regarded as an independent measurement on the "observer sub-system" which is causally separated from the physical random process.

The following psychological variables of the subjects were measured: Believes about "psychic powers"(SG), locus of control (IPC) (Krampen 1981), personality traits (FPI) (Fahrenberg et al. 1977), present state (mood) (EWL) (Jahnke & Debus 1978) and a confidence score (PRIOR) of the subject's success in the experiment.

Each subject did 4 runs with a Markow-chain of 600 trials under two conditions, namely with and without feedback on the quantum physical process. (In fact the experiment also contained two further conditions with a different random generator which, for brevity, are not reported here. The final results and conclusions under these conditions, however, are similar but less distinct).

To summarize the situation we can hypothetically describe the whole system under feedback condition as a quantum physical self-referential system with two parts which we call the "observer" and the "observed". The organizational closure is introduced by the instruction and by the feedback to the observer. The meaning of the instruction is only defined in the context of the given feedback information. Two independent (locally separated!) sets of variables are measured: The physical variables of the Markow-chains (the observed) and the psychological variables of the observers. If the underlying structure of this system would in fact be an non-classical system as predicted by the MPI we would expect significant correlations between the psychological and the physical variables indicating the existence of non-local correlations within the system. In the non-feedback condition, however, the system is totally separated because there is no feedback loop which may establish the organizational closure. There is no "meaning" of the process for the subject because he or she cannot observe it. As a consequence we would not expect significant correlations between the psychological and physical variables.

6. Measurement of pragmatic information

The relevance of the feedback information is especially taken into account by a specific physical variable DIM which measures the "pragmatic information" of the feedback given to the observer by the display. Pragmatic information can only be defined in the context of the system. In this case the relevant context is defined by the instruction and the special form of the display. Since the instruction says that the observer had to "push" the column to the top of the row the meaning of a "hit" ("1") depends on the actual position of the light column on the display. If, for instance, the column has already reached the top the observer could not even detect a further hit. If the column has reached the bottom a further "miss" ("0") could not be detected and of course the challenge for the observer is quite different. The variable DIM weights the hits depending on it's actual position on the display. If pragmatic information would in fact be the relevant descriptor of organizational closure we would expect this variable to show consistently the highest correlations to the psychological variables, but only under the feedback condition. All the other physical variables which are not discussed here in detail, measure special statistical features of the Markow-chains ("Shannon-type" measure of information) and were used to find out whether (local) signals might have overcome the shielding and may be superimposed on the Markow-chains. To a certain extent they may also contribute to non-local correlations since they may also exhibit certain features of pragmatic information (for further details see Lucadou 1986).

Finally there should be made a remark concerning the characteristics of a possible observer effect on the physical variables. One of the usual misunderstandings in this respect is the expectation that a specific signal could be found in the physical variables alone that indicates the existence of an observer effect without correlating them with the psychological variables ("Shannon-type" information). However, this would be in variance to the assumed non locality of the state function. Any real signal would include instantaneous signal transfer which would contradict to the requirement of Lorentz invariance. This does not mean that it would be impossible to predict the size and direction of the correlation. However, any experimental manipulation to use this correlation as a mean to transfer information would change the system in such a way that the correlation would vanish. In a recent paper (Lucadou 1994) it is shown that this property of non-local correlations leads to a new understanding of the problem of repeatability of psychological experiments and that the usual methodological requirement of double blindness is not sufficient to prevent an experimenter effect (see Rosenthal 1969, Rosenthal et.al. 1978).

From this point of view we would not expect a specific physical process or variable indicating an "influence of the observer" on the physical process but merely correlations between pairs of the independent, randomly distributed physical and psychological variables. The notion of "an influence of the observer" which is often used in the context of the so-called "subjectivistic" interpretations of quantum theory (and which we have used as a psychological trick to attribute "meaning" to the random process) is indeed inconsistent with quantum theory because it would imply a non-local signal transfer. Thus we cannot distinguish the observed physical process from its "normal" random behavior without making reference to the psychological variables. The experimental distribution of all physical variables of the random process shows indeed no deviation from the expectation values under the null hypothesis.

On a more qualitative basis and from some previous investigations we were able to make some predictions about the psychological content of the non-iocal correlations. Also from the point of view of the required "flexibility" of the observer to "understand" the "meaning" of the feedback information, we would expect that those observers who can be classified as non-anxious, non-neurotic, non-depressive, non-inhibited and extraverted would be more successful in establishing an organizational closure than those who can be classified along the corresponding antagonistic categories. These hypotheses were formulated before the experiment to avoid any post-hoc attribution.

7. Results of the experiment

Again, it is important to put emphasis on the fact that all psychological variables (trait and states) of the subjects were measured by questionnaires *before* the observation-experiment. If the observer effect is in fact a non-local correlation this could only show up in the corresponding correlation matrices. Hence, the results are given by the two correlation matrices showing the relationship between psychological and physical variables for non-feedback (figure 3) and feedback conditions (figure 4). Each row of the matrices represents a psychological variable (scale) of 299 subjects and each column represents a physical variable of the random process (for a detailed description see references). Hatching ($p < .01$) or framing ($p < .05$) of a cell indicates a significant correlation between both. Both correlation matrices contain 24 * 23 correlations, hence 27,6 correlations would be expected by chance (at the $p < .05$ level). However, the difference between the two conditions (non-display [34 cells] vs. display [75 cells]) is highly significant even for conservative non-parametric test. Using a 2*2 contingency table one obtains a $X^2=17.11$, $p=0.001$.

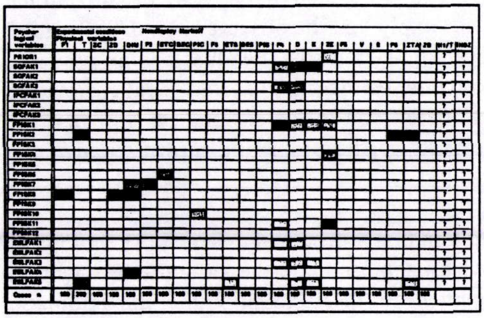

Fig. 3.

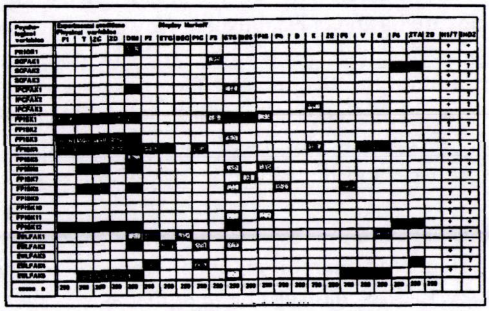

Fig. 4.

If a line shows up many correlations this means that the corresponding psychological variable is a relevant one for the establishment of the organizational closure. If many correlations are indicated in a row this means that the corresponding physical variable is very sensitive in relation to the non-local correlation. The number of the significant correlations under the non-feedback condition does not exceed the number of random correlations which would be expected at this significance level. This means that these correlations can be considered as accidental correlations without meaning. Thus we can conclude that according to our expectations we could not find a non-local correlation under the non-feedback condition.

Under the feedback conditions, however, the number of correlations is increased significantly. Furthermore the tendency of most of the correlations is in agreement with the expectations of our psychological hypotheses (mentioned above). This is indicated in the last two rows. The row labeled H1/T shows the expected tendency of the correlation ("+" for positive correlations and "-" for negative ones, and "?" if no hypothesis was formulated beforehand) and the row TNDZ shows the measured direction of the correlation (if no significant correlation was found this is indicated by "?").

Finally, a direct support of the relevance of the feedback and also a support of the phenomenological model of pragmatic information can be found in the fact that indeed the variable measuring the pragmatic information of the feedback DIM showed not only the highest number of significant correlations to the psychological variables but also consistently the strongest correlation coefficients. This shows that external attribution of meaning is a necessary condition for the occurrence of the observer effect.

However, we still have to ask whether this result could have been produced by some unexpected local physical influences which may have overcome the shielding. For this purpose several correlation techniques (as mentioned above) were used to find physical signals which may modulate the random process. Without going into the details here, it can be said that within the accuracy of the methods applied, neither a common influence on the five Geiger-Mueller tubes could be found nor does any other variable exhibit a distribution indicating a signal different from stochastical behavior.

These results can be interpreted in the following way: "Allowed" stochastical fluctuations of the psycho-physical system (process plus observer) can be "triggered" or "selected" by the observer according to his or her psychological structure if and only if an organizational closure has been established. However, this does not imply that the observer could "influence" or control the observed as could be done by local signal transfer. Feedback is an essential condition for this process. The "observer effect" can only be measured as non-local correlation between psychological and physical variables. This non-local correlation mirrors the organizational closure of the system which is caused by the pragmatic information of the feedback and the self-reference of the observer.

Furthermore the result is suggestive for the assumption that indeed macroscopic psychological systems may exhibit an underlying structure which is isomorphic to the structure of quantum theory. This may also be regarded as a further argument for the assumption that the axiomatic structure of quantum theory is system theoretical in nature.

In the meantime the results of this study had been corroborated by independent data and independent methods. The data stem from different experiments which where performed to measure an "observer effect" on quantum physical stochastical processes (see Radin & Nelson 1989). Unfortunately in most of these experiments the psychological variables are only described qualitatively. Thus the impression arises that the observer could in fact exert an influence on the physical process. A closer analysis, however, shows that the data do not support the notion of an "influence" because they do not hit the criteria for signals (for details see May et. al. 1995). Since most researchers still adhere to the classical paradigm the discussion about "influence" versus "non-local correlation" is still rather controversial (see Lucadou 1995).

8. Replication of experiments involving non-local correlations

In physics non-local correlations can be measured by so-called EPR-experiments (e.g. Aspect et al. 1982). If the spin of the two particles is measured after the local separation it turns out that the spin of the two separated particles is still correlated except of the distance between the two particles. The assumption of the "classical" model that the system is totally separated if it is locally separated leads to a different angular correlation function between the two spin measurements than empirically found. Under very special conditions the classical C0(v1,v2) and the non-classical correlation function C1(v1,v2) between two measured variables (spin-measurements) differ considerably. However, any attempt to "use" the non-local part of the correlation C1-C0 as a "superluminal telegraph" cannot work, because it would be necessary to select single particles from an isotropic spin distribution without performing a spin measurement. The mere measurement of the correlation does not include a "superluminal" signal transfer because a coincidence measurement of corresponding particles does not include a selection only on the basis of one measurement but uses classical (local) signal transfer from both detectors.

Let us now assume, that in a set of data from an experiment with a psycho-physical system S1 a correlation can be found which includes non-local correlations within the system. Let us further assume that the experimenter does not know before the experiment which variables show a correlation. In this case he is actually not able to prepare the system S1 via the action a in such a way that he could select single cases and transfer an amount of information by means of the (non-local) correlations. From the point of view of the MPI his ignorance about the possible correlations is a part of the action *a* which constitutes the system.

After the experiment, however, the pragmatic information *i* gained from the experiment does not only change the knowledge of the experimenter but also the "meaning" of the previous action *a* to *a'*. If the experimenter would start an (seemingly) "identical replication", he would again use action *a* to prepare the system S1. However, since the meaning of *a* has changed he uses *a'* in the case of an identical replication and he could actually use the new pragmatic information *i* to select cases and to transfer signals via the non-local correlations. Since this is not allowed the non-local correlation must necessarily decline even in the case that the experimenter does not factually use this possibility. Similar to the negative result measurement in quantum mechanics a factual measurement is not necessary to destroy a non-local correlation.

At first glance the change from the action *a* to *a'* seems to be immaterial, from a system-theoretical point of view, however, and also from the point of view of operationalization there is a clear and distinct change in the system caused by the pragmatic information *i* of the previous experiment and it seems not very useful to neglect this fact.

From this point of view, the distinction between the "internal" and the "external" pragmatic information of an observer experiment gives a criterion for the replication of the non-local correlations. The seemingly "internal" meaning exists only "post hoc" as correlation. It is a feature of the "organizational closure" of the system which is created by the external attribution of meaning to the system. If the "internal" pragmatic information about the system available to the experimenter from a previous experiment could be "used" to code a real external signal, the non-local correlations change or disappear, leading to a result completely different from the previous experiment.

From this point of view it becomes clear why it is so difficult to prepare "observer effects" in experiments in the exo-world. In the context of the MPI we have formulated this conclusion as follows:

(1) Observer effects are non-local correlations in psycho-physical systems which are induced by the pragmatic information which creates the organizationally closed (endo-) system.

(2) Any attempt to use a non-local correlation in the exo-system as a signal transfer makes the non-local correlation vanish or change.

According to this model the repetition of single trials shows the same property: If a single trial turns out to be a "hit" ("because" the subject is a e.g. an exrovert) the next trial has a smaller chance for becoming a hit again. Thus, with respect to the repetition of single trials in such experiments the relative deviation (hit rate H) from the statistical expectation value depends, according to the MPI (and assumed that all psychological conditions remain constant), from the run length (n):

$$H(n) = const / \sqrt{(n)} \qquad (3)$$

If one assumes that the observer effect would be a real signal instead a non-local correlation one would expect that the relative deviation H(n) would be constant and the effect could thus be statistically accumulated:

$$H(n) = const \qquad (4)$$

The results of the meta-analysis of more than 300 studies with different run length showed an astonishing good agreement with equation (3) (Vassy 1990). It should be mentioned that equation (3) was a real prediction of the MPI, which was made in advance.

However, one should not conclude from these considerations that a direct replication of an experiment involving non-local correlations is not possible. The MPI simply shows that the idea of an "identical replication" is an illusion. On the other hand it demonstrated that the usual double blind technique, which is used in social sciences to prevent an experimenter-expectancy-effect is not sufficient to allow a direct replication of a previous experiment.

To clarify this point let us assume that in an experiment it has been found that a certain "independent" variable *vi* correlates with a "dependent" variable *vd*. The usual procedure in social science requires at least a separation of two groups with high respectively low scores in *vi* (for instance highly intelligent versus less intelligent mice). Under double blind technique the experimenter is not allowed to know which characteristic belongs to which group but in most cases (for practical reasons) it is known that two experimental groups with different characteristics exist. In practice the experimenter of the replication study actually knows that a difference between the groups is expected. It is obvious that in this case the experimenter could "use" his knowledge to code a signal with the two groups even if he does not know the actual value of the variable *vi*. Thus it would be possible to transfer this coded signal to the independent variable *vi* via the expected correlation. If the correlation is a non-local one as a consequence it must decline.

This is of course a very simple example and in real replication experiments the conditions under which the experimenter could use the knowledge about the previous experiment can vary considerably. Moreover, such conditions are very often not reported in detail in the experimental report. Therefore it is very often difficult to give an estimation about the effect size of this "non-classical experimenter-effect". However it is possible to prevent it rather easily: It has to be warranted that the knowledge of the experimenter about the previous experiment actually does not enable him or her to operationalize any kind of signal transfer via the measured correlations. For instance the information from the measurements could be coded in such a way that the experimenter remains "blind" until the final evaluation is performed. It is clear that only the experimenter of the first study fulfills this condition in an ideal way and therefore it is not surprising that in social sciences a remarkable decline effect between original experimental reports and the effect size in later replication studies is often observed.

Obviously it would be necessary to test this model on the basis of existing replication studies. The main problem seems in the moment, that most experimental reports are not very explicit concerning the details of the double blind conditions because this is not generally regarded as a problem.

9. Pseudosignals

Nevertheless the "impression" of many observers that the observer effect is a "real force" should not be laid aside as a mere illusion. From the point of view of the observer (i.e., from her or his *endo-perspective*), she or he is "influencing" the observed random sequence according to the instruction. Since this leads to many typical misunderstandings with respect to a proper distinction of endo- and exo-descriptions of a system, it is useful to introduce the specific notion of a *pseudo-signal* in order to characterize non-local correlations as they arise within an endo-description of the system. Internally, pseudo-signals appear to be deterministic "signals". However, from the point of view of the exo-description of the system they are nothing but non-local correlations. Pseudo-signals are experimentally inaccessible.

As we cited Primas above with respect to physical systems: "Experimentally inaccessible ontic states are not meaningless..." Concerning the psychology of the observer it becomes obvious that the description of such inaccessible ontic states is not meaningless since the "impression" (of signals) of the observer is necessary to create (in the endosystem) the pragmatic information, which produces the organizational closure of the psycho-physical system as a whole. Without these "illusionary impressions" psycho-physical non-local correlations could not emerge. Or to put it in a metaphorical language: As long as the subject is able to stay in the "heaven of the endosystem" she or he *is* "part" of universal laws of nature and thus inter-connected with everybody and everything which has "meaning" for her or him.

On the other hand, it *is* an illusion to believe that pseudosignals can be used to transfer information. Information transfer requires a real measurement which is not possible inside the endosystem - an "impression" is no operationalization. But it is also impossible to transfer information by pseudosignals in the exosystem, where "impressions" might be operationalized (e.g. by measuring actions). In the exosystem, a pseudo-signal is no signal but just a non-local correlation. Again in a metaphorical language: If the subject leaves the "paradise of unintentional, holistic interconnectivity" and enters the "hell of observer experiments" she or he is no more able to use the non-local correlations in a definite way because they are cut off by the separation of the observer and the observed in the exosystem. There may remain "patterns" as a vague "memory of the paradise", but in most cases these patterns have lost their meaning. If we detect by normal signal transfer that such a pattern fits with a pattern in the exo-world we call this a "hit" or "clairvoyance".

In psychological systems, however, one might think of a conversion from a given exo-system into an endo-system, for instance by introducing a meta-description in such a way that the meta-level becomes a new exosystem and hence the original level can be regarded as corresponding endo-system. This can be done, for instance by measuring the "awareness of impressions"," awareness of emotions" etc. In this case the "awareness of impressions" can be regarded as exo-system and the system of "impressions" as endo-system. It is important to realize that the concept of "awareness of impressions" cannot be applied to the level of "impressions" themselves, but often such different levels of description are not clearly distinguished.

In general it is not always easy to avoid the illusion that the observer effect is a kind of influence of the "mind over matter". It seems plausible that this misunderstanding is one of the reasons (in terms of sociology of science) why observer effect has been overlooked for such a long time both in physics and in psychology.

From this point of view there seems to be no hope that a post-Cartesian science (Primas 1990) could ever enable us to heal the Cartesian cut by consciously sending real signals from "mind to matter". The "reunification of the world" or a "reentry into the paradise" can only occur on a subconscious (dream-like) level. But in spite of the impossibility of a conscious operationalization, the observer effect demonstrates that the Cartesian separation between mind (res cogitans) and matter (res extensa) is less fundamental than we have been taught to believe.

References

Aspect, A., Dalibard, J., and Roger, G. (1982). Experimental realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: a new violation of Bell's inequalities. Phys. Rev. Lett, 49, 91-94.

Atmanspacher (1997). The Exo- and Endo-Concepts in the Context of Physics. This Volume pp. *-*.

Bell, J.S. (1966). On the problem of hidden variables in quantum mechanics, in: Review of Modern Physics 38, 447-452.

Bohm, D. (1980) Wholeness and the implicate order. Routledge & Kegan Paul: London, Boston and Henly.

Fahrenberg, J., Selg, H., Hampel, R. (1978). Das Freiburger Persönlichkeitsinventar FPI. Göttingen: Hogrefe (3.Aufl.)

Jahn, R.G. (1981). The Persistent Paradox of Psychic Phenomena: An Engineering Perspective, in: *Proceedings of the IEEE 70* (2): 136-170.

Jahn, R.G., Dunne, B.J. (1986). On the Quantum Mechanics of Consciousness, with Application to Anomalous Phenomena. *Foundations of Physics 16*, (8), 721-772.

Jahnke, W., Debus, G. (1978). Die Eigenschaftswörterliste EWL. Eine mehrdimensionale Methode zur Beschreibung von Aspekten des Befindens. Göttingen: Hogrefe.

Jordan, P. (1947). Verdrängung und Komplementarität. Hamburg: Storm.

Kornwachs, K., Lucadou, W.v. (1985). Pragmatic Information as a Nonclassical Concept to Describe Cognitive Processes. Cognitive Systems, 1, (1), 79-94.

Krampen, G. (1981). IPC-Fragebogen zu Kontrollüberzeugungen ("Locus of Control"). Göttingen: Hogrefe.

Lucadou, W.v. (1986). Experimentelle Untersuchungen zur Beeinflußbarkeit von stochastischen quantenphysikalischen Systemen durch den Beobachter. Frankfurt: H.-A. Herchen Verlag.

Lucadou, W.v. (1994). Wigner's friend revitalized?, in: Atmanspacher, H. & Dalenoort, G. (eds.): "Inside Versus Outside" (p. 369-388), Springer: London, Berlin, Heidelberg, New York, Paris, Tokyo, Hong Kong.

Lucadou, W.v. (1995). *Psyche und Chaos*. Franfurt: Insel Verlag.

Lucadou, W.v., Kornwachs, K. (1983). The Problem of Reductionism from a System-theoretical Viewpoint, in: *Zeitschrift für Allgemeine Wissenschaftstheorie XIV/2*, 338-349.

May, E.C., Utts, J.M. & Sottiswoode, S.J.P. (1995). Decision Augmentation Theory: Applications to the Random Number Generator Database, in: Journal of Scientific Exploration 9, 453-488.

Primas, H. (1990). Mathematical and philosophical questions in the theory of open and macroscopic quantum systems. In: A.I. Miller (ed.): Sixty-two years of uncertainty, 233-257, New York: Plenum.

Primas, H. (1992). Time-asymmetric phenomena in biology complementary exophysical descriptions arising from deterministic quantum endophysics. Open Systems & Information Dynamics 1, (1), 3-34.

Primas, H. (1996). Synchronizität und Zufall. Zeitschrift für Parapsychologie und Grenzgebiete der Psychologie, 38, (1/2), 61-91.

Radin, D.I. & Nelson, R.D. (1989). Evidence for consciousness-related anomalies in random physical systems, in: Foundations of Physics 19, 1499-1514

Rosenthal, R. (1969). Interpersonal expectancies: the effects of the experimenter's hypothesis. In: R. Rosenthal and R. Rosnow (eds), Artifact in Behavioral Research (pp. 181-277). New York: Academic Press.

Rosenthal, R., Rubin, D.B. (1978). Interpersonal expectency effects: The first 345 studies. Behavioral and Brain Science, 3, 377-415.

Varela, F.J. (1981). Autonomy and autopoiesis. In: G. Roth, H. Schwengler (eds.): Self-organizing systems (pp. 14-23). Frankfurt: Campus.

Vassy, Z. (1990). Experimental study of precognitive timing: Indications of a radically noncausal operation. Journal of Parapsychology 54, 299-320.