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RESEARCH ARTICLE

Parapsychological Phenomena as Examples of Generalized 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 of how such effects could be conceptualized. In general, parapsychological (PSI) research has been rather devoid of theorizing 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 were 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 nonlocal correlations. These are predicted by Generalized 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 analyze the standard paradigms of PSI-research along those lines and describe how they can be reconceptualized as instances of such generalized nonlocal correlations. A direct consequence of this conceptual framework is that misrepresentations 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 of 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 Journal are among those who have experienced this truism (Gernert 2008, Martin 1998). This view has been haunting science since the heydays of neopositivism at the beginning of the 20th century in the Vienna circle, when philosophers of science thought that the kernel of science is observation, and that 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, because 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, 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 such as the French National Academy, or political decisionmakers, or important newspaper editors.

In our day, these opinion leaders outside the scientific community proper are powerful science editors of journals, newspapers, and TV magazines, funding agencies, and political decisionmakers (Emerson, Warme, Wolf, Heckman, Brand, & Leopold 2010, Henderson 2010, Lee, Sugimoto, Zhang, & Cronin 2013, Ritter 2011).

A successful scientific theory for any class of phenomena thus consists of 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 among those who 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 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 which 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, 130 years of research, some at high-profile university institutions, have not really brought us any further toward 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 (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 1970s, 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 outside 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 within the larger 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 Generalized 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 generalized 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 with 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 paved the way in practical terms and Francis

Bacon 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 1990:182). Experiments are willful 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. 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:109ff). Experiments are detectors for such stable, replicable, regular causes, or at least for conditions of that type which we can use to analyze 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 hopes to experimentation. While early-days PSI research was mainly observational in nature, mapping PSI experiences of the population and 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-days 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 [London] *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 1882:48, 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 criticized his colleagues for adopting a crypto-signal theoretical model, when he wrote:

> The phrase *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: 294)

Barrett notes correctly that "thought transference" adopts a theoretical model that assumes some signal travelling through space from one mind to another, and criticizes it for its theoretical assumptions. 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 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 at the finite speed of light of approximately 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 radiated into a fixed direction but rather emitted in 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 the signal has 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 kind of signal. 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 a result of intensive large-scale research over several decades, gravitational detectors are expected 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.

In addition to electromagnetic and gravitational interactions, the current standard model of physics knows 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 conceptualized. 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 on the order of some microvolts, and hence will decay rapidly. How do we explain telepathic effects over many thousands of miles, as have been documented? How do we 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 backward 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 were 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 undiscovered. Such a theoretical stance comes at high cost: 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 clearly be 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 nonlocal and non-causal model.

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

Generalized Quantum Theory

Generalized 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 generalizes 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 cannonball 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 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. In psychology this is obviously the case rather frequently. For instance, 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 itself has changed. 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 participant. 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 willfully 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 is useful 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 clear and meaningful way, without employing additional structural features necessary for quantum physics in the narrow sense, was developed under the name of “Generalized Quantum Theory” (GQT), initially called “Weak Quantum Theory” (Atmanspacher, Filk, & Römer 2006, Atmanspacher, Römer, & Walach 2002, Filk & Römer 2011). By shedding features that are specific for quantum physics, the formalism of GQT is applicable and in fact has found many applications beyond the realm of physics. Filk and Römer (2011) provide a list of applications, and Atmanspacher and Römer (2012) applied it to sequencing of questions in questionnaires. If necessary, the formalism of GQT can be enriched stepwise to again yield 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, i.e. “measured” in a meaningful way, yielding a result that has factual validity. This means the following: If a measurement of A has yielded 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 following A the system is in an eigenstate of B, and after a measurement of A following 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 that 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 an 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 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 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 operationalized as incompatible or non-commuting operations. The result of our analysis of generalizing 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 generalized 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 areas that might require such quantum-like descriptions. For instance, it has been shown that the switching behavior of bistable images follows a dynamic that can be predicted and modeled using GQT (Atmanspacher, Bach, Filk, Kornmeier, & Römer 2008, Atmanspacher, Filk, & Römer 2004). Others have found that using a quantum-like formalism for modeling results of cognition experiments makes the modeling more precise and more closely conforming to empirical results (Pothos & Busemeyer 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”. 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 generalized 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 generalized form of nonlocal correlations.

Schrödinger had discovered this phenomenon in 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 polarization in a given direction, then we would have immediate knowledge about the corresponding polarization 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 polarization of neither of the single photons is determined until it is measured. Exactly which polarization 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 nonlocal 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 systems such that these inequalities should 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, & Roger 1982, Aspect, Grangier, & Roger 1982). Because the experimental setup was such that a communication between the measurement apparatuses was excluded by principle, these correlations are nonlocal: No classical signal mediates this corresponding behavior. Rather, it is a consequence of the systemic setup. It has been shown meanwhile that photons, electrons, or multi-particle systems can be entangled, and entanglement has been experimentally shown to hold over many kilometers (Gröblacher, Paterek, Katenbaek, Brukner, Zukowski, Aspelmeyer, et al. 2007, Hackermüller, Uttenthaler, Hornberger, Reiger, Brezger, & Zeilinger 2003, Kwiat, Barraza-Lopez, Stefanov, & Gisin 2001, Pan, Bouwmeester, Daniell, Weinfurter, Zeilinger, et al. 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, Harrabi, Yoshibara, Nakamura, Lloyd, & Tsai 2007, Olmschenk, Matsukevich, Maunz, Hayes, Duan, & Monroe 2009, Parigi, Zavatta, Kim, & Bellini 2007, Petta, Johnson, Taylor, Laird, Yacoby, Lukin, Marcus, Hanson, & Gossard 2005, Reichle, Leibfried, Knill, Britton, Blakestad, Jost, Langer, Ozeri, Seidelin, & Wineland 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 factorizable 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 polarization observables of the individual photons, whose values are in fact indeterminate in the global entangled state. Measuring one local polarization 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, 2011b).

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 observables 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 nonlocal 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 a 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 setup of GET is strictly driven by the systemic setup of the whole system and independent of its physical makeup. 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 meaning or 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 of 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 nonlocal 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-transfer, 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, as with siblings, parents and children, or are psychologically close, such as lovers or spouses. Also, doctors and therapists report these phenomena and use them as therapeutic intuition. One could make a case that therapeutic fantasies, which 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 cases (Simmonds 2006); but this leads us too 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 nonlocal 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 something 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 with 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 nonlocal 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 future potentiality, or the aim of healing, and current reality, the actual situation. This may be the vehicle of operation, but clearly we need more conceptual analysis.

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. Remote viewing studies have shown this is possible, at least in principle (May 1996, McMoneagle 2000, Puthoff 1996, Targ 1996, Targ & Katra 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 has touched, held in the hand, or 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 U.S. intelligence has shown that it works but is not precise enough for espionage (Targ 1996, Puthoff 1996, Utts 1996). 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 causes (Lucadou 1995). The more spectacular cases are called poltergeist, where visible events in the macro-world happen without apparent causes. Documented cases report tables whirled around and toppled, bookcases 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 seem 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 in pursuing 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 if there is fire!" 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 conceptualized? 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 subsystem 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 nonlocal correlation becomes 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 felt the strong connection, verbalized this, and helped the secretary express and live through her feelings, the poltergeist would not have been necessary. In that sense, we conceptualize poltergeist as a more massive form of nonlocal 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 realizations, when voluntary subjects are to influence random processes, is 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 a 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 thing. 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 present, 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 generalized nonlocal correlations within a generalized 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 fulfill this requirement. Wherever some willful 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: Generalized entanglement correlations are nonlocal and hence will eschew any detector system long-term that is geared toward 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 signals (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 generalized 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 analyzer (Mossbridge, Tressoldi, Utts, Ives, Radin, & Jonas 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 nonlocal to code a signal that would be causal, and because derived from nonlocal 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

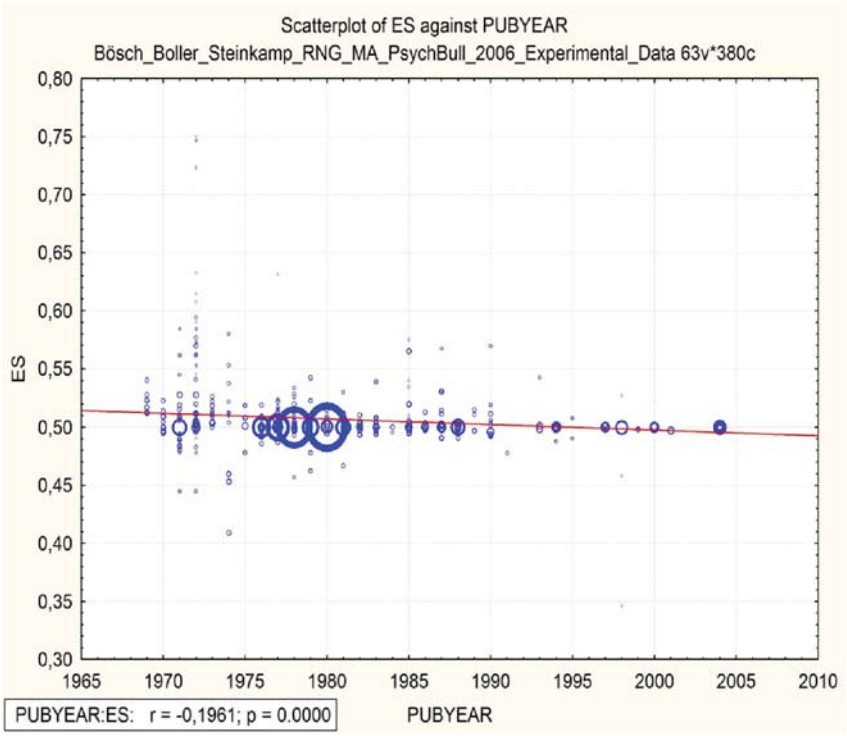

Figure 1. **Scatterplot of correlation of Effect Size (ES; mean chance expectation = 0.5) versus publication year, weighted by study size that is indicated by the size of the bubbles, showing a clear significant negative correlation indicating a decline effect.**

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 nonlocal correlations cannot and must not be misinterpreted as causal signals. This is exactly 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 analyzed by Bösch, Steinkamp, and Boller (2006) clearly exhibits such a decline effect (Figure 1).

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 most of the time and hence methodological aspects are unlikely explanations for the decline. Decline effects would also be expected as a consequence of experimental testing and thus misrepresentation 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 generalized case? It is important to analyze how the experimental test in physics was done. In what we term "experiment" in this paper, 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, polarization 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 generalized situation, we must stop classical experimentation. Some experimenters instinctively do the right thing: They never repeat experiments exactly the same way, 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, identical replicability of experimental paradigms is key to accepting a phenomenon as a fact.

A way out is to design an experiment which is indirect. We did that by using a matrix approach to analyzing 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 those conducted by the PEAR (Princeton Engineering Anomalies Research) 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*45 cells which gives a huge array of 2,025 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 proven replicable in four previous attempts and was now successfully replicated by an independent replication (data in preparation for publication).

Thus it seems, if we obey the framework conditions of the NT theorem and build an experimental setup, that, in principle, cannot be used to distill 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 condition. For it is completely irrelevant which cell of the matrix will exhibit the significant correlations as long as they 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 nonlocal and the local one. A local model would predict that the cells stay the same. The nonlocal 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 with significant correlations jump between cells across experiments.

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 nonlocal model prohibits. It would predict that correlations stay the same, but the effect in mean shift will decline toward zero.

With some ingenuity, 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, that GET effects can be replicably shown.

In sum: We have shown that a theoretical model that is predicated on generalized entanglement correlations derived from a generalized 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 assumptions fail in PSI research. It makes understandable 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 we point toward future development of the field.

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