

## Parapsychological Phenomena as Examples of Generalised Nonlocal Correlations – A Theoretical Framework

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Abstract:

Scientific facts are constituted as consensus about observable phenomena against the background of an accepted, or at least plausible, theory. Empirical data without a theoretical framework are at best curiosities and anomalies, at worst they are neglected. The problem of parapsychological research since its inception with the foundation of the Society of Psychical Research in 1882 was that no sound theoretical basis existed. On the contrary, the proponents of the SPR often indulged in a theoretical model that ran contrary to the perceived materialism of mainstream science, and many tried to use the data of parapsychological research to bolster the case of “mind over matter”, yet without producing a good model, how such effects could be conceptualised. In general, parapsychological (PSI) research has been rather devoid of theorising and, if anything, assumed a tacit signal-theoretical, local-causal model of some sort of subtle energy that would be vindicated, once enough empirical data are amassed. History, and data, proved this stance wrong. We will present a theoretical approach that challenges this local-causal, signal-theoretical approach by proposing that parapsychological phenomena are instances of a larger class of phenomena that are examples of non-local correlations. These are predicted by Generalised Quantum Theory (GQT) and can be expected to occur, whenever global descriptions of a system are complementary to or incompatible with local descriptions of elements of such a system. We will analyse the standard paradigms of PSI-research along those lines and describe how they can be reconceptualised as instances of such generalised non-local correlations. A direct consequence of this conceptual framework is that a mis-representations of these phenomena as local causes, as is done in direct experimentation, is bound to fail long term. Strategies to escape this problem are discussed.

## Introduction

### *What is a Scientific Fact and Why Parapsychological Data are no such Facts*

One of the biggest misunderstandings of science by popular writers and indeed empirical researchers is the assumption that a scientific fact is exclusively constituted by trustworthy and replicable observations by competent observers (Dawkins, 2006; Loughlin, Lewith, & Falkenberg, 2013; Martin, 2004; Sheldrake, 2013). One could not be more mistaken, and readers, as well as authors, of this Journals are among those that have experienced this truism over again (Gernert, 2008; Martin, 1998). This view has been haunting science since the heydays of neopositivism in the beginning of the 20<sup>th</sup> century in the Vienna circle, when philosophers of science thought that the kernel of science is observation, and many observations are joined together to arrive at theories (Smith, 1994). This crudely and purely inductive view of science has since proved plainly wrong (Suppe, 1977). Hanson showed that each and every observation is theory laden, and that no such thing as naïve, objective observation exists. Popper argued that only a deductive way of reasoning, starting from theory, or at least a hypothesis, a daring conjecture, would enable science to progress, since every inductive model of science would not be able to solve the Humean problem (Popper, 1976). This consists of a circular argument: each inductivist model has to stipulate at least one non-empirical sentence, the induction principle itself, in order to be able to use inductive observation in the first place. More historical and pragmatic approaches to science proved Popper insufficient (Kuhn, 1955, Putnam, 1975 #7896; Laudan, 1977), and if there is any consensus among Science and Technology Study scholars at all, then it is a historical social consensus about how science operates (Toulmin, 1985). It is a largely social enterprise, within which those observations are counted as facts that can be communicated well, because they are made against the background of an accepted theory, have been shown to be reasonably robust against modifications and can be replicated by competent observers. Social-historical studies, like those of Bruno Latour, have shown that consensus about theories and observation is only a minimal requirement (Latour, 1999; Latour & Bastide, 1986). A scientific agent needs to be able to also draw on the benevolence of important communicators and political agencies. In the examples studied by him these were elite groups like the French National Academy, or political decision makers, or important newspaper editors. In our days these non-scientific opinion leaders are powerful science editors of journals, newspapers and TV magazines, of funding agencies and political decision makers (Emerson et al., 2010; Henderson, 2010; Lee, Sugimoto, Zhang, & Cronin, 2013; Ritter, 2011).

A successful scientific theory for some class of phenomena, thus, consists at least of three components:

1. There is a good theoretical model that is accepted by a majority of scientists active in the investigation of these phenomena.
2. There is a repeated and replicable observation that can be shared by competent observers and replicated within reasonable limits by them.
3. There is a communicative consensus within the scientific discourse and those that wield the wands of power therein. This consensus has to pertain both to the acknowledgement of the observations and the acceptability of the theoretical model.

1) without the 2) and 3) is only a toy model, interesting to play with, but without consequences. 2) without 1) and 3) is an anomaly at best, but normally just a nuisance. 1) and 2) without 3) constitutes a scientific fringe culture.

Parapsychology (PSI), since its inception that can be dated to the foundation of the Society of Psychical Research in 1882 (Society for Psychical Research, 1882), is at best such a scientific fringe culture, without, however, really agreeing on a good and accepted theoretical background. If there was any commonality among the founders of PSI-research then it was a tacit opposition against what was perceived as the crypto-materialism of the mainstream scientific model. However, some 130 years of research, some of it at high-profile university institutions, have not really brought us any further towards some acceptance by the mainstream. The reasons for this are debatable. Mainstream science is not convinced by a vague and undifferentiated rejection of materialism. Moreover, critics normally point to the fact that a lot of the evidence is purely anecdotal and some of the experimental evidence fails some crucial tests, such as independent replicability and stability of observations under changed framework conditions (Alcock, 2003; French, 2003; Milton & Wiseman, 1999). Although meta-analyses of experimental models in PSI research are generally positive overall, with stunning odds, even though effect sizes are sometimes small (J. Mossbridge, Tressoldi, & Utts, 2012; Schmidt, 2012; Schmidt, Schneider, Utts, & Walach, 2004; Storm, Tressoldi, & Di Riso, 2012; Tressoldi, 2011), it cannot be denied that some decisive replication studies have failed spectacularly, pouring water on the mills of critics (Jahn et al., 2000; Milton & Wiseman, 1999; Ritchie, Wiseman, & French, 2012; Schmidt, Erath, Ivanova, & Walach, 2009; Schmidt, Tippenhauer, & Walach, 2001).

Apart from this, very little attention has been paid to the theoretical background models that might hold for parapsychological effects. After some popularity of observational theories in the 70ies, most researchers seem to have turned back to a tacit local, signal theoretical concept of PSI-effects. We will explain in the following section, what we mean by that. By now it should be clear, why PSI is at best fringe, scientifically speaking:

- The observations communicated within and out of the PSI-community are not really stable and replicable enough.
- There is no accepted/acceptable background theory.
- There is no consensus about those purported facts within the PSI-community, let alone the scientific community.

In what follows we will tackle the issue of a sufficient background theory that offers a model which is, at least potentially,

1. communicable and acceptable, because it connects to the core of mainstream science,
2. capable of making clear, why the empirical pattern of overall effect and failure to replicate in decisive experiments repeats itself
3. able to make the varied phenomenology of PSI phenomena understandable.

We will use the model of Generalised Quantum Theory (GQT) which we have developed as a theoretical frame (Atmanspacher, Filk, & Römer, 2006; Atmanspacher, Römer, & Walach, 2002; Filk & Römer, 2011). From it we can derive generalised entanglement correlations (GET) as predicted theoretical consequences, which can in turn, at least potentially and in principle, explain PSI phenomenology (Lucadou, Römer, & Walach, 2007, we also refer to this publication for technical details omitted in this note). We will show for a few examples what this means. We will finally mention some framework conditions for future empirical work that can be derived from our model.

## The Local-causal Model of PSI and the Signal-Theoretical Assumptions of the Experimental Approach

Experiments are the final arbiter and authority of modern day science, ever since Galileo and others have paved the way in practical terms, and Francis Bacon has laid the theoretical foundations. Experiments are precise questions to Nature, and experimental results are Nature's answer to us. Two decisive presuppositions often go unnoticed, which we should recall. One was already made explicit by Francis Bacon, the other seems trivial, but is rarely discussed. Bacon defined experiments as explicitly sought experiences. "Experience remains. If it happens just in passing, we call it accident. If we seek it out, we call it experiment." (Bacon, 1990, 1.82) Experiments are wilful manipulations of Nature. Observations are naturally occurring experiences, experiments are manipulated experiences. Thus experiments make the presupposition that we can actually manipulate something and still receive a valid answer. The second, even more important presupposition is that experiments presuppose a continuity and stability in Nature. No matter by whom, where on earth, or when an experiment is made, we expect, *grosso modo*, the same results. We do this, because we assume that experiments are detectors of stable causes, and those causes, we assume, are regular. If something works only on Mondays, and some other days, we would not count it as a regular cause. Already Hume had made regularity one of the hallmarks of the notion of a cause, the other being temporal precession and local contiguity (Hume, 1977; Section IX, p. 109ff.). Experiments are detectors for such stable, replicable, regular causes, or at least for conditions of that type which we can use to analyse causes from them. An astronomer who observes a red-shift in a certain stellar region of a certain magnitude will expect to see this through any good telescope on earth on any good observation night, and if he communicates his observation to other astronomers he will be confident that they will also see the same amount of red-shift. This is a regular phenomenon that can be used to infer potential causes, for instance the speed of a retracting light source, or the magnitude of some deflecting source, depending on the theory. Precisely because experiments have been so pivotal and successful in the history of modern science, it is not surprising that PSI researchers turned their hope to experimentation. While early day PSI research was mainly observational in nature, mapping PSI experiences of the population, observing mediums and séances, J.B. Rhine and others introduced the experimental paradigm. Thereby they transposed the tacit presuppositions of experiments – regularity, locality, availability at will – onto the subject matter of PSI. It is important and worthwhile to note that the early day researchers did not necessarily hold such a crypto-causal theory of PSI effects. Barrett, for instance, wrote, in what was the first call to the public to help with research by offering instances of "thought reading" in the Times:

*"I shall be glad to receive communications ... on two points - of cases of the direct action of one mind upon another giving rise to an apparent transfusion of thought or feeling, occurring either in abnormal conditions ... or of cases where, under normal conditions, perceptions may seem to occur independent of the ordinary channels of sensation."* (Barrett, 1882, p. 48, Italics ours)

Note that he spoke of "transfusion of thought or feeling" presupposing some sort of correlational or connectedness model. Fifty years later he explicitly criticised his colleagues for adopting a crypto-signal theoretical model, when he wrote:

*"The word 'thought transference' is apt to be misleading, as it seems to suggest a transmission of ideas between two persons across material space; but, as I said, space does not seem to enter into the question at all. Here it may be interesting to note that in the first publication of the discovery of this super-sensuous faculty, I called it not 'thought transference', but transfusion of thought. We are now coming back to this idea, for telepathy is probably the intermingling of our transcendental*

*selves or souls.*" (Barrett, 1924, p. 294)

Barrett notes correctly that "thought transference" adopts a theoretical model that assumes some signal is travelling through space from one mind to another, and criticises it for its theoretical assumptions and reverberations. It is exactly this theoretical assumption that has then inspired experimental research in PSI. It has not only inspired it, it was the tacit presupposition on which experimental work is predicated in very general terms.

Such a model assumes, tacitly, that PSI effects (Lucadou, 1995)

1. are regular
2. are accessible at will
3. are transported by some, as yet unidentified, local-causal carrier.
4. can be accumulated statistically
5. are in principle independent of meaning.

All these assumptions are in our view all problematic, probably even wrong, but have rarely been debated critically. What is most important among them, though, is the locality assumption.

### *The Locality Principle and the Difficulties of a Local Model of PSI*

"Locality" means that regions in our universe that influence each other causally need to be connected by a physical signal that exchanges energy in order to make the influence real (Reichenbach, 1957). Since, according to Special Relativity, signals can only travel by the finite speed of light of approx. 300.000 km/sec all potentially known signals in the universe take at least some time to reach from an agent to its target. If distances are large, and if the signal is not beamed into a fixed direction but rather emitted into all directions, then signal dilution and the inverse power law come into play: The energy of a signal as collected by a detector decays by the inverse squared distance between source and detector, i.e. the further away a cause of influence, the stronger does the signal have to be initially to reach its target. This is why mobile phone signals need repeaters to boost their energy.

Now, any cause that can be conceived of in our current physical world model, needs to conform to this generic model and obey these presuppositions to be called a cause. In other words, in our mainstream model causes are always some kinds of signals. In addition, all signals can be described by the transmission of particles, either usual particles or field quanta if the signal is conceived as the field effect. For instance, photons are the quanta of the electromagnetic field. As for the gravitational field, gravitational interactions are ubiquitous, the existence of gravitational waves is well established by indirect evidence, for instance from double pulsars, and as the result of intensive large scale research over several decades, gravitational detectors are expected directly to register gravitational waves in the near future. The detection of single quanta of the gravitational field, called gravitons, is hardly feasible: Because of the low frequencies of all known gravitational fields the energies of the gravitons must be extremely low.

Besides electromagnetic and gravitational interactions, the current standard model of physics knows about two more kinds of fundamental interactions: so called weak and strong interactions. Both of them have a very short range, much less than the diameter of an atom. Gravitational effects under laboratory conditions are very small indeed. So, on the basis of the Standard Model of the universe, apart from the transmission of ordinary matter, currently only the electromagnetic force is a candidate for an effective local-causal model of PSI effects. Such influences can experimentally be shielded off easily and effectively.

Every local model of PSI based on known established facts has to face very serious problems:

If any local cause is presupposed, and just for argument's sake we assume the electromagnetic force

is seen as a candidate, then it becomes very difficult to understand how effects at a large distance can be conceptualised. Granted that there may be a weak signal being emitted by a brain – and the invention of the EEG was in fact predicated on just such an assumption following a telepathic experience of its inventor, Hans Berger - we can assume it is weak, in fact it is in the order of some microvolts, and hence will decay rapidly. How to explain telepathic effects over many thousand miles, as have been documented? How to explain distant healing that has been documented at least anecdotally to be independent of distance?

Any local signal is bound – by the current standard model – to travel forward in time. A vast array of PSI effects are independent of time, or even reach backwards in time or forward in time. Precognition is a communication of a mind with its future state. Using a local model would mean that we can communicate faster than light. This, in turn, gives rise to paradoxes of intervention into the past that have been demonstrated 40 years ago to arise, if a local model of signal transfer violates Special Relativity (Fitzgerald, 1971). Hence local signal theoretical models of PSI run into severe difficulties, when it comes to explaining precognition.

One can always stipulate other or new kinds of signals that are as yet not discovered. Such a theoretical stance comes at high costs: The scientific community is reluctant to accept such an assumption a priori, because it would mean that the whole well proven standard model that is complex enough as it stands would have to be reworked, and no one wants to do that without a very good reason. Thus there is bound to be wild resistance against such a proposal. This is in part a social, but very important argument. Some such models have been proposed, for instance assuming multi-dimensional geometries that would allow for other types of regular signals (e.g. Zöllner, 1922, Heim 1984, 1989). But for competent physicists they can be clearly seen not to be state of the art and/or contradicting established physical facts.

We think that the locality-principle fails in PSI research for various reasons (1) The empirical database is incompatible with its basic assumptions: PSI effects are independent of distance and time. This is a strong argument against any local model, at least within the constraints of the standard model. (2) PSI effects are also not in the same sense regular and available at will as local-causal effects are normally assumed to be. Hence, we feel, it is time to search for a non-local and non-causal model

## Generalised Quantum Theory, Generalised Entanglement, and a Non-Local Model of PSI

### *Generalised Quantum Theory*

Generalised Quantum Theory was born out of two impulses: For one, there was the intuition that a theoretical structure that was so successful in explaining the material world might also be useful in other contexts. In addition, we wanted to see what a minimal theoretical frame would look like that could call itself quantum-theoretical and yet would be free of the restrictions that are typical for physical quantum theory proper. So, if one generalises quantum theory and asks the question: Exactly what is it that defines a theory as “quantum theoretical”? Then there is a simple and surprising answer: It is the capability of the theory to handle incompatible, or complementary, or non-commuting operations. (Atmanspacher, Filk, & Römer, 2006; Atmanspacher, Römer, & Walach, 2002; Filk & Römer, 2011; Walach & Stillfried, 2011; Walach & von Stillfried, 2011). Our normal, classical, theories do not have that requirement: We can measure the trajectory of a cannon ball and then determine its momentum, or the other way round. The measurement of one variable is independent of that of the other variable, and neither measurement necessarily disturbs the

measured object or invalidates previous other measurements. This is the type of theory that is applied in nearly all branches of science currently, except in the quantum realm. We call such a theory a classical theory. However, we assume that there are many other instances, where quantum-type theories are necessary. Whenever a measurement necessarily and inevitably impacts on the measured object and changes its state, we have a non-classical situation that needs to be described by a quantum-type, or a non-classical theory. Psychology makes obvious that this is the case rather frequently. Whenever a therapist directs the attention of a client to his or her as yet undefined bad feelings and the client then comes up with a precise description, the feeling has changed itself. This is the gist of good therapy. Whenever a patient uses the items of a questionnaire to describe some state of affairs the answering of the questionnaire will have changed the state to some extent. Any introspection is bound to change the state of mind of the object. Thus, a lot of psychology is in fact a good candidate for a quantum-like theoretical treatment. Learning and understanding, for instance, are non-commuting operations. Normally, we learn first and then understand, and we cannot wilfully change the sequence. Clinically speaking it will make a difference whether we first try to understand a patient and then apply a battery of questionnaires or vice versa. All those operations, where sequencing effects are of importance and where a different sequence of events will yield different results, are non-classical, or quantum-type, in nature and a quantum-like theory suggests itself to model them.

As already mentioned, a general formalism providing a minimal scheme in which the essential notions of incompatibility, complementarity and entanglement (to be described later in this note) can be defined in a clean and meaningful way, without employing additional structural features necessary for quantum physics in the narrow sense was developed under the name of “Generalised Quantum theory” (GQT), also called “Weak Quantum Theory”. (Atmanspacher, Filk, & Römer, 2006; Atmanspacher, Römer, & Walach, 2002; Filk & Römer, 2011). By shedding off features which are specific for quantum physics the formalism of GQT is applicable and in fact has found many applications beyond the realm of physics. (For a list of applications see Filk & Römer, 2011 an application to the relevance of orders of questions in questionnaires is given in Atmanspacher & Römer, 2012) If necessary, the formalism of GQT can be stepwise enriched up to the full quantum theoretical formalism.

It turns out that in fact the only and most important decisive marker of a quantum-like theory is exactly its capacity to model incompatible operations. For a complete description of GQT we refer to the original publications (Atmanspacher, Filk, & Römer, 2006; Atmanspacher, Römer, & Walach, 2002; Filk & Römer, 2011). Here we restrict ourselves to a few hints. In GQT the notions of “system”, “states” and “observables” are taken over from physical quantum theory. An observable  $A$  of a system is a feature of the system which can be observed “measured” in a meaningful way giving a result which has factual validity. This means the following: If a measurement of  $A$  has given a result, say  $a$ , then immediately after the measurement the system is in an “eigenstate”, in which a repeated measurement of  $A$  would yield the same result  $a$  with certainty. After a measurement of  $B$  after  $A$  the system is in an eigenstate of  $B$  and after a measurement of  $A$  after  $B$  the system is in an eigenstate of  $A$ . Two observables  $A$  and  $B$  are called *complementary* or *incompatible*, if there are measured values of one of them, say value  $a$  of  $A$ , such the no eigenstate of  $A$  to the value  $a$  can be an eigenstate of  $B$ .  $A$  and  $B$  are justly called incompatible, because we cannot always define their values precisely at the same time. For incompatible observables  $A$  and  $B$  the order in which they are measured will matter. In this sense,  $A$  and  $B$  do not “commute with each other. Observables  $A$  and  $B$  are called *compatible*, if they are not complementary, i.e if their measurements are interchangeable and do not disturb one another. In a classical setting every observable is compatible with all the others. In (Generalized) Quantum theory two observables need not be compatible but may be complementary. Whenever one of the two incompatible

observables is precisely defined, our knowledge of the other observable may be reduced in precision. In quantum physics proper the Heisenberg uncertainty relationship is an expression of this situation. Yet such incompatible or complementary observables have to be employed at the same time to describe one and the same object or situation. For particles, the classical example is given by location and the momentum. Previous classical theories had no need of such concepts. It was Nils Bohr and his co-researchers who were the first to discover that in order to model quantum-physical effects one had to employ two concepts at the same time that are in conflict, yet are both necessary. Bohr imported the notion “complementarity” from psychology to describe this situation conceptually (Rosenfeld, 1953, 1963). Through the precise definition within quantum mechanics complementarity became a clear notion and is in fact operationalised as incompatible or non-commuting operations. The result of our analysis of generalising quantum theory yielded the somewhat surprising, but easy to grasp result:

*The defining element of any quantum theoretical approach is the capacity to handle non-commuting, or incompatible, or complementary operations.*

If everything else is relaxed, definitions given up, precisions dropped and the final element left intact that is necessary to define a quantum-theoretical approach, it is the handling of such incompatible variables or operations. Thus, the stipulation and the challenge of generalised quantum theory is that other situations might require such a description as well. We have above pointed to some examples from psychology. There are quite a few other aspects which might require such quantum-like descriptions. For instance it has been shown that the switching behaviour of bistable images follows a dynamic that can be predicted and modelled using GQT (Atmanspacher, Bach, Filk, Kornmeier, & Römer, 2008; Atmanspacher, Filk, & Römer, 2004). Others have found that using quantum-like formalism for modelling results of cognition experiments makes the modelling more precise and more closely conforming to empirical results (Pothos & Bussemeyer, 2013). One can speculate that other situations of our lived world contain incompatible descriptors.

Typical candidates for such pairs could be

- goodness and justice
- form and content
- structure and function
- individual and community

to name but a few.

What is important to understand here is that complementary or incompatible concepts cannot be located on the same conceptual plane. Contradictory pairs of opposites can be formally modelled as negations:  $a = \neg b$ ;  $b = \neg a$  such as in “warm is not cold”, or “false is not true”. Complementary pairs are not located on the same plane. Figuratively speaking: they can only be located on an orthogonal conceptual system, and none can be reduced to the other, but of course not all orthogonal concepts are complementary.

Whenever such candidates for complementary or incompatible pairs are necessary, we are dealing, by default, with a quantum-like system and a generalised quantum theory (GQT) is applicable to handle such situations.

### *Entanglement*

One interesting consequence of GQT is of particular importance: GQT, as well as physical quantum theory, predicts a generalised form of non-local correlations.

Schrödinger has discovered this phenomenon already 1935 in the formalism of Quantum Theory and named it “entanglement“ (Schrödinger, 1935). It denotes a situation whereby elements of a quantum system remain correlated no matter how separated they are in space or in time. Suppose

we have a quantum system, two twin-photons say, that have been down-converted through a beam splitting crystal, and we were able to send one photon to alpha-centauri and the other photon to some other star and we had a measurement apparatus on alpha-centauri that measures one of the photon's properties, say its polarisation in a given direction, then we had immediate knowledge about the corresponding polarisation of the second photon that is, by definition, several light years away. Thus, no potential local signal could travel and convey the information between the two measurement apparatuses. This phenomenon occurs because the so-called entangled state of the total system is well determined, but the polarisation of neither of the single photons is determined until it is measured. . Exactly which polarisation value will be measured for one photon is uncertain, but once there is one value defined by measurement, the other one is immediately known. This holds independent of space and time. This correlation is called entanglement, or EPR-correlation (for Einstein, Podolsky and Rosen, who were the first to use this situation for a thought experiment), or non-local correlation.

Entanglement has long remained a kind of a theoretical nuisance of quantum mechanics, but now it is an established fact with emerging technical applications. Moreover, Bell (Bell, 1964, 1987) derived inequalities for correlations between disjoint parts of certain composite system such that these inequalities should be always be fulfilled in classical systems but are violated for some entangled states of quantum systems. These inequalities are experimentally testable and are indeed found to be violated, a strong argument for quantum theory and against an exclusively classical world view. (Aspect, Dalibard, & G., 1982; Aspect, Grangier, & Roger, 1982). Because the experimental set-up was such that a communication between the measurement apparatuses was excluded by principle these correlations are non-local: no classical signal mediates this corresponding behaviour. Rather, it is a consequence of the systemic set-up. It has been shown meanwhile that photons, electrons, multi-particle systems can be entangled and entanglement has been experimentally shown to hold over many kilometers (Gröblacher et al., 2007; Hackermüller et al., 2003; Kwiat, Barraza-Lopez, Stefanov, & Gisin, 2001; Pan, Bouwmeester, Daniell, Weinfurter, & Zeilinger, 2002; Salart, Baas, Branciard, Gisin, & Zbinden, 2008; Stefanov, Zbinden, Gisin, & Suarez, 2002). Futuristic applications such as quantum computing and encryption are founded on this phenomenon, and proof-of-principle studies have already been conducted (Duan, 2011; Nielsen & Chuang, 2000; Niskanen et al., 2007; Olmschenk et al., 2009; Parigi, Zavatta, Kim, & Bellini, 2007; Petta, 2005; Reichle et al., 2006; Svozil, 2001; Tóth & Lent, 2001). .

For what follows it is important to note that we do not assume that quantum-mechanical, physical entanglement correlations are magnified and transported into the macroscopic realm. Although not impossible in principle, such a scenario is unlikely, because these correlations decay fast, as soon as interactions with other systems are happening.

In quantum physics, entanglement is normally discussed by constructing the state space of a composite system as a tensor product of the state spaces of its components and entangled states are defined as not being factorisable with respect to the tensor product. The notion of tensor products is not available in the most general form of GQT. But, in fact, even in quantum physics the core of the notion of entanglement is independent of these technical details. The decisive feature is a complementarity relationship between global observables pertaining to the system as a whole and local observables pertaining to its parts. In the two photon example, the global observable is an observable having the entangled global state as an eigenstate. This observable is complementary to the local polarisation observables of the individual photons, whose values are in fact indeterminate in the global entangled state. Measuring one local polarisation changes the entangled global state. Now, the notion of entanglement can readily be taken over into GQT a consequence of complementarity between global and local observables (Atmanspacher, Filk, & Römer, 2006; Atmanspacher, Römer, & Walach, 2002; Filk & Römer, 2011, Lucadou, Römer & Walach 2007. For

a detailed discussion of entanglement in GQT with many examples see Römer, 2011a)

The genuinely quantum theoretical phenomenon of *entanglement* can and in general will show up also in GQT if the following conditions are fulfilled:

- 1) A system is given inside which subsystems can be identified. Entanglement phenomena will be best visible if the subsystems are sufficiently separated such that local observable pertaining to different subsystems are compatible.
- 2) There is a global observable of the total system, which is complementary to local observables of the subsystems.
- 3) The total system is in an *entangled state*. For instance, eigenstates of the global observable are typically entangled states.

Given these conditions, the measured values of the local observables will in general be uncertain because of the complementarity of the global and the local observables. However, entanglement correlations will be observed between the measured values of the local

observables. These correlations are non local and instantaneous. Einstein, trying to argue for an incompleteness of quantum mechanics, spoke about “spooky interactions” in this connection.

Entanglement correlations are not due to causal interactions between the subsystems.

Rather such correlations without interactions are a witness of the holistic character of composite quantum systems: The states of the subsystems in general do not determine the state of the total system. Vice versa, the holistic state of the total system does not determine the measured values of local observables pertaining to the subsystems. The holistic character of the total quantum state resides in entanglement correlations between the subsystems which enter into the common pattern of a global entangled state.

It is not difficult to show, that in quantum physics entanglement correlations cannot be used for signal transmission between different subsystems. This must also hold in GQT in order to prevent bizarre intervention paradoxes and is formulated as an axiom NT (“Non Transmission”) (Lucadou, Römer, Walach, 2007) in GQT. One may even turn the argument around and state, that whenever correlations between subsystems can be used for signal transfer, they must be of causal nature and entanglement must be absent or at least not dominant.

Like quantum-mechanical entanglement correlations, GET correlations are not bound by space and time. Theoretically they can be even quite strong because they are not necessarily subject to the tendency of rapid decay prevailing in quantum physics.

Note two important corollaries here:

The set-up of GET is strictly driven by the systemic set-up of the whole system and independent of its physical make-up. The system in question could be a physical system, a mental system, or a mix of two different systems. But they have to be joined together by a strong common systemic boundary, for instance by the meaning (pragmatic information, PI) that defines the system (Weizsäcker, 1974). Second: The GQT model makes no predictions as to whether such correlations are ontic in nature, as in quantum physics proper, or epistemic, i.e. due to our lack or knowledge or our epistemic condition. For practical purposes this is irrelevant, but it should be noted. Some experimental PSI phenomena appear to be ontic (Schmidt, 1976, Lucadou, Römer, & Walach, 2007).

## Application to PSI Research

Thus, whenever we have a clearly defined system that binds together subsystems whose description is complementary to the description of the whole system we expect non-local correlations between the systemic elements. Let us probe the model for particular situations. We start with the usual

parapsychological terminology, but it goes without saying that these concepts are attached to the model of signal-transfere and thus the empirical and theoretical basis to use them is questionable as we argued above. The following discussion will put these phenomena in the framework of our GET-non-signal-model.

### *Telepathy*

Telepathy, or “thought reading” as Barrett had called it, is the phenomenon that one mind has access to the content of another mind without classical means of knowledge or communication. This happens, typically, not with people we meet by accident, but normally only when the two persons are somehow related with each other, like between siblings, parents and children, or psychologically close, like in lovers or spouses. Also, doctors and therapists report these phenomena and use it as therapeutic intuition. One could make a case that therapeutic fantasies, that psychoanalytically trained therapists often refer to as “transferences”, are in fact instances of such telepathic connections, and Freud is known to have been interested in these case (Simmonds, 2006); but this leads to far astray. In all those cases we have a clear systemic boundary: The boundary is constituted by kinship and genetics, or by a ritual, as in marriage or in a therapeutic situation. The global observable is connectedness or “organizational closure”(OC) (Varela, 1981). The local observables are separation or individuality. These, we hold, are complementary, and hence the preconditions for non-local correlations between the two systems are fulfilled. Mental content of one system can appear as mental content of the other system, and vice versa. Exactly when and why such an experience is bound to happen is difficult to predict, as the model is not precise enough for such predictions. Experience and anecdotal evidence would suggest that this happens mostly when one individual is in need or in danger, when the connection is very strong as in couples wildly in love, or material is bothering a person, as in unprocessed trauma or dissociation, or in strong unintegrated inner pain.

It is clear from this analysis that the process can be reversed.

### *Healing*

This happens in instances of intentional healing, whether from a distance or in contact (Walach, 2005). Here a healer forms a strong systemic bond, normally through a ritual, cultivates an intention in his or her mind, usually supported by ritual or imagination, and, by virtue of the non-local correlatedness between the two persons, the envisaged situation may occur. The complementary pair is again connectedness and individuality. Likely there is also a second complementary pair operative here: The imagination of the desired state as actual leads to a complementarity between the aim of healing and actual treatment. This may be the vehicle of operation, but clearly, we need more conceptual analysis here.

### *Clairvoyance*

In clairvoyance content is experienced mentally that is physically available elsewhere, as in remote viewing or when people guess material that is somewhere present where they have no classical access to. Remote viewing studies have shown this possible, at least in principle and sometime (May, 1996; McMoneagle, 2000; Puthoff, 1996; Targ, 1996; Targ & Kutra, 2000; Utts, 1996). Again, we have a ritual systemic closure (OC) between an individual and the object, sometimes through a physical ritual that an envelope or something else is touched, held in the hand, put somewhere close to one's body. Sometimes the ritual is purely mental. The same complementarity

holds as above between connectedness (global variable) and separation (local variables). And by virtue of GET content may show up in the mind of the person seeking the information. Again, we do not know, under which circumstances such processes work, and the classified work of US intelligence has shown that it works but is not precise enough for good espionage. But the model can make plausible why and how this can happen.

### *Psychokinesis*

Psychokinesis, spuk or poltergeist phenomena happen, whenever an inner mental process affects a physical system directly without the mediation of classical local cause (Lucadou, 1995). The more spectacular cases are called poltergeist, where visible events in the makro-world happen without apparent causes. Documented cases report tables whirled around and toppled, book cases fallen over, fires started and extinguished by themselves, knives, stones and other heavy objects thrown around, etc (Imich, 1995; Roll, 2003; West, 1990) Phenomenologically speaking such situations seems to require an “agent”, someone who suffers from a – usually – unconscious conflict that cannot be and must not be known and expressed. In such a situation the poltergeist phenomenon seems to “express” the mental content phenomenologically. One of us was involved in a poltergeist-resolution where a young female secretary was strongly focused on her boss, a relationship which was impossible to express, because the boss was happily married and had no interest to pursue a relationship. In short: The spuk started, when the boss had to go on a business trip. He said to his employees: “Only call me, when it burns!”. Sure enough, after the boss had gone on his trip, fires started in his office. The boss had to return. Later, the shutters of the windows, without anybody setting them ablaze began to burn when his wife came to the office. As a funny aside, the German word for shutters is “Jalousie”, derived from the French, meaning “jealous”. Thus, this particular poltergeist also had the phenomenological wisdom to express the inner dynamics of the jealous secretary, who likely was jealous of the wife..

How can such a strange situation be conceptualised? Again, we have a strong systemic closure (OC) that ties together various systemic elements. We normally have poltergeist phenomena within families. Here we have it within a company and within a sub-system of the company formed by the boss and his secretary, who, however, has no chance of expressing and fulfilling, perhaps not even admitting or being aware of her feelings. This forms a strong subsystem between the secretary and her boss. Again, complementarity between connectedness and individuality holds, describing the global and the local observables. Strong emotional material, usually disavowed or disconnected from the inner life, seeks some form of expression. As it happens, the expression is found in the outer reality that bears some symbolic connectedness with the total system. Thus, a non-local correlation is made operative that exists between elements of a system by virtue of a strong systemic boundary. Exactly why material objects are involved, and not, say only mental content as in clairvoyance is a point for debate. One could speculate that, had the boss been more receptive and telepathically felt the strong connection, verbalised this and helped the secretary express and live through her feelings, the poltergeist would not have been necessary. In that sense, we conceptualise poltergeist as a more massive form of non-local correlation that is normally felt in telepathy, that becomes operative if telepathy fails, or perhaps under yet to be defined other boundary conditions.

Micro-PK as is used in experimental realisations, when voluntary subjects are to influence random processes, are simply a more artificial setting using the same processes.

### *Precognition and Presentiment*

Precognition is, conceptually speaking, the most challenging phenomenon, because it defies, by definition, a local explanation. In it a mental system receives content about its future state. Even if precognition is targeted at future events, as in classical prophecies, it is still a relationship of a mind with its future state, as the events can only be relevant as known or otherwise mentally present. A slight variation is presentiment, where the content is not consciously known but subconsciously felt and made visible by, for instance, monitoring autonomic arousal. But if we adopt a wide notion of “mind” and “mental content” to also comprise subliminal mental material and all elements processed by our neuronal system, then we can also include presentiment.

We have again a systemic boundary that comprises the mental system and its future state. The boundary is set here by meaning (PI). Precognitive events and presentiment effects are not arbitrary, but happen for a reason. In presentiment they have been experimentally discovered in situation, where the individual is about to face potentially threatening situations and can thus be thought of as a warning system. In other precognitive situations, as in precognitive dreams, we observe, phenomenologically speaking, the same. They usually either have a warning or a preparatory function that help the individual deal with dangerous or important situations. Thus the systemic closure is one of meaning and relevance. As an interesting aside, this can only be defined by the future event that actually will happen in the distant future. However, if it forms a systemic boundary with a present mental system, then, by definition, a future meaning has an effect in the presence, pointing to a deficient current notion of time anyway. But this is just an aside. Systemic closure is produced by meaning and importance, or the pragmatic information that is being processed. The complementarity that is operative here seems to be one between potentiality, the global descriptor, and actuality, the local descriptor. This forms the basis for the entanglement between the present moment state of the mental system and its future state.

Thus, we have covered the major instances of PSI or anomalous cognition that form the basis of the various parapsychological phenomenologies. We have shown that one and the same model can form the basis of an understanding of such phenomena in terms of generalised non-local correlations within a generalised quantum theory. Obviously, the key issues are twofold: We need to nominate a clear candidate for a strong systemic boundary. In all instances, such systemic boundaries are either given or intentionally set. And we need a pair of complementary observables that describe the system and its components. In most cases the complementarity between connectedness and separation will be sufficient to fulfil this requirement. Wherever some wilful or involuntary action in the real world is part of the phenomenology, it might be the case that a second complementarity between actuality and potentiality comes into play. And it might be the case that this acts as a driver.

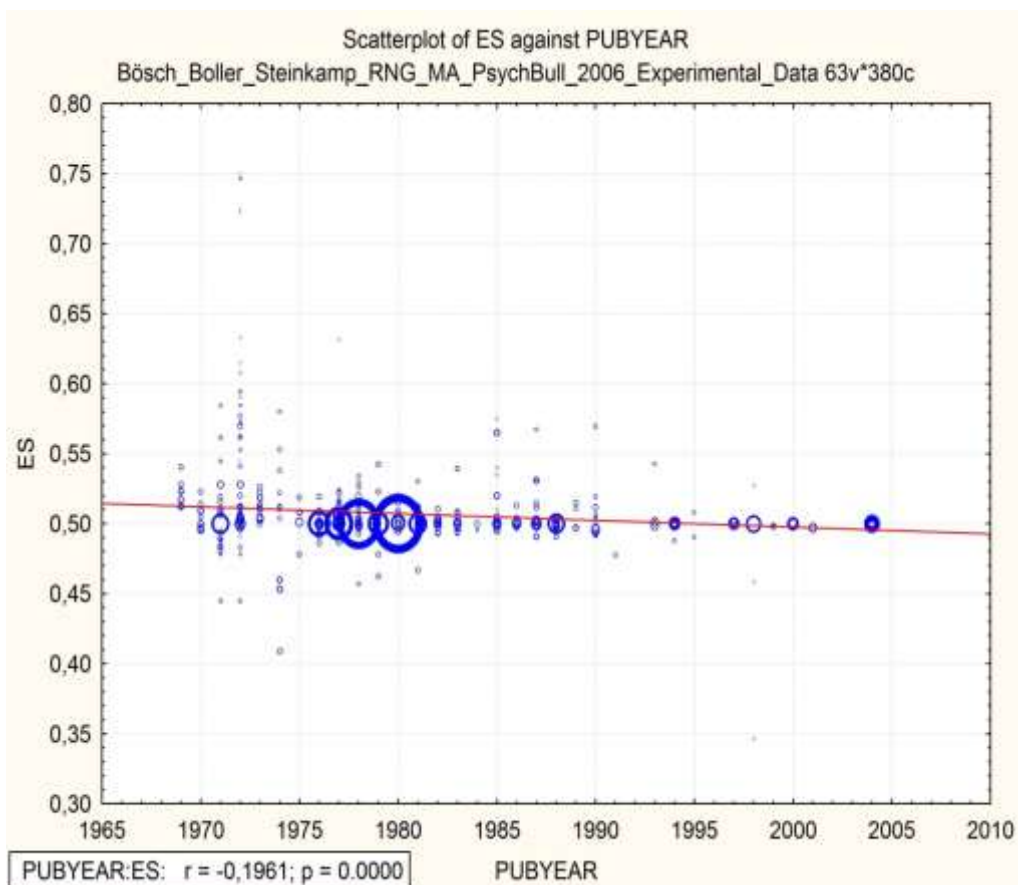
## Consequences, Empirical Observations, Future Directions

One consequence of this model should be immediately obvious: Generalised entanglement correlations are non-local and hence will eschew any detector system long-term that is geared towards detecting regular, local causality, such as classical experimentation is. This is the reason why we have postulated the no-signal-transfer axiom (NT axiom). In quantum physics proper it is clear and has been proven that entanglement correlations cannot be used to convey classical signal (Lucadou, Römer, & Walach, 2007). If this is done or could potentially be done entanglement breaks down. While this can be formally proven for the quantum physical case, in the generalised case we simply assume it as an axiom. This has two consequences: Whenever we set out to “prove” PSI effects, using classical experiments, we are in fact coding a signal. The results of the first experiment can be used, in principle, to code a signal the second time the experiment is repeated. Suppose we always see a rise in an EDA-curve (Electro Dermal Activity), shortly before a

threatening image is presented. We develop the smart idea to build a danger-sensing system for soldiers, for instance, by attaching the EDA of a subject to an analyse (Mossbridge et al., 2014). Whenever the EDA rises repeatedly above a threshold defined by previous experimentation, we call it a hit. And the hit moves the subject to stop, for instance. That way, we could use entanglement correlations that are non-local to code a signal that would be causal and because derived from non-local correlations not bound to the locality conditions of special relativity. Apparently, nature does not allow such a scenario (due to the intervention-paradox), and the prediction from the NT-axiom would be: such a device will be unreliable. Not in all instances, where the EDA-signal goes up, will there be danger, and in some dangerous situations the EDA signal will instead go down, killing the bearer of the device and demonstrating that non-local correlations cannot and must not be misinterpreted as causal signals. Exactly this is, what classical experimentation does, and this is, in our view, the reason, why some decisive replications failed. Granted, overall and across experiments, meta-analyses show effects, although also here it is debated, whether there is not a decline of effects.

For instance, the largest and longest sequence of comparatively identical experiments of micro-PK analysed by Bösch, Boller and Steinkamp (2006) clearly exhibits such a decline effect (Figure 1).

Figure 1 – Scatterplot of correlation of Effect Size (ES; mean chance expectation = 0.5) versus publication year, study size indicated, showing a clear significant negative correlation indicating a decline effect



One could argue that decline effects are also expected, when stricter control conditions are applied. We don't think that this is a valid argument in this case, as the experiments have been conducted the same way over most of the time and hence methodological aspects are unlikely explanations for the

decline. Decline effects would also be a consequence of experimental testing of correlational effects. Hence, in the very long run, the strategy of amassing experimental evidence and distilling out a true effect size using meta-analysis might be treacherous. It can only be used, if there is such a thing as a true effect size in the sense of a causal signal. Our expectation would be that this will not work long term, because there is no causal effect in the first place.

This is also the reason, by the way, why pragmatically speaking the most robust advice one can give to victims of spuk phenomena is to observe and document the effects as closely as possible, with cameras covering all angles. This restriction of the degrees of freedom of the effect seems to have the consequence of destroying the correlations. It turned out, that in practice, this method is very successful.

Sometimes one can hear the argument: Why, in physics entanglement correlations have been experimentally proven. Why not for the generalised case? It is important to analyse how the experimental test in physics was done. In what we term “experiment” here, an experimental condition is tested against an artificially created control condition. This gives rise to the potential signal coding in a replication experiment. In physics entanglement correlations were proven against a theoretical prediction that was derived from a precise theory. That is, in the physical entanglement experiments two streams of data were generated, polarisation measurements of stream A and analogous measurements of stream B. Their correlation function was then compared not against another, artificially produced control condition but against the theoretical expectation derived from Bell's inequalities. This is a completely different experimental and theoretical situation. For in no way could the correlation function measured in this data stream in any way be used to generate a signal.

Thus, in order to construct an experimental proof in the generalised situation we must stop with classical experimentation. Some experimenters do instinctively the right thing: they never repeat experiments exactly the same, but always change some parameters. The problem only arises with exact replications. As soon as changes are introduced – new parameters, new variables – the system is, technically and conceptually speaking, a new system. But for scientific acceptance replicability of experimental paradigms is key.

A way out is to design an experiment which is indirect. We did that by using a matrix approach to analysing a micro-PK experiment. In this experiment a classical micro-PK situation was generated, instructing volunteers to influence a display that was driven by a random number generator. A classical experiment such as have been conducted by the PEAR lab, would look at the mean shift against expectation values. We constructed a large array of potential correlations using 5 physical variables derived from the experiment and 5 psychological variables, such as number of key presses and time used for the runs. Since each experiment consisted of 9 runs we had a matrix of  $45 \times 45$  cells which gives a huge array of 2025 potential correlations between physical and psychological variables. Now, in any correlational analysis one would expect a certain number of significant correlations by chance. However, if entanglement correlations are also operative, we would expect more significant correlations than by chance. Furthermore we constructed a negative control by letting the system run empty and pasting the psychological variables into the physical matrix, correlating these empty runs with the psychological variables. This experiment had already proved replicable in four previous attempts and was now successfully replicated by an independent replication.

Thus it seems, if we obey the framework conditions of the NT theorem and build an experimental set-up that, in principle, cannot be used to distil a signal out of the experiment when identically replicated, GET effects seem to be amenable to experimental analysis. The correlational matrix approach obeys this boundary conditions. For it is completely irrelevant which cell of the matrix will exhibit the significant correlations as long as there are more numerable than expected by

chance and more than seen in the control condition. Only if we were to fix the effect and predict which cell it will show up in would we be on the trajectory of defining signals and would fail. This would, incidentally, also constitute an empirical test between the two models, the non-local and the local one. A local model would predict that the cells stay the same. The non-local model would predict that the cells have to change, but the effect overall stays the same. This is already true for the five experiments conducted so far: the effect stays the same, but the cells in the matrix that are significant correlations jump.

Another way to test these models against each other would be to run a series of replications of the matrix experiment. While the local model looks at the mean shift and expects a replicable mean shift over experiments this is exactly what the non-local model prohibits. It would predict that correlations stay the same, but the effect in mean shift will decline towards zero..

With some ingenuity also other experimental models can be adapted such that it becomes operationally impossible to code signals from experiments and their replications. Then, this would be our prediction, GET effects can be replicably shown.

In sum: We have shown that a theoretical model that is predicated on generalised entanglement correlations derived from a generalised quantum theory can be used to model PSI effects of all kinds. This makes it preferable over other models that can only cover certain types of phenomenologies. We have also shown that such a model explains why local assumption fail in PSI research. It makes plausible, why we have exactly the data structure in the field that we have. This makes the model preferable over any tacit or explicit local signal-theoretical models. We have also shown why experimentation has to proceed in indirect ways and pointed towards a future development of the field.

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#### References

- Alcock, J. E. (2003). Give the null hypothesis a chance: Reasons to remain doubtful about the existence of PSI. *Journal of Consciousness Studies*, 10(6-7), 29-50.
- Aspect, A., Dalibard, J., & G, R. (1982). Experimental test of Bell's inequalities using time varying analyzers. *Physics Review Letter*, 49, 1804-1807.
- Aspect, A., Grangier, P., & Roger, G. (1982). Experimental realization of Einstein-Podolsky-Rosen-Bohm-Gedankenexperiment: A new violation of Bell's inequalities. *Physics Review Letter*, 49, 91-94.
- Atmanspacher, H., Römer, H., & Walach, H. (2002). Weak quantum theory: Complementarity and entanglement in physics and beyond. *Foundations of Physics*, 32, 379-406
- Atmanspacher, H., Bach, M., Filk, T., Kornmeier, J., & Römer, H. (2008). Cognitive time scales in a Necker-Zeno-model for bistable perception. *The Open Cybernetics and Systems Journal*, 2, 234-251.
- Atmanspacher, H., Filk, T., & Römer, H. (2004). Quantum Zeno features of bistable perception. *Biological Cybernetics*, 90, 33-40.
- Atmanspacher, H., Filk, T., & Römer, H. (2006). Weak Quantum Theory: Formal Framework and Selected Applications. In A. Khrennikov (Ed.), *Quantum Theory: Reconsiderations of Foundations - American Institute of Physics, Conference Proceedings*. New York, USA: Melville.
- Atmanspacher, H., Römer, H. (2012). "Order Effects in Sequential Measurements of Non-Commutative Psychological Observables", Sept. 2011, <http://arxiv.org/abs/1201.4685>, *Journal of Mathematical Psychology* 56 (2012), 274-280.
- Bacon, F. (1990). *Neues Organon. Lateinisch-deutsch. Hrsg. und mit einer Einleitung von. W. Krohn*. Hamburg: Meiner.
- Barrett, W. F. (1882). First report on thought reading. *Proceedings of the Society for Psychical Research*, 1, 13-64.

- Barrett, W. F. (1924). Some reminiscences of Fifty Years' Psychical Research. *Proceedings of the Society for Psychical Research*, 34, 275-297.
- Bell, J. S. (1964). On the Einstein-Podolsky-Rosen-paradox. *Physics*, 1, 195-200.
- Bell, J. S. (1987). *Speakable and Unsayable in Quantum Mechanics*. Cambridge: Cambridge University Press.
- Bösch, H., Steinkamp, F., & Boller, E. (2006). Examining psychokinesis: the interaction of human intention with random number generators - a meta-analysis. *Psychological Bulletin*, 132, 497-523.
- Dawkins, R. (2006). *The God Delusion*. London: Bantam Press.
- Duan, L.-M. (2011). Quantum correlation between distant diamonds. *Science*, 334, 1213-1214.
- Emerson, G. B., Warme, W. J., Wolf, F. M., Heckman, J. D., Brand, R. A., & Leopold, S. S. (2010). Testing for the presence of positive-outcome bias in peer review. *Archives of Internal Medicine*, 170, 1934-1939.
- Filk, T., & Römer, H. (2011). Generalized Quantum Theory: Overview and latest developments. *Axiomathes*, 21, 211-220.
- Fitzgerald, P. (1971). Tachyons, backwards causation and freedom. *Boston Studies in the Philosophy of Science*, 8, 415-436.
- French, C. C. (2003). Fantastic memories: The relevance of research into eyewitness testimony and false memories for reports of anomalous experiences. *Journal of Consciousness Studies*, 10(6-7), 153-174.
- Gernert, D. (2008). Ho to reject any scientific manuscript. *Journal of Scientific Exploration*, 22, 233-243.
- Gröblacher, S., Paterek, T., Katenbaek, R., Brukner, C., Zukowski, M., Aspelmeyer, M., et al. (2007). An experimental test of non-local realism. *Nature*, 446, 871-875.
- Hackermüller, L., Uttenthaler, S., Hornberger, K., Reiger, e., Brezger, B., Zeilinger, A., et al. (2003). The wave nature of biomolecules and fluorofullerenes. *Physical Review Letters*, 91, 90408-90401-90408-90404.
- Heim, B. (1984). *Elementarstrukturen der Materie. Einheitliche strukturelle Quantenfeldtheorie der Materie und Gravitation Bd. 2*. Innsbruck: Resch-Verlag.
- Heim, B. (1989). *Elementarstrukturen der Materie. Einheitliche strukturelle Quantenfeldtheorie der Materie und Gravitation Bd. 1*. Innsbruck: Resch-Verlag.
- Henderson, M. (2010). End of the peer review show. *British Medical Journal*, 340, 738-740.
- Hume, D. (1977). *A Treatise of Human Nature*. London: Dent.
- Imich, A. (Ed.). (1995). *Incredible Tales of the Paranormal: Documented Accounts of Poltergeists, Levitations, Phantoms, and Other Phenomena*. New York: Bramble Books.
- Jahn, R. G., Dunne, B. J., Bradish, G. J., Dobyns, Y. H., Lettieri, A., Nelson, R. D., et al. (2000). Mind/machine interaction consortium: PortREG replication experiments. *Journal of Scientific Exploration*, 14, 499-555.
- Kuhn, T. (1955). *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
- Kwiat, P. G., Barraza-Lopez, S., Stefanov, A., & Gisin, N. (2001). Experimental entanglement distillation and 'hidden' non-locality. *Nature*, 409, 1014-1017.
- Latour, B. (1999). *Pandora's Hope: An Essay on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.
- Latour, B., & Bastide, F. (1986). Writing science - Fact and fiction: The analysis of the process of reality construction through the application of socio-semiotic methods to scientific texts. In M. Callon, J. Law & A. Rip (Eds.), *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World* (pp. 51-66). Houndmill & London: Macmillan.
- Laudan, L. (1977). *Progress and its Problems: Towards a Theory of Scientific Growth*. Berkeley: University of California Press.
- Lee, C. J., Sugimoto, C. R., Zhang, G., & Cronin, B. (2013). Bias in peer review. *Journal of the American society for Information Science and Technology*, 64, 2-17.
- Loughlin, M., Lewith, G., & Falkenberg, T. (2013). Science, practice and mythology: A definition and examination of the implications of scientism in medicine. *Health Care Analysis*, 21, 130-145.
- Lucadou, W. v. (1995). *Psyche und Chaos. Theorien der Parapsychologie*. Frankfurt: Insel.
- Lucadou, W. v., Römer, H., & Walach, H. (2007). Synchronistic Phenomena as Entanglement Correlations in Generalized Quantum Theory. *Journal of Consciousness Studies*, 14(4), 50-74.
- Martin, B. (1998). Strategies for dissenting scientists. *Journal of Scientific Exploration*, 12, 605-616.
- Martin, B. (2004). Dissent and heresy in medicine: models, methods, and strategies. *Social Science and Medicine*, 58, 713-725.
- May, E. C. (1996). The American Institutes for Research Review of the Department of Defense's STAR GATE Program: A commentary. *Journal of Scientific Exploration*, 10, 89-107.
- McMoneagle, J. (2000). *Remote Viewing Secrets*. Charlottesville VA: Hampton Roads Publ.
- Milton, J., & Wiseman, R. (1999). Does PSI exist? Lack of replication of an anomalous process of information transfer. *Psychological Bulletin*, 125, 387-391.
- Mossbridge, J., Tressoldi, P. E., & Utts, J. (2012). Predictive physiological anticipation preceding seemingly

- unpredictable stimuli: a meta-analysis. *Frontiers in Psychology*, 3(Artc. 390).
- Mossbridge, J. A., Tressoldi, P., Utts, J., Ives, J. A., Radin, D., & Jonas, W. B. (2014). Predicting the unpredictable: critical analysis and practical implications of predictive anticipatory activity. *Frontiers in Human Neuroscience*, 8(Articl. 146), doi: 10.3389/fnhum.2014.00146.
- Nielsen, M. A., & Chuang, I. L. (2000). *Quantum Computation and Quantum Information*. Cambridge; New York: Cambridge University Press.
- Niskanen, A. O., Harrabi, K., Yoshibara, F., Nakamura, Y., Lloyd, S., & Tsai, J. S. (2007). Quantum coherence tunable coupling of superconducting qubits. *Science*, 316, 723-726.
- Olmschenk, S., Matsukevich, D. N., Maunz, P., Hayes, D., Duan, L.-M., & Monroe, C. (2009). Quantum teleportation between distant matter qubits. *Science*, 323, 486-489.
- Pan, J.-W., Bouwmeester, D., Daniell, M., Weinfurter, H., & Zeilinger, A. (2002). Experimental test of quantum nonlocality in three-photon Greenberger-Horne-Zeilinger entanglement. *Nature*, 403, 515-519.
- Parigi, V., Zavatta, A., Kim, M., & Bellini, M. (2007). Probing quantum commutation rules by addition and subtraction of single photons to/from a light field. *Science*, 317, 1890-1893.
- Petta, J. R., Johnson, A.C., Taylor, J.M., Laird, E.A., Yacoby, A., Lukin, M.D., Marcus, C.M., Hanson, M.P., Gossard, A.C. (2005). Coherent manipulation of coupled electron spins in semiconductor quantum dots. *Science*, 309, 2180-2184.
- Popper, K. R. (1976). *Logik der Forschung* (6. verb. Auflage ed.). Tübingen: J.C.B. Mohr.
- Pothos, E. M., & Busemeyer, J. R. (2013). Can quantum probability provide a new direction for cognitive modeling. *Behavioral and Brain Sciences*, 36, 255-327.
- Puthoff, H. E. (1996). CIA-initiated remote viewing program at Stanford Research Institute. *Journal of Scientific Exploration*, 10, 63-76.
- Putnam, 1975 #7896;
- Reichenbach, H. (1957). *The Philosophy of Space and Time*. New York: Dover.
- Reichle, R., Leibfried, D., Knill, E., Britton, J., Blakestad, R. B., Jost, J. D., et al. (2006). Experimental purification of two-atom entanglement. *Nature*, 443, 838-841.
- Ritchie, S. J., Wiseman, R., & French, C. C. (2012). Failing the future: three unsuccessful attempts to replicate Bem's 'retroactive facilitation of recall' effect. *PLoS One*, 7(3), e33423.
- Ritter, J. M. (2011). Impact, orthodoxy and peer review *British Journal of Clinical Pharmacology*, 72, 367-368.
- Roll, W. G. (2003). Poltergeists, electromagnetism and consciousness. *Journal of Scientific Exploration*, 17, 75-86.
- Römer, H. (2011). Why do we see a classical world? In *Contributions to the Symposium in Honour of B. Hiley, Helsinki, Nov. 2010*.
- Römer, H.: (2011a) *Verschränkung*, 2008, in : "Post-Physikalismus", M. Knaup, T.Müller, P. Spät eds, Verlag Karl Alber, (Freiburg /München) 2011, ISBN 978-495-48464-7
- Rosenfeld, L. (1953). Strife about complementarity. *Science Progress*, 41, 393-410.
- Rosenfeld, L. (1963). Niels Bohr's contribution to epistemology. *Physics Today*, 16(Oct), 47-54.
- Salart, D., Baas, A., Branciard, C., Gisin, N., & Zbinden, H. (2008). Testing spooky actions at a distance. *Nature*, 454, 861-864.
- Schmidt, H. (1976). PK effect on prerecorded targets. *Journal of the American Society for Psychical Research*, 70, p. 267-291.
- Schmidt, S. (2012). Can we help just by good intentions? A meta-anaylsis of experiments on distant intention effects. *Journal of Alternative & Complementary Medicine*, 18, 529-533.
- Schmidt, S., Erath, D., Ivanova, V., & Walach, H. (2009). Do you know who's calling? Experiments on Anomalous Cognition in Phone Call Receivers. *The Open Psychology Journal* 2, 12-18.
- Schmidt, S., Schneider, R., Utts, J., & Walach, H. (2004). Remote intention on electrodermal activity - Two meta-analyses. *British Journal of Psychology*, 95, 235-247.
- Schmidt, S., Tippenhauer, G., & Walach, H. (2001). Connectedness between participants in an experiment on distant intention. In *The Parapsychological Association 44th Annual Convention. Proceedings of Presented Papers* (pp. 285-300). Durham, NC: The Parapsychological Association.
- Schrödinger, E. (1935). Discussion of probability relations between separated systems. *Proceedings of the Cambridge Philosophical Society*, 31, 555-563.
- Sheldrake, R. (2013). *The Science Delusion: Freeing the Spirit of Inquiry*. London: Hodder & Stouton.
- Simmonds, J. G. (2006). The oceanic feeling and a sea change: Historical challenges to reductionist attitudes to religion and spirit from within psychoanalysis. *Psychoanalytic Psychology*, 23, 128-142.
- Smith, B. (1994). *Austrian Philosophy. The Legacy of Franz Brentano*. Chicago: Open Court.
- Society for Psychical Research. (1882). Objects of The Society. *Proceedings of the Society for Psychical Research*, 1, 3-6.
- Stefanov, A., Zbinden, H., Gisin, N., & Suarez, A. (2002). Quantum correlations with spacelike separated beam splitters

- in motion: Experimental test of multisimultaneity. *Physical Review Letters*, 88, 120404-120401-120404-120404.
- Storm, L., Tressoldi, P. E., & Di Riso, L. (2012). Meta-analysis of ESP studies, 1987-2010: Assessing the success of the forced choice design in parapsychology. *Journal of Parapsychology*, online.
- Suppe, F. (Ed.). (1977). *The Structure of Scientific Theories*. Urbana: University of Illinois Press.
- Svozil, K. (2001). Quantum information: the new frontier. In I. Antiniou, C. S. Calude & M. J. Dinneen (Eds.), *Unconventional Models of Computation* (pp. 248-272). London, Heidelberg: Springer.
- Targ, R. (1996). Remote viewing at Stanford Research Institute in the 1970s: A memoir. *Journal of Scientific Exploration*, 10, 77-88.
- Targ, R., & Kutra, J. E. (2000). Remote viewing in a group setting. *Journal of Scientific Exploration*, 14, 107-114.
- Tóth, G., & Lent, C. S. (2001). Quantum computing with quantum-dot cellular automata. *Physical Review A*, 63(52315), 1-9.
- Toulmin, S. (1985). Conceptual revolutions in science. In R. S. Cohen & M. W. Wartofsky (Eds.), *A Portrait of Twenty-Five Years: Boston Colloquium for the Philosophy of Science 1960 -1985* (pp. 58-74). Dordrecht: Reidel.
- Tressoldi, P. E. (2011). Extraordinary claims require extraordinary evidence: the case of non-local perception, a classical and Bayesian review of evidence. *Frontiers in Psychology*, 2(2), Art 117.
- Utts, J. (1996). An assessment of the evidence for psychic functioning. *Journal of Scientific Exploration*, 10, 3-39.
- Varela, F. J. (1981), Autonomy and autopoiesis. In: G. Roth, H. Schwengler (eds.): *Self organizing systems* (Frankfurt: Campus), pp. 14-23
- Walach, H. (2005). Generalized Entanglement: A new theoretical model for understanding the effects of Complementary and Alternative Medicine. *Journal of Alternative and Complementary Medicine*, 11, 549-559.
- Walach, H., & Stillfried, N. v. (2011). Generalised Quantum Theory—Basic idea and general intuition: A background story and overview. *Axiomathes*, DOI 10.1007/s10516-010-9145-5.
- Walach, H., & von Stillfried, N. (2011). Generalizing Quantum Theory - Approaches and Applications. *Axiomathes* 21 (2)(Special Issue), 185-371.
- Weizsäcker, E. v. (1974), Erstmaligkeit und Bestätigung als Komponenten der pragmatischen Information. In: E. v. Weizsäcker (Hrg.): *Offene Systeme I* (Stuttgart: Klett), pp. 83-113.
- West, D. J. (1990). A pilot census of hallucinations. *Proceedings of the Society for Psychical Research*, 48, 264-300.
- Zöllner, F. (1922). *Vierte Dimension und Okkultismus*. (hg. von R. Tischner). Leipzig Mutze 1922