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Abstract German

Medium-term influences of a person on a *quantum random number generator* (qRNG) due to induced correlations postulated by the *unus mundus theory* according to Pauli and Jung have already been established several times in earlier studies. However, this sometimes required very large samples. This study investigated a possible sample reduction by using several qRNGs per person. In a roulette game, additional qRNGs were added to the experimental group apart from their own qRNG, while these had no relevance for the control group and should therefore not be influenced. All qRNGs were analyzed. Across various analyses, there were striking differences between the experimental and control groups that one would not expect from a skeptical approach. The effects are rather small, but give an indication that a sample reduction might be possible by extending a system with one person and one qRNG to a system with one person and several qRNGS. Further research should pursue this approach in order to gain a better understanding of mind-matter interactions more quickly.

Abstract english

A person's medium-term influences on quantum random number generators (qRNG) due to induced correlations postulated by the *unus-mundus-theory* of Pauli and Jung have been reported multiple times in previous studies. However, in some cases very large sample sizes were necessary. This work investigated a possible reduction of sample size by using multiple qRNGs per person. In a game of roulette additional qRNGs were added to the result of their own qRNG in the experimental group while they were irrelevant for the control group and were therefore not expected to be influenced. The results were calculated across all qRNGs. Over various analyses noticeable differences between experimental and control group that one wouldn't expect from a skeptical point of view were found. The effects are rather small, but they indicate a possible reduction of sample size by using an expansion from a system with one person and one qRNG to a system with one person and multiple qRNGs. Future research should continue this approach in order to achieve a deeper understanding of the interactions between mind and matter more quickly.

Keywords: *unus mundus*, mind-matter, systems with multiple qRNGs

Introduction

Interaction between mind and matter

The question of how mind and matter are connected has preoccupied mankind for millennia.

for thousands of years. Today, modern neuroscientific research assumes that the brain is the physical basis of the mind and that the mind is no different from the brain (Bear, Connors & Paradiso, 2018).

However, if you follow this assumption, you have to answer a number of other questions: *the easy problems* and *the hard problem of consciousness*. The *easy problems* refer to the question of how various phenomena can be explained computationally or neuronally, for example how attention is focused. The *easy problems* can be investigated using the standard methods of cognitive science, which has been done with great success. The *hard problem of consciousness* deals with why the objective information processing of thought and perception is accompanied by a subjective component. There is little dispute that experience[1]arises from a physical basis, but the question of how and why remains unanswered. Objectively, it seems unreasonable that a physical processing is accompanied by a subjective experience. The explanatory gap between neural processes and experience cannot be closed by explaining the former, which is why the *hard problem of consciousness* cannot be solved by standard methods (Chalmers, 1995).

A related problem with the assumption of a physical basis of subjective processes is free will. Shariff, Schooler and Vohs (2008) distinguish between *the easy problems* and *the hard problem of free will*, analogous to the questions raised by the topic of *consiousness*. In this context, the *easy problems* also refer to the question of the

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[1]English term: experience.

underlying neuronal mechanisms and related topics. They can also be solved with the methods that are currently available. The *hard problem of free will* goes beyond this and refers to the question of whether conscious will can influence the material world, or whether phenomenal experiences can be translated into physical events. If the subjective experience of will can influence actions, the question of how also arises.
This means that the topic of how the mental and the physical interact is also relevant to the study of free will.

The existence of free will is highly controversial and this paper does not claim to represent the debate in full. Shariff et al. (2008) also emphasize that free will could be an illusion. The existence of consciousness is demonstrated by a person's subjective experience. Free will, on the other hand, is not proven by experiencing it. However, according to the authors, the studies on the *easy problems of free will* have neither confirmed nor refuted that conscious thoughts can be the cause of actions. Shariff et al. also point out that consciousness obviously exists, although there are no arguments for this from a material point of view. Nevertheless, one should be careful to speculate that free will is another anomaly in an otherwise materialistic world. Nevertheless, correcting a misunderstood relationship between subjective experience and physical matter could provide an answer to the question of consciousness and free will.

Thus, if one rejects a materialist worldview because of the explanatory gaps in the form of the *hard problem of consiousness* and the *hard problem of free will*, one will inevitably look for alternative theories. Chalmers (1995) presented as a solution the idea that information can be divided into two basic aspects, a physical and a one physical and one phenomenal. According to this hypothesis, the physical processing of information is accompanied by experience because this is an inherent part of the information. However, Chalmers considered this *double-aspect principle* to be very speculative and underdetermined, as many central questions had not yet been clarified at that time. A related theory was discussed in an exchange of letters between Pauli and Jung. Here the possibility is discussed that, in addition to matter and psyche, there is a third factor that enables interactions between matter and psyche. A transcendental basis is discussed that underlies the physical and the psychic. Jung writes of an *unus mundus* that confronts the unified human being. In order for the latter to be able to recognize it, a split occurs, which is a prejudice of consciousness (Meier, 1992).

Before the *unus mundus* theory is discussed in more detail, a summary of some important quantum mechanical basics is given below, as the *unus mundus theory* developed relates to quantum mechanics (QM). These fundamentals are also relevant for the design of the experiment carried out.

Quantum mechanical basics

Wave-particle duality, wave function and superposition

In classical mechanics, if the positions and momentum of all particles of matter are known at a certain point in time, it is possible to clearly determine what the past of the system looked like or what the future will look like. The system behaves deterministically and can be described using Newton's equations. The situation is different in QM. At this level, matter exhibits wave properties as well as particle properties; this is referred to as wave-particle duality. This has serious consequences for the measurability of a system. The wave-particle duality describes not only matter, but also light, which was long regarded as electromagnetic waves (Bartelmann et al., 2018).

To better explain the wave-particle duality, the double-slit experiment with electrons is illustrated as an example. This could theoretically also be carried out with other particles such as neutrons or atoms, but the principle remains the same. A beam of electrons is shot at a photographic plate, whereby the beam must pass through an aperture with a double slit before it hits the plate. The electrons generate an interference pattern on the photographic plate, as would be expected with a wave. In contrast to a typical wave, such as a sound wave, however, the impact points of the individual electrons can be recognized in the interference pattern as if small projectiles had hit the screen. The interference pattern is not caused by the interaction of many simultaneously incident electrons. If individual electrons are shot through the double slit one after the other, the same interference pattern gradually builds up (Bartelmann et al., 2018).

With wave phenomena, however, there are always uncertainty relations, as a wave is never localized in space or time. In the case of particles described as matter waves, the location and momentum of a particle cannot be measured simultaneously with arbitrary precision for this reason. At a certain point, approximate or probabilistic statements must be accepted. This is formalized in Heisenberg's uncertainty principle. Uncertainty relations apply not only to position and momentum, but also to other pairs of observable quantities, so-called incompatible quantities. In contrast to compatible observables, the order in which these are measured is relevant. This means that a particle cannot be assigned a fixed location and a fixed momentum at the same time.

probability distributions can be specified, which, as just explained, are not independent of each other (Bartelmann et al., 2018).

In the non-relativistic limit case and in compliance with the uncertainty relations for each state of a particle at any time, a probability $\omega(t,\boldsymbol{x})d^3x$ or $\tilde{\omega}(t,\boldsymbol{p})d^3p$ of finding the particle location or particle momentum within a small environment of $\boldsymbol{x}$ or $\boldsymbol{p}$ with volume d^3x or d^3p when measuring the particle location or particle momentum. The following applies

$\int\omega(t,\boldsymbol{x})d^3x = 1 = \int\tilde{\omega}(t,\boldsymbol{p})d^3p\ ,\forall t$, as you will find any location and any impulse at any time. location and any impulse will be found at any time. The probability densities correspond to the absolute value squared of the wave function normalized to one in the location or momentum space: $\omega(t,\boldsymbol{x}) = |\psi(t,\boldsymbol{x})|^2$ or $\tilde{\omega}(t,\boldsymbol{p}) = |\tilde{\psi}(t,\boldsymbol{p})|^2$.

With this statistical interpretation of the wave function based on Born $\psi(t,\boldsymbol{x})$[2] describes the state of the system at any point in time. So far, however, no descriptive meaning has been found for the wave function $\psi(t,\boldsymbol{x})$ itself. The wave function can also describe the temporal behavior of a system as a solution to the Schrödinger equation (Bartelmann et al., 2018).

In QM, states can be superimposed at any given time, which can be represented using the wave function. This is referred to as superposition. This in turn defines a new possible state and is also a solution to the Schrödinger equation. In QM, a particle such as an electron can therefore be in a superimposed state, which would be treated as completely separate states in classical physics (Bartelmann et al., 2018).

[2] Fourier transforms can be used to convert $\psi(t,\boldsymbol{x})$ and $\tilde{\psi}(t,\boldsymbol{p})$ into each other (Bartelmann et al., 2018), which is why only the wave function in spatial space is referred to below.

Entanglement, EPR paradox and Bell's inequalities

The wave function can also be used to formalize the entanglement of particles. Entangled particles have a correlated property, such as spin. For example, if the spin of one particle is measured to be 1 in any direction for two anti-correlated particles, it is immediately known that a measurement of the spin of the other particle in the same direction will result in the value -1. However, the spin is not fixed before the measurement and the measurement process for one particle should no longer influence the spin of the other at a sufficiently large distance. Consequently, the principle of locality is violated[3], in which it is assumed that there can be no change in the state of the second system when one system is measured if no interaction between the two systems is possible. In this context, one therefore speaks of non-locality. It should also be mentioned that this does not contradict the causality principle of the special theory of relativity because no information can be transferred (Bartelmann et al., 2018).

The entanglement of particles became relevant, among other things, in the question of whether the description of reality by QM can be considered complete. Einstein, Podolsky and Rosen (1935) assumed that a complete theory should be able to describe every element of reality. Accordingly, it should be possible to make reliable predictions without disturbing the system. The existence of incompatible quantities in QM posed a problem in this respect. The authors formulated a thought experiment with which they came to the conclusion that the description of reality by the wave function is not complete. The so-called EPR paradox was mathematically formalized by Bell (1964). Using assumptions about entangled

[3]The principle of locality cannot be fulfilled if QM fulfills the principle of reality, i.e. that for a perturbation-free and reliable prediction of the value of a quantity, an element of physical reality exists that is assigned to the quantity (Bartelmann et al., 2018).

particles, Bell's inequality was derived: $1 + E(n, ñ) - |E(m, n) - E(m, ñ)| \geq 0$. Here, m,n and ñ describe direction vectors of the component of the spin in any direction and $E(\cdot,\cdot)$ describes the expectation value of the spin product. In a local-realistic theory with hidden variables, Bell's inequality would be satisfied. One can already show a violation of the inequality with a coplanar choice of certain angles for the three spin orientations (Bartelmann et al., 2018)[4]. The idea that there are additional parameters that complement QM is therefore not compatible with the statistical predictions of QM under the assumption of a local realistic theory with intact causality (Bell, 1964).

Bell's theoretically formulated considerations on the EPR paradox have since been tested in practice several times, for example by Aspect, Dalibard and Roger (1982). The results agreed with the predictions of QM and at the same time there was a strong violation of Bell's inequalities. This finding has since been replicated in a large number of experiments with various entangled particles. The predictions of QM are in perfect agreement with the result, while Bell's or related inequalities are violated. Finally, technical progress has almost completely eliminated the last experimental difficulties, so that local theories with hidden variables can be ruled out. QM is therefore a non-deterministic theory (Bartelmann et al., 2018).

Measurement and interpretations of QM

However, the indeterminism of QM is by no means the only point that is difficult to grasp. The concept of measurement in QM is also much more complex than

[4]The textbook has been cited here instead of the original source because the proof of contradiction was carried out differently in the original and is somewhat more difficult to understand. The textbook is recommended as a reference book, especially for those less familiar with physics. However, Bell's inequality is of course equivalent in both sources, as is the resulting conclusion.

in classical physics. A measurement requires a reciprocal influence between the object to be measured and the measuring instrument. In classical physics, the physical influence of a measurement can in principle be arbitrarily minimized, which is not possible in QM due to Heisenberg's uncertainty principle or due to the uncertainty of quantities such as position and momentum. Since measurements therefore always affect the object to be measured, in QM only a combined system consisting of the object to be measured and the measuring instrument can have physical properties. To better illustrate the influence of a measurement, the example of the double-slit experiment is used again here. As soon as any kind of measurement is used to find out which of the two slits the electron has passed through on its way to the screen, the interference pattern disappears. Instead, a pattern corresponding to that of a point particle is observed (Bartelmann et al., 2018).

According to the Copenhagen interpretation of QM, a so-called collapse of the wave function occurs here. An unmeasured electron is in a superposition of all possible paths between source and screen and interference occurs. However, as soon as a measurement is made, the interference pattern disappears because the electron only travels the measured path. More generally, this means that the state vector of a system collapses to the eigenstate whose corresponding eigenvalue was observed as the measured value. If the system were to be measured again, the result would certainly be the same value. Accordingly, the Copenhagen interpretation requires a separation between the quantum system and the classical environment or an observer. The Copenhagen interpretation makes no statement about how the collapse takes place (Bartelmann et al., 2018).

At this point, it should be mentioned that the Copenhagen interpretation is by no means accepted by all physicists. QM itself is one of the best

Theories of physics, their interpretation and many fundamental questions remain a point of contention to this day, for example a quantum theory of gravity or the process of measurement. Due to the separation between QM and classical physics, classical properties of a quantum system cannot be derived as limiting cases.
The question of where the boundary of a closed system runs and what can be considered an observer is equally unresolved. The Copenhagen interpretation is widespread and is preferred by many physicists, but there are a number of alternative interpretations and theories such as Bohmian mechanics, theories with spontaneous localization, the many-worlds interpretation and the decoherence program[(5)] (Bartelmann et al., 2018).

However, "favored by many physicists" is definitely relative. In a survey of 33 participants at a conference on the foundations of QM, physicists, philosophers and mathematicians, among others, were asked about their preferred interpretation of QM. The Copenhagen interpretation had the most votes with 42%, followed by information-based or information-theoretical interpretations with 24% and the many-worlds interpretation or the *many-minds interpretation* with 18%, but not even half of the participants voted in favor of the Copenhagen interpretation (Schlosshauer, Kofler & Zeilinger, 2013)[6]. This survey is of course not representative of physicists as a whole, but it gives an impression of the current state of the debate: Unanimity looks different.

With regard to the boundary of a quantum system, it should also be mentioned that measuring devices that interact with a quantum mechanical superposition are also included in the quantum system.

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[5]For an explanation of the examples given, the corresponding texts in the textbook are recommended.
[6]It is interesting to speculate how the result would have changed if the interpretation or the application-oriented "shut up and calculate" approach had been included.

superposition. A new combined system is created based on the fundamental rules of QM and, according to the theory of QM, there is no end to the theoretically infinitely long chain of combined systems (Dechamps, Maier, Pflitsch & Duggan, 2021).

So far, the concepts of QM have been explained according to the current findings of physics. However, other fields such as psychology are now also concerned with the question of how QM should be interpreted and what role an observer plays in this. Among other things, this is related to the question of whether consciousness plays a fundamental role in the process of measurement and the reduction of quantum states, or whether an observer could be the end of the theoretically infinitely long chain of combined systems. This consideration has been discussed by various physicists since the beginnings of QM (Dechamps et al., 2021).

Dechamps et al. (2021) propose an extension of QM. According to current interpretations, consciousness is not given a role in the reduction of a quantum state and this hypothesis is considered empirically falsified[7]. In the standard experiments of QM, however, the specific result, for example through which slit the electron propagates in the double-slit experiment, plays no significant role for a conscious observer. Therefore, according to the authors, there is no consciousness-induced collapse of the quantum state in these cases. However, as soon as the result is linked to meaning for the observer, there is a correlation between the mental state of the observer and the measurement process. Accordingly, the measurement delivers an influenced result. According to Dechamps et al.

[7]An example of this is the work of Yu and Nikolić (2011).

can be fully considered and their validity and causal coherence remain intact as long as measurements with meaningful results are not considered.

Unus mundus theory by Pauli and Jung

At this point, reference is made to the *unus mundus theory* in order to provide a theoretical framework for the possible influences of consciousness. This theory belongs to the *dual-aspect approaches*, which assume that mental and physical domains are parts or manifestations of an underlying, undivided, psychophysically neutral reality. In the undivided reality, mind and matter are not separate; the separation only occurs in an epistemic split. However, the *dual-aspect approaches* differ, among other things, in whether the mental and physical domains can be reduced to the underlying neutral basis. Pauli and Jung's unus *mundus theory* falls under the decompositional approaches. It is assumed that the mental and physical domains can neither be reduced to the neutral domain nor to each other; the neutral domain is holistic. The *unus mundus theory* is considered particularly salient due to its far-reaching empirical consequences and has proven to be the most robust and generalizable model in the analysis of extraordinary experiences (Atmanspacher, 2020).

In unus *mundus theory*, the underlying, psychophysically neutral and holistic reality is referred to as *unus mundus*. Its symmetry must be broken in order to produce the dual, complementary aspects of the mental and material domains. This is known as the epistemic split. There is a sharp separation between the mental domain or conscious objects and the material domain or observed objects, whereas the separation from the underlying *unus mundus* is somewhat more fluid. The *unus mundus* can be understood from the mental side via Jung's collective unconscious and from the material side via the material domain.

can be achieved via the non-locality of QM. A spectrum of boundaries is assumed in which each new level is closer to the *unus mundus* and thus more holistic than the previous one[8]. The epistemic division of the *unus mundus* into mental and material domains leads to correlations between mind and matter (Atmanspacher, 2014).

The mind-matter correlations are not caused by a direct causal interaction between mind or mental states and matter or material states. Accordingly, the problem of how categorically different domains can interact does not arise. There are only indirect interactions via the *unus mundus*. A distinction is made between two types of correlations. Structural correlations are caused by the archetypes. These are psychophysically neutral, transcendental (or metaphysical) principles which, as organizing factors, influence mind and matter exclusively unidirectionally. They arise due to epistemic divisions of the *unus mundus* (Atmanspacher, 2012).

Consequently, the conscious mental and classical physical contents correspond in structural correlations. The archetypes of structural correlations are so fundamental that they are permanent and persistent over time. They are not experienced as particularly meaningful and do not depend on a person's attention (Atmanspacher, 2020). Structural correlations are assumed to be context-independent, consistent and therefore empirically reproducible. Neuronal correlates of consciousness or stable psychosomatic correlations, for example, would be classified in this area. This type of correlations thus defines a starting point of ordinary and stable psychophysical correlations (Atmanspacher, 2012).

[8]This spectrum of boundaries represents an extension of the original theory, as Pauli and Jung themselves did not suggest it (Atmanspacher, 2014).

Induced correlations arise due to a backreaction, which results in a change of consciousness in the unconscious and accordingly, via the *unus mundus*, also in the material. A measurement of a physical system also causes changes at the quantum mechanical level[9], which in turn can lead to changes in mental states. Induced correlations thus describe bidirectional influences between the mental and material domains and the *unus mundus* (Atmanspacher, 2012). They can also arise due to archetypal patterns that are less fundamental than those of structural correlations. These patterns are only activated in certain situations (Atmanspacher, 2020).

Induced correlations are therefore considered context-dependent and only occur occasionally. Consequently, they are fleeting and not or not easily reproducible. Induced correlations can be classified as positive or negative deviations from the starting point of structural correlations. An event with an overemphasis of correlations can be classified as a positive induced correlation above the starting point. An example of this would be Jung's synchronistic events[10]. Negative induced correlations below the baseline would be events that are perceived as dissociative (Atmanspacher, 2012). Such events include, for example, sleep paralysis and out-of-body experiences in which normal structural correlations are disrupted. Extraordinary experiences due to induced correlations are, however

[9]Strictly speaking, Atmanspacher (2012) does not explicitly refer to the level of QM in this context, but to physical ontic reality.

[10]Two (or more) seemingly coincidental, not necessarily simultaneous events are called synchronistic if they each have an internal and external component, a direct causal connection is absurd or unimaginable and they correspond in terms of their often symbolic meaning (Atmanspacher, 2012).

not to be equated with mental illness, they also occur in the normal population (Atmanspacher, 2020).

Dechamps et al. (2021) describe the induced correlations in more detail in relation to QM. When mental activities cause a change in the unconscious, this leads to an influence on the associated quantum mechanical states via the *unus mundus*. These exist in a superposition and can be described using a wave function. There is an influence on the amplitudes of the wave function in the quantum mechanical states that correspond to the mental activities. In the case of an epistemic split, this leads to an increase in the probability of these states being realized. Consequently, induced correlations represent a violation of the indeterminism of QM. This violation only occurs if, when measuring a quantum mechanical system, the specific result is considered meaningful by a conscious observation. However, the induced correlations are described as rare and unsystematic special cases, even if a meaningful context is given. Accordingly, the indeterminism of QM is not violated overall by the local or fleeting induced correlations. At the same time, this means that induced correlations are difficult to measure empirically.

Disappearing effects

In contrast to other phenomena, induced correlations cannot be proven by large numbers. According to Pauli, synchronistic phenomena disappear in such statistics (Atmanspacher, 2014). The disappearance of synchronistic phenomena is described in more detail in the context of *Generalized Quantum Theory*. This theory generalizes QM beyond the context of ordinary physics while retaining quantum mechanical concepts such as complementarity and entanglement.

Concepts such as systems, states and observables are also adopted, although the systems are to be considered much more generally. For example, a group of conscious individuals could be defined as a system. In *Generalized Quantum Theory*, synchronistic or PSI phenomena are understood as entanglement correlations. In normal QM, entanglement correlations cannot transmit information or controllable causal actions. This principle is treated as an axiom in *Generalized Quantum Theory*. It can be deduced from this that a so-called decline effect occurs, which is frequently observed in PSI experiments. In a decline effect, initially positive results disappear in the course of data collection or replication until a null effect finally emerges. The *Generalized Quantum Theory* also postulates a reciprocity between the effect strength and the reliability of PSI phenomena. The stronger an effect is, the less it can be reproduced and vice versa. In addition, PSI phenomena are attributed the property that they disappear where you want to investigate them and that they appear in another unexpected place instead. In such cases, one speaks of a displacement effect (von Lucadou, Römer & Walach, 2007).

A special case of *Generalized Quantum Theory* is the *Model of Pragmatic Information* (MPI) (von Lucadou et al., 2007). The MPI describes PSI phenomena as non-local entanglement correlations in socio-psycho-physical, self-organizing and organizationally closed systems. PSI phenomena are induced by the pragmatic information generated by the system. In MPI, pragmatic information is the meaning of information measured by its effect on the system. Pragmatic information is the product of *novelty* and *confirmation*. Novelty is the part of the pragmatic information that is completely new to the system, and confirmation is the part that is already known to the system. Novelty and confirmation are complementary to each other. Accordingly, meaningful information must be pre-structured in a certain way for the system to be able to accept it (confirmation).

At the same time, a certain degree of novelty is required to trigger a change in the system (firstness). A statement in a foreign language, for example, would not contain any confirmation because it cannot be understood. In turn, a repetition of an already known statement would not be a first. In both cases, the pragmatic information would be zero. Consequently, pragmatic information is not static, but very dynamic (von Lucadou, 1995).

The amount of pragmatic information in a system is limited. For this reason, and because of the complementary nature of first time and confirmation, an increase in confirmation leads to a reduction in first time and vice versa.

Consequently, first time and confirmation must be neither minimal nor maximal for the greatest possible value of pragmatic information. Pragmatic information is maximized when the message contains equal amounts of first time and confirmation (Maier, Dechamps & Rabeyron, 2022). According to the MPI, only conceptual replications should be carried out in order to obtain both firstness and confirmation in as equal proportions as possible. In the case of identical replications, the firstness decreases further and further and the pragmatic information consequently tends towards zero (von Lucadou, 1995).

Maier and Dechamps (2018) discuss a possible extension of the MPI. According to the authors, the declining confirmation may follow a systematic pattern. The second law of thermodynamics states that the entropy of a system increases over time. Therefore, if information is transferred with the help of entanglement correlations, this not only violates the no-signal theorem of QM, but also the second law of thermodynamics. As soon as mentally induced deviations from the true randomness of QM occur, entropy acts against it. This weakens the effect and the counter-effect of entropy also decreases again, so that deviations can occur once more, even if they are now weaker than initially observed. Accordingly, the temporary course of the effect should follow a systematic pattern that is comparable to a damped harmonic oscillation.

Accordingly, from the concepts presented so far, the following can be deduced about the occurrence of induced correlations in a quantum mechanical experiment: First, induced correlations occur in such a context when the potential measurement results are meaningful to the unconscious state of a conscious observer. The unconscious state of the observer has an organizing influence. Second, when unconscious mental states are activated, there is an influence on the probability of the realization of certain conscious states and their associated physical manifestations in an epistemic split. Thirdly, the indeterminism of QM is not globally violated by such effects. Consequently, they occur randomly if one considers the mean values of the possible measurement results. Nevertheless, they follow a non-random, systematic pattern over time (Dechamps et al., 2021).

Empirical research

The empirical investigation of induced correlations falls into the area of micro-psychokinesis (micro-PK) research (Dechamps et al., 2021). Micro-PK refers to the apparent[11]influence of living systems on inanimate, probabilistic systems, whereby the effects produced in this process can only be explained by statistical

[11]One of the reasons for using the term apparent influence is to leave open the possibility that micro-PK effects are correlations rather than direct influences (Cardeña, Palmer & Marcusson- Clavertz, 2015).

methods and there is no transmission through known physical forces or energies. According to another definition, micro-PK describes PK effects on systems that are too small for direct observation with the naked eye. Micro-PK experiments include the observation of the influence of dice, coin tosses or *random number generators* (RNGs) (Cardeña et al., 2015).

Usually, RNGs are used that are based on a quantum mechanical process and are accordingly called quantum RNGs (qRNGs). As explained above, a true coincidence is therefore used. The processes used here are superpositions of two possible states, for example the decay or non-decay of an atom or, as in the present study, one of two possible paths of a photon. The result of the process is then linked to a consciously experienced stimulus, such as the lighting of one of two lamps or the presentation of a positive or negative image. The explicit or implicit task of the test subjects in these studies was to mentally influence the result. A large number of studies have now been conducted with various variations in the intentions of the observer and the measurement methods. In a meta-analysis, an overall significant effect and thus evidence for an observation-dependent deviation from the true randomness of QM was found. Consequently, there is evidence for the existence of induced correlations (Dechamps et al., 2021).

According to Cardeña et al. (2015), reliable estimates for the effect size of micro-PK or guidelines for large replications based on power analyses are currently not possible through meta-analyses. It should also be noted that many micro-PK studies could not be easily replicated (Dechamps et al., 2021).

One example of a failed replication is the benchmark experiment of the PEAR laboratories (Princeton Engineering Anomalies Research) and its consortium replication. The benchmark experiment by Jahn, Dunne, Nelson, Dobyns and Bradish (2007) from 1997[12]was a twelve-year study with almost 2.5 million trials from 91 subjects. A microelectronic random number generator was used in the study. The participants sat in front of the device, but had no physical contact. Depending on the instructions, they were asked to achieve more or fewer bit numbers than the theoretical mean value or not to influence the result. At the end of the experiment, the Z-score was 3.8 and the result was highly significant. The consortium replication was a collaboration with two other groups. The same experimental protocol was used as in the original study and the primary hypothesis was also retained. Despite an impressive amount of data generated from 227 participants, only a non-significant Z-score of 0.6 was found. However, it should be noted that there were errors in the design of the replication that could explain its failure. Furthermore, a combination of the two data sets still yields a highly significant effect with a Z-score of 3.2 (Cardeña et al., 2015).

Most studies in the context of micro-PK research make no explicit reference to Pauli and Jung's *unus mundus theory*. In principle, this is not a major problem, as there are other theories that predict micro-PK effects. However, unlike most theories, the *unus mundus* theory makes statements about the contribution of unconscious processes in the development of induced correlations. Accordingly, it is necessary to investigate the unconscious mental state of the participants and its variations in combination with the results of a qRNG, which correspond to the unconscious states (Dechamps et al., 2021).

Maier and Dechamps (2018) investigated the influence of unconscious goals in the form of cigarette addiction on micro-PK. A qRNG chose between pictures with the

[12]The cited source from 2007 is a reprint of the original article.

smoking and neutral pictures, which were subsequently shown to the test subjects. The hypothesis was that habitual cigarette smokers should influence this process. Study 1 found strong evidence for micro-PK and no deviation from chance in non-smokers. Study 2 was a preregistered replication trial with high power, but did not replicate the result of Study 1 and instead showed strong evidence for the null hypothesis. A combination of the two data sets showed a remarkable effect progression over time, which was comparable to the emergence and subsequent decline of an effect. This progression was only observable in smokers; no emergence and decline of an effect was observed in non-smokers or in simulations.

In the work of Dechamps et al. (2021), the correlations between the reduction of a quantum state and the (un)conscious states of an observing person were empirically tested. For this purpose, subliminal priming was used to induce an influence on the probability of certain quantum mechanical measurement results (study 1 and 2) or a stronger oscillation of the effect than expected by chance (study 3 and 4). The replicability of the effects was also investigated. Study 1 found strong initial effects that could no longer be shown in the later replications, i.e. studies 2 to 4. According to the authors, the results argue against the incompleteness of QM in psychophysical situations as generated in the studies. The results are consistent with standard QM. However, the authors note that the data do not completely falsify the validity of Pauli and Jung's *unus mundus theory* and the MPI, even though no positive evidence was found.

Overall, there are now a large number of studies whose results support the existence of PSI phenomena. Nevertheless, the topic is still the subject of much debate.

According to the proponents of PSI phenomena, their existence has now been sufficiently proven by research has now been sufficiently proven by research and we should now focus more on the processes underlying PSI phenomena instead of continuing to try to prove their existence. The skeptics, on the other hand, attribute the results of the studies to errors, biases and other forms of questionable research practices. Two different views can therefore be derived from the debate. One possibility is that the hundreds of researchers in the field of PSI research over a century have cheated or been deceived, despite using the most reliable research methods. The alternative is that PSI phenomena exist and that human consciousness can interact with its environment beyond the usual boundaries of space and time (Rabeyron, 2020).

A detailed examination of both points of view is not carried out in this paper[13], instead concentrating on the hypothesis that PSI phenomena exist. If one now assumes their existence and wants to carry out further research in this area, it quickly becomes apparent that sometimes huge samples of test subjects or enormously high trial numbers are necessary. The benchmark experiment of the PEAR laboratories and its consortium replication, for example, each had trial numbers in the millions (Cardeña et al., 2015). Maier and Dechamps (2018) were the first to find strong evidence for the investigated effect with just under 100 test subjects, while Dechamps et al. (2021) took roughly 1700. Achieving such numbers is almost impossible with normal means in the former case or possible, but still very time-consuming and sometimes cost-intensive in the latter (two) cases. Accordingly, this raises the well-known question for many researchers in the field of psychology of how to reduce the necessary number of test subjects. Rabeyron (2020) suggests that the strange data patterns in the results

[13]A closer look at the two opposing viewpoints was conducted by Rabeyron (2020).

of PSI research not as obstacles or as a random influence, but as a way to better understand PSI effects and their properties. Following this suggestion, this paper investigated whether the inherent properties of induced correlations or PSI effects can be used to reduce the sample size.

In scientific research, it is normally assumed that the researcher or observer is generally separate from or independent of the dependent variable. Influencing the result is avoided as far as possible so that the result depends on the independent variable and not on the thoughts, intentions, beliefs or doubts of the researcher. This should allow other people to demonstrate the same result under the same conditions. This model works very well, as can be seen from the extensive and reliable scientific evidence and technological advances. However, according to the PSI studies, it is suggested that some kind of "direct" interaction between individuals and their environment is possible. However, this would influence the results of the experiments, which apparently follow the scientific principle. There could be an intentional or unintentional direct interaction between the researcher or the observer and the observed test object[14] (Rabeyron, 2020).

If one combines these considerations with the above-mentioned problem of the Copenhagen interpretation, that the question of where the boundary of a closed system runs and what can be considered an observer is unresolved, it should theoretically be possible to extend the system with one person and one qRNG to a system with one person and several qRNGs (14).

[14]The consequences of such a situation for science are discussed by Rabeyron (2020) and also briefly taken up again later in the discussion of the theory.

qRNGs can be extended. The nonlocal correlations between mind and matter would act in the same way for multiple qRNGs linked to one person. This would result in more data points per person and consequently fewer subjects or fewer trials per subject would be required. To test this hypothesis, a system was created in this study in which one person was linked to several qRNGs. For this purpose, the results of the qRNGs were linked to financial gain or loss for the subject. The experimental group was informed of the result of several qRNGs, while the control group was only informed of the result of one qRNG. However, the same number of qRNGs were run in both groups and their results were considered. As the result of the additional qRNGs did not play a role for the participants in the control group, the results were not to be influenced. Only in the experimental group should a correlation be formed between the test subject and all qRNGs.

In summary, the following is expected:

H1: In a comparison of the mean value against the value expected by chance, positive deviations from chance are expected in both the experimental and the control group, i.e. more profit. In a descriptive comparison of the sequential course of the effect, the experimental group has a stronger and faster effect. H2: It is expected that the effect of the experimental group will be greater than that of the
control group, i.e. that the positive deviation from chance is stronger in the experimental condition.

In addition, for an exploratory study, roulette experts and non-experts were divided according to the median importance of winning, gender and median age. In each of these groups, a descriptive comparison between the sequential comparison between the sequential courses of the effect in the experimental and control groups and a direct comparison of the effect.

Methods

Test participants

The sample consisted of 34 participants (9 male, 23 female, 2 diverse; mean age=27.26, SD_{age}=12.65). They were contacted via social networks (e.g. WhatsApp, email) or direct contact. The link to participate was sent via the same social networks. The prerequisites for participation were being of legal age and having a good command of German.

Materials

A Quantis qRNG from id Quantique was used in this study. This qRNG passed the DIEHARD and NIST tests, which are used to check the randomness of numbers from a number generator. It is considered to be one of the most powerful and cost-effective methods for generating truly random numbers at high bit rates (Turiel, 2007). The Quantis qRNG has already been used in other studies such as in Dechamps et al. (2021). The qRNG produces a superposition of two quantum states, both of which have an equally high probability of being realized in a measurement. For this purpose, photons are sent through a semi-transparent, mirror-like prism. The state that is realized during a measurement is translated into a binary (i.e. 0 or 1) bit, which in the experiment determined the color drawn in the roulette game. Due to the quantum mechanical design, the color was therefore determined by a real coincidence.

The device on which the test subjects took part was not recorded. As the link was sent via social networks, it can be assumed that the game was played via various devices with an internet connection (e.g. cell phone, laptop, computer, tablet, etc.)

was used to participate. No mouse or keyboard was required in the experiment, which would have precluded participation on mobile devices or similar.

Design

A between-subject *design* was used in the study. The experimental and control groups both played an online roulette game with ten rounds in which they could bet black or red. The outcome of the roulette game, i.e. which color was drawn, was decided by a quantum random number generator. The test subjects were then informed of the result and the possible win or loss. Both the experimental and control groups were able to have their winnings paid out at the end, which was known in advance. Losses were set to zero.

In addition to the roulette table at which the test subject played, there were 99 other roulette tables. There, bets were placed on the same color chosen by the test subject. However, the other roulette tables were independent and could produce different results to the subject's table. The result of the additional roulette tables was also determined by a quantum random number generator.

The difference between the experimental and control groups was that the results of the additional roulette tables were communicated to the subject in the experimental group and the corresponding profit or loss was taken into account. The control group was not informed of the result of the additional roulette tables and it had no influence on the subject's profit or loss.

Experimental procedure

After opening the link sent to the test subjects, they were shown the instruction text (appendix), which differed depending on the group. By clicking on *Next*> , they were taken to the next page, on which an example corresponding to the example corresponding to the group was shown. Below the explanatory text (appendix) was a visual image of a trial with the amounts of the example. By clicking on *Next* > again, the test subjects were taken to a page with information on data protection. Only after the test participants had accepted the privacy policy could they continue by clicking on *Start trial*.

The first trial then began. The test participants were asked the question "Which color would you like to bet on?" and they could *choose* between two boxes with the colors *black* and *red*. After making their choice, they were shown the result. A box with "Total winnings: ...€" showed the total winnings updated in each trial. Below this was a box with the color drawn and a tick or cross, which indicated the correspondence with the subjects' choice. Below the color box, "Round profit: ...€" was displayed. In the experimental group, "The robots have won this round: ...€" showed the result of the robot clones. In the experimental group, their winnings were also included in the total winnings and the round winnings were therefore the total winnings of the person and the robots. Clicking on *Next* took the user to the next trial. A total of ten trials of this type were carried out.

Afterwards, a "Thank you for taking part! We would now like to know a few more details about you." to the questionnaire. The test subjects were able to answer the question "How old are you?" in a text field. For "Which gender do you feel you belong to?" there were the options "female", "male" and "diverse". The question "Do you know the game of roulette?" offered the answers "yes" and "no".

Then the question "How important was winning to you?" was asked and the test subjects were able to choose their answer on a scale of 1 to 7, with 1 representing "not at all important" and 7 "very important". After the questionnaire, the participants were shown the closing text (appendix) and informed how they could have their winnings paid out.

Data analysis

In this study, bayesian analysis was used instead of frequentist analysis. In a Bayesian analysis, the probability of an effect is updated with each new data point. The evidence for an effect depends on the probability of the data under both the null hypothesis and the alternative hypothesis. Accordingly, the two probabilities are weighed against each other to estimate for which hypothesis the data provide more evidence. The resulting score is called the Bayes Factor (BF). A BF of ten or higher is considered strong evidence for the null or alternative hypothesis. To calculate the BF, a previously defined probability distribution of the effect size is required.

effect size is required. This Cauchy distribution $\delta \sim Cauchy\ (0, r)$ with the scaling parameter r and the center point

scaling parameter r and the center point 0 indicates the prior, i.e. the probability of the data assuming an effect, e.g. $P(Daten|_{H(1)})$. For the choice of r there are

different recommendations and standards (Maier & Dechamps, 2018). In line with

Dechamps et al. (2021), a non-informative prior according to a

Cauchy distribution centered around 0 with r=0.1 ($\delta \sim Cauchy\ (0;\ 0.1)$), which is based on a estimate of the effect size of Cohen's *d*=.1 and has already been used in the micro-PK research of the authors' working group.

The advantage of Bayesian statistics is that a high BF can only be achieved if the power of the sample size is high enough. In contrast to frequentist testing, it is therefore not possible to inadvertently measure an effect in a study with too little power. In bayesian statistics, it is permitted to add further data or test subjects to the data set until a previously determined BF for the null or alternative hypothesis is reached. It is also permitted to end the data collection when the desired BF has been reached (Maier & Dechamps, 2018). In the study presented here, the sequential course of the effect was important, so that no BF was previously defined as an endpoint. Nor was a necessary sample size specified, as this study was primarily an investigation into whether the design would generally lead to an effect, although only a small sample was available.

The statistical programs RStudio 2023.03.0+386 and JASP 0.10.2.0 were used for the analysis. The preparation, the calculation of the descriptive data, the majority of the splits according to conditions and the linear regressions were carried out in RStudio. JASP was also used for splitting the data and for the Bayesian t-tests.

Results

Planned analyses

In the sequential analysis of the effect course, it was expected that the mean value in both the experimental and the control group would be greater than the value expected by chance, i.e. greater than five. It was also expected that the experimental group would show a stronger and faster effect than the control group when the sequential effect courses were compared descriptively (H1). The effect of the experimental group should also be greater than that of the control group in a statistical comparison between the two groups (H2).

To investigate H1, *one-sample* Bayesian t-tests were conducted in the experimental and control groups to determine whether the mean value of the trials obtained was greater than five. For the experimental group, there was strong evidence for the null hypothesis (BF_{01}= 10.834). For the control group, there was also strong evidence for the null hypothesis (BF_{01}= 11.660). The sequential courses are shown in Figure 1 (experimental group) and Figure 2 (control group). A descriptive comparison shows that there are clear differences at the beginning. The experimental group shows a moderate effect for the alternative hypothesis at times and only from around 600 test subjects or robots does the curve show a zero effect. In the control group, such a curve can be seen right from the start.

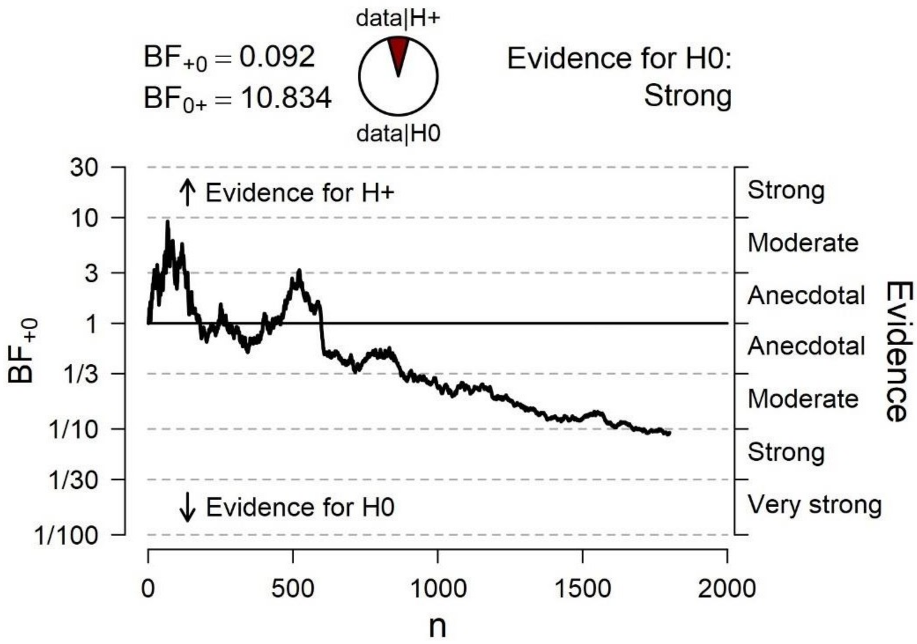

Figure 1: Sequential analysis of the Bayes factor in the experimental group. n is the number of test subjects or robots, with 100 data points assigned to each test subject. It was tested whether the mean value of the trials won was greater than the value of five expected by chance. Overall, the null hypothesis is more probable, although initially there are swings towards the alternative hypothesis.

A Bayesian *independent-samples* t-test was calculated for the statistical analysis of the difference between the experimental and control groups. It was checked whether the mean value of the trials won in the control group was less than the mean value in the experimental group. There was moderate evidence for the

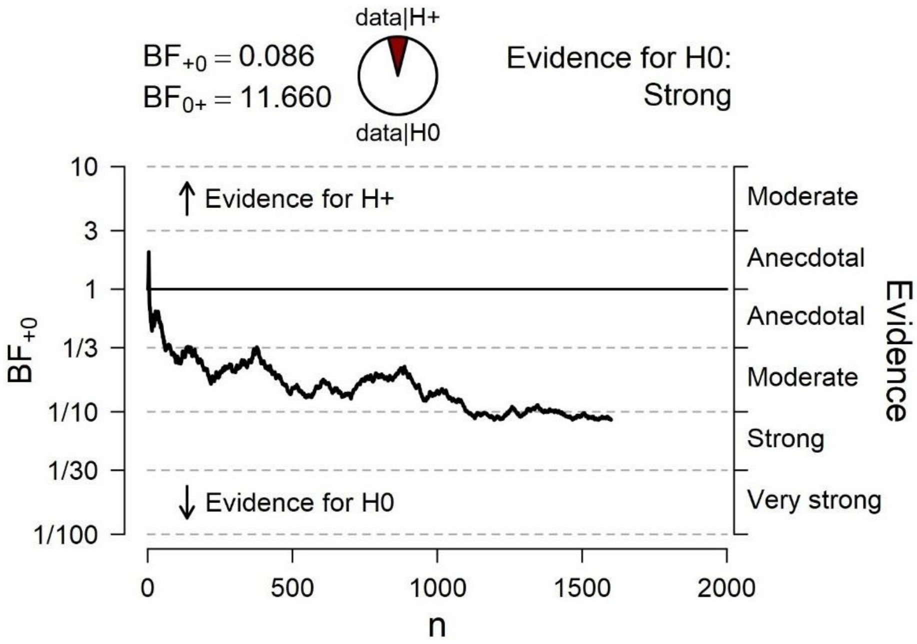

Figure 2: Sequential analysis of the Bayes factor in the control group. n is the number of subjects or robots, with 100 data points assigned to each subject. It was tested whether the mean value of the trials won was greater than the value of five expected by chance. Overall, the null hypothesis is more probable.

Null hypothesis (BF_{01}=3.321). The sequential course of the effect can be seen in Figure 3 and there is strong evidence for the alternative hypothesis in between with a BF of over ten, before the curve moves in the direction of a null effect with around 1,500 test subjects or robots.

Additional groups were formed for an exploratory study. The sample was divided into roulette connoisseurs and non-connoisseurs, by median importance of winning, by gender and by median age. In each of these new groups, a descriptive comparison of the sequential analyses of the Bayes factor for the *one-sample* t-tests of the experimental and control groups and an *independent-samples* t-test were again performed. The groups roulette non-experts and gender diverse were not considered here, as the number of subjects in these groups was too low (3 roulette players).

these groups was too low (3 roulette non-experts, 2 diverse). The sizes of the remaining

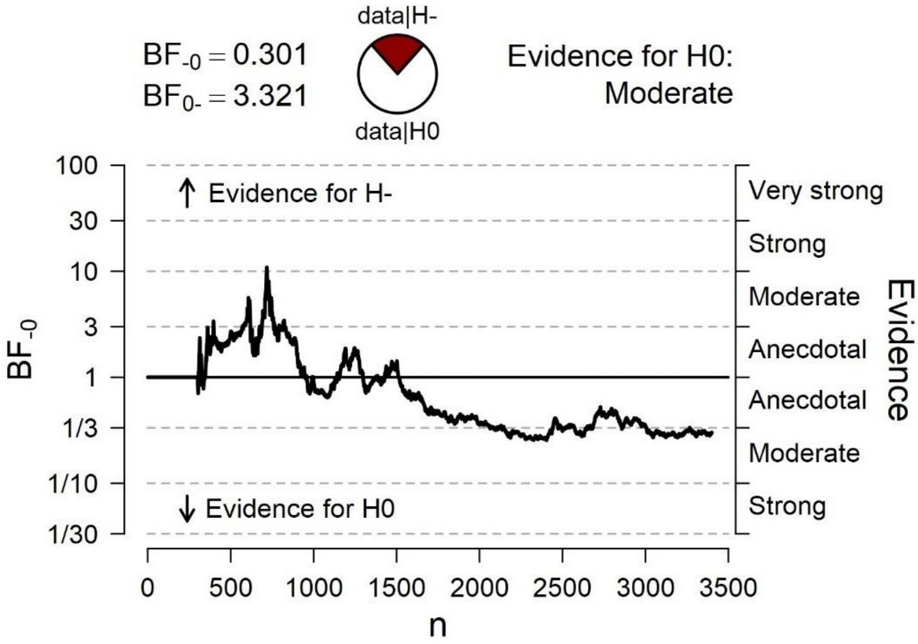

Figure 3: Sequential analysis of the Bayes factor. n is the number of test subjects or robots, whereby 100 data points are assigned to each test subject. It was tested whether the mean value of the trials won was less in the control group than in the experimental group.
Overall, the null hypothesis is more likely, but in the meantime there was strong evidence for the alternative hypothesis with a BF of over ten.

Groups (31 roulette connoisseurs, 17 importance of winning< median of the sample (3.5) or 17 ≥ median, 9 men, 23 women, 9 age < median of the sample (21 years) or 25 ≥ median) were considered sufficient for analysis. The unequal age distribution is due to the fact that a number of test subjects were exactly 21 years old.

Table 1 and Table 2 provide an overview of the results of the *one-sample* t-tests of the experimental and control groups and the *independent-samples* t-tests of the difference between the two groups. A graphical representation was omitted, as the curves for initial effects differ only to a limited extent from the curves already shown in Figure 1 and Figure 3. Overall, it can be seen that in all bayesian t-tests, the

Table 1

Presentation of the results of the exploratory investigations of the directed bayesian one-sample *t-test (mean value greater than five) by additional groups*

	one-sample t-test of the experimental group	
	BF_{01}	Sequential analysis of the Bayes factor
Roulette connoisseur	9,299	Initial effect *, from approx. 600 VP zero curve
WG< Median	6,808	Initial effect *, from approx. 300 VP zero curve
WG≥ Median	6,487	Initial effect *, from approx. 200 VP zero curve
Men	3,238	No initial effect, fluctuates around BF one
Women	9,392	Initial effect *, from approx. 300 VP zero curve
Age< Median	5,398	No initial effect, zero curve
Age≥ Median	7,625	Initial effect *, from approx. 600 VP zero curve
	one-sample t-test of the control group	
	BF_{01}	Sequential analysis of the Bayes factor
Roulette connoisseur	10,503	No initial effect, zero curve
WG< Median	2,798	No initial effect, fluctuates around BF_{10}1/3
WG≥ Median	12,101	No initial effect, zero curve
Men	2,459	No initial effect, fluctuates around BF_{10}1/3
Women	12,549	No initial effect, zero curve
Age< Median	6,859	No initial effect, zero curve
Age≥ Median	7,098	No initial effect, zero curve

Note. WG= Importance of winning, VP = test subject or robot, BF= Bayes factor. * or ** means intermediate exceedance of the Bayes factor three or ten in the direction of the alternative hypothesis.

The null hypothesis is more probable, even if there are differences in the degree of evidence for it (anecdotal BF one to three, moderate three to ten, strong from ten). In addition, the majority of the *one-sample* t-tests in the experimental group have a moderate initial effect, while in the control group there is no such effect variation in any group. In the *independent-samples* t-tests, the sequential analyses

Table 2

Presentation of the results of the exploratory investigations of the Bayesian independent-samples *t-test (mean value in the control group less than in the experimental group) by additional groups*

	independent-samples t-test	
	BF_{01}	Sequential analysis of the Bayes factor
Roulette connoisseur	3,204	Initial effect **, from approx. 1500 VP zero curve
WG< Median	4,664	Initial effect **, from approx. 700 VP zero curve
WG≥ Median	1,478	No initial effect, fluctuates around BF one
Men	2,730	Initial effect *, from approx. 500 VP zero curve
Women	2,072	Very short initial effect *, fluctuates around BF one
Age< Median	2,288	No initial effect, similar to a zero curve
Age≥ Median	3,233	Initial effect **, from approx. 1,000 VP zero curve

Note. WG= Importance of winning, VP = test subject or robot, BF= Bayes factor. * or ** means interim excess of the Bayes factor three or ten in the direction of the alternative hypothesis.

The initial effects were more varied, but there were several moderate or strong initial effects.

It should also be mentioned that of the 23 test subjects who could have cashed out, only eight did so. As the participants started with €1 in their account, the number of people with a financial result above €0 does not correspond to the number of people who had a positive deviation from the value expected by chance.

Additional analyses

Various simple linear regressions were also calculated. For this purpose, the average of the hits per test subject was calculated, i.e. the average of the value of the test subject and the associated robots. This was the dependent variable in all linear regressions. The independent variable in one half of the analyses was the number of the test subject, which was assigned in the order of participation. Experimental and control groups were considered separately. In the experimental group, the number of the test subject explained a significant proportion of the variance of the hit average (R^2= .286, F(1,16)= 6.395, p= .022). The intercept and the regression coefficient of the model were also significant (α = 5.084, t(16) = 88.936, p < .001; β = -0.008, t(16) = -2.529, p = .022). The corresponding plot can be seen in Figure 4. In the control group, the number of the subject did not contribute significantly to the explanation of the variance (R^2= .002, F(1,14)= 0.031, p= .862). The intercept was significant (α= 4.965, t(14) = 44.347, p< .001), while the regression coefficient was not significant (β= -0,001, t(14)= -0.177, p= .862). The corresponding plot can be seen in Figure 5.

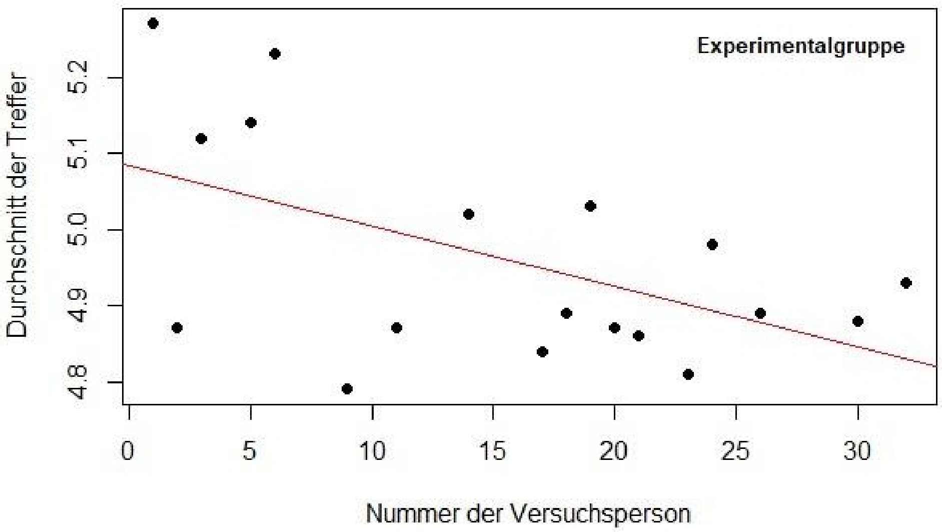

Figure 4: Plot of the linear regression in the experimental group as a function of the subject number. The average of the hits is the average of the value of the test subject and the corresponding robot.

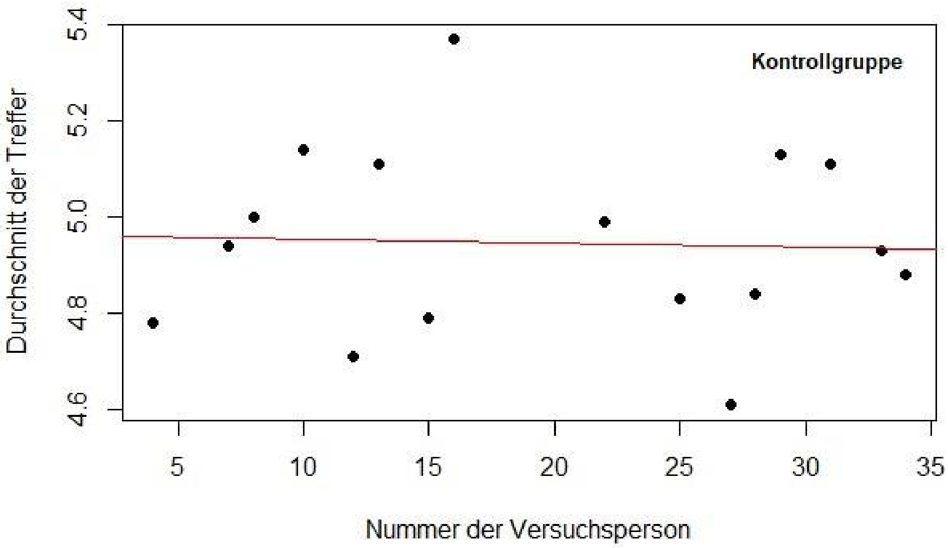

Figure 5: Plot of the linear regression in the control group as a function of the subject number. The average of the hits is the average of the value of the test person and the associated robots.

In the other half of the analyses, the time in hours since the start of the experiment, i.e. the participation of the first person, was selected as the independent variable. The experimental and control groups were again considered separately. In the experimental group, the time since the start of the experiment did not make a significant contribution to explaining the variance

(R^2= .120, F(1,16)= 2.175, p= .160). The intercept was significant (α= 4.999, t(16)= 119.366, p< .001), while the regression coefficient was not significant (β= -0.000, t(16)= -1.475, p= .16). The corresponding plot can be seen in Figure 6. In the control group, there was also no significant explanatory contribution from the time since the start of the experiment (R^2= .026, F(1,14) = 0.373, p = .551). The intercept was again significant (α = 4.979, t(14)= 69.717, p< .001), while the regression coefficient was once again not significant (β= -0.000, t(14) = -0.611, p= .551). The corresponding plot can be seen in Figure 7.

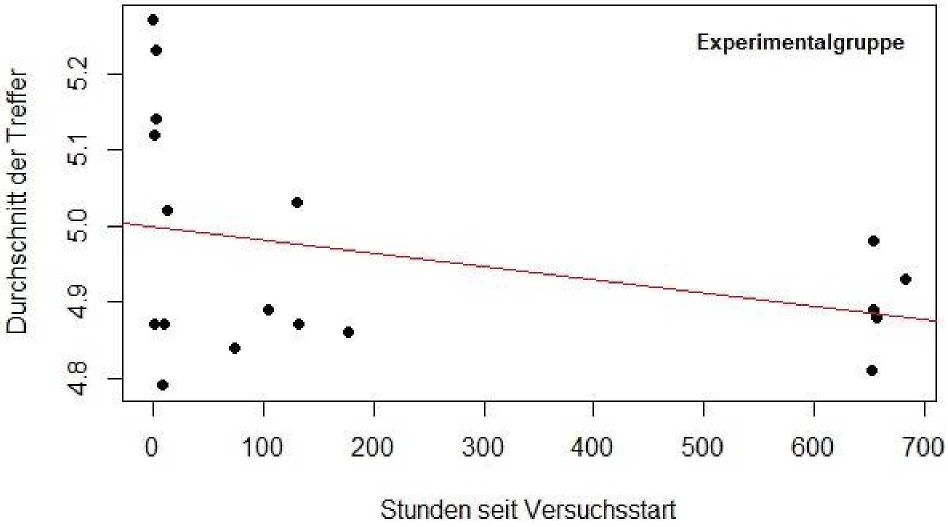

Figure 6: Plot of the linear regression in the experimental group as a function of the hours since the start of the experiment, i.e. the participation of the first person. The average of the hits is the average of the value of the test person and the corresponding robot.

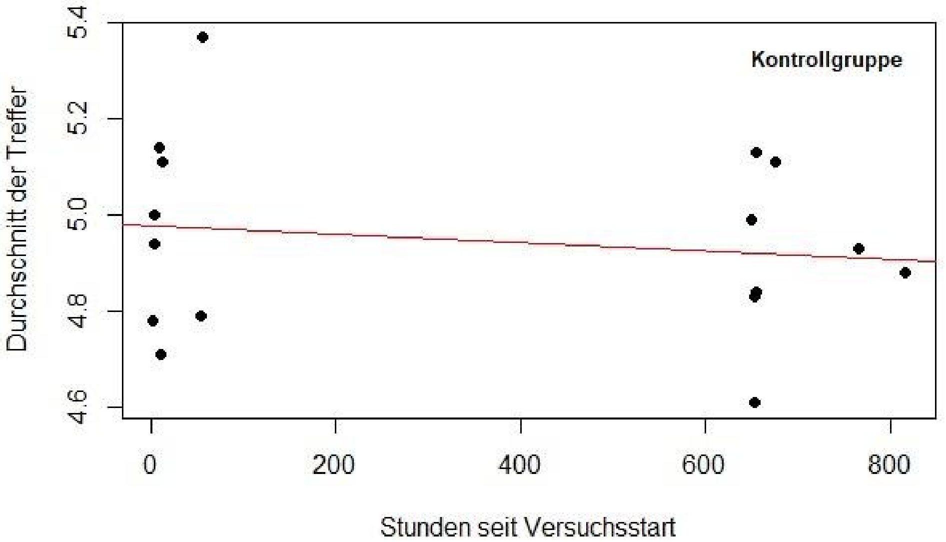

Figure 7: Plot of the linear regression in the control group as a function of the hours since the start of the experiment, i.e. the participation of the first person. The average of the hits is the average of the value of the test person and the associated robots.

Based on the visual impression, homoscedasticity was tested using the Breusch-Pagan test. In the experimental group, both the number of the test subject (p = .008) and the time since the start of the experiment (p = .030) showed a violation of homoscedasticity. There was no violation in the control group (number of the test subject p= .755, time since start of test p= .361). If one calculates Consequently, if the robust standard errors for the intercept and the regression coefficient are calculated in the experimental group, both the subject number (α= 5.084, t(16)= 60.630, p< .001; β= -0.008, t(16)= -2.049, p= .057) as well as time since the start of the trial (α= 4.999, t(16)= 97.077, p< .001; β= -0.000, t(16)= -1.742, p= .101) only the axis intercepts were significant.

Discussion

Interpretation of the data

This paper dealt with the question of whether the number of test subjects required to investigate an effect in PSI studies can be reduced by expanding the previously used system with one person and one qRNG to a system with one person and several qRNGs. The decline explained in the theory section is not emphasized for the interpretation of the results, as previous studies such as Maier and Dechamps (2018) and Dechamps et al. (2021) have already dealt with it and the question of this work was whether similar processes are possible with fewer test subjects. Accordingly, the evaluation of the hypotheses does not consider the final result of the BF, but whether there was an effect within the sequential analysis.

The results are partly in line with the expectations for H1, as the experimental group now shows moderate evidence for the alternative hypothesis. However, the control group shows no effect. In retrospect, this could have been expected as the robots are not influenced by the subject if their outcome has no meaning for the subject. Accordingly, a possible effect of the test subject is lost in the clear majority of the 99 robots. In a descriptive comparison of the effect curves, the experimental group automatically has a stronger and faster effect than the control group, as the latter, as already mentioned, shows no effect at all. However, it is clear that there are descriptive differences between the two groups.

There was a significant difference between the experimental group and the control group with a temporary BF of over ten. Consequently, the data support H2, i.e. that the effect of the experimental group is greater than that of the control group. The fact that the control group shows no effect does not change the significant difference. The only experimental difference between the two conditions was the feedback of the additional qRNGs or robots to the subject. Consequently, it seems that it is indeed possible to achieve similar effects with a small number of subjects as with a much larger sample by extending the system with one person and one qRNG to a system with one person and several qRNGs. However, the significant difference in sequential progression was only a brief blip. Although the excess of the BF of ten is clearly visible, one should still be cautious at this point with statements about the strength of the difference in the effects and consider this result more as an indication that further studies of this type could be promising.

The exploratory analyses showed that the majority of the *one-sample* t-tests in the experimental group showed a moderate initial effect, while there were no such effect fluctuations in the control group. In the *independent-samples* t-tests, there was a strong initial effect in the roulette experts, the group whose value for the importance of winning was below the median of the sample, and in the subjects who were older or the same age as the median. At this point, however, one should be careful about attributing special characteristics to the respective groups. It

Although it is quite possible that it is precisely these groups that cause the difference between the experimental and control groups, another explanation seems more plausible. If you randomly draw people from a sample with an effect, the effect will be retained or lost depending on the people drawn. The fact that the sequential analyses of the groups with an effect in Figure 1 and Figure 3 differ only to a limited extent supports this consideration. There are no drastically different effect progressions with, for example, stronger effects. Accordingly, the interpretation suggests that knowledge of the game of roulette, the importance of winning, gender and age are irrelevant for the effect. However, this is definitely not a definitive statement. For this, further analyses in other samples or experiments would be necessary. For good statements about these variables, significantly larger samples would again be necessary, as in this case it is about the characteristics of individual people and not about a fundamental effect.

However, if the factors mentioned do not actually play a role, this would be very interesting. The theory assumes that the qRNG is influenced by a meaningful context. As the number of roulette non-experts was too small for meaningful analyses, it is unclear how the situation has changed for these people. However, it can be assumed that the financial gain or loss is significant even without knowledge of the game of roulette.

What is more striking is the apparent lack of relevance of the importance of winning. If one really wants to assume relevance, the effect is evident in the test subjects for whom winning was less important. Actually, one would intuitively assume that the test participants who absolutely wanted to win would show a stronger or generally stronger effect. Importance cannot be equated with the importance of winning, but the two concepts are presumably closely linked. For

For this reason, a correlation would actually have been expected. At this point, however, it must be taken into account that the conscious and unconscious importance of winning can certainly differ and that only conscious beliefs were asked about in this experiment.

In addition, linear regressions were calculated in both the experimental and control groups. Here, the average of the hits per test subject, i.e. the average of the value of the test subject and the associated robots, was set as the dependent variable in relation to the number of the test subject or the time since the start of the experiment, i.e. the participation of the first person, in hours. There were significant axis intercepts, but after accounting for violated homoscedasticity, there were no significant regression coefficients. However, it is interesting to note that the violation of homoscedasticity was only present in the experimental group. This can also be observed descriptively in Figures 4 to 7. It can be seen that the fluctuations are greater at the beginning than towards the end of the data collection. In the experimental group, there are initially some values that are higher than the average than the other data points. The position of these values can be explained by the fact that the effect appeared at the beginning and later disappeared again due to a decline. The result of the linear regression or the violation of homoscedasticity is therefore consistent with the result of the Bayesian analyses. Consequently, a striking difference between the experimental and control groups can be seen not only in the bayesian statistics, but also in a much more frequently used analysis.

Limitations and approaches for future research

As already reported in the results section, not all test subjects had their total winnings paid out. It cannot be ruled out that this may have influenced the outcome of the experiment. The experiment is designed to ensure that the result of the qRNG is meaningful for the test subject. Depending on whether the participants have had their total winnings paid out, the result of the roulette means something different. However, an analysis with only the test subjects who had their winnings paid out would overestimate the effect, as the eleven people who had a negative result overall would not be taken into account. Similarly, the effect would be underestimated if only the test subjects with paid out or negative total winnings were considered. In general, a different meaning is likely to be associated with the result in the case of negative total profit, as the test participants did not have to pay anything in these cases. It would be interesting to conduct a follow-up experiment in which the result really has the same meaning[15]for all test subjects, for example a laboratory experiment.

At the same time, it can be assumed that this difference is probably rather negligible for the basic induction of meaning. Maier and Dechamps (2018), for example, found results based on the presentation of images. This had no further consequences than the actual payout of a prize won. In general, many games have the effect that you want to win them, regardless of the impact on real life. The amount of winnings that could be won here was also small, which is why such effects were rather small anyway. Although no abnormalities were found in this experiment in connection with the question of how important winning was to the test subjects, the basic situation should still differ enough from an unrelated and meaningless experiment with two possible outcomes to make effects possible. However, the effect size may well be influenced by this, which should be investigated in further studies.

[15]Of course, financial gain will mean different things to different people, but the difference due to negative or (un)paid total gain can be eliminated.

It is also not excluded that the exact wording of the instruction is relevant for the strength of the effect. The subjects in the experimental group were told that there were "robot clones" of them who chose the same thing but played at their own tables (see Appendix). It is possible that a different result would have been obtained if the test subject had been told that they themselves were playing at several tables. Similarly, it might have been a slightly different situation if the robot clones had bet and played completely independently. This experiment was based on the assumption that a system with one person and one qRNG can be extended to a system with one person and several qRNGs and that a different instruction or situation could influence this extension. However, the difference should be negligible. The extension of the system is probably due to the importance of the financial gain, as this has significantly more weight for the subject. Even if the financial gain remains the same across the different instructions or situations, it could be interesting to take a closer look at these effects. An exact replication of this experiment will most likely no longer yield any effects due to the decline described in the theory section, but conceptual replications could focus on different instructions or situations, among other things.

As you can see from the above considerations, it is currently still unclear what exactly causes or influences the effect. To make this point even clearer: If the control group had only been told at the very end that there were robot clones of them and that they would now also receive their winnings or that they would now receive nothing because of this, then the result of the qRNGs would again be meaningful for the test subjects. In this case, an influence would actually be expected again.

Discussion of the theory

Imprecise predictions

A clear weakness of the explanatory approach described in the theory section can now be seen here. The current theory is still too imprecise. It predicts that induced correlations occur when potential measurement results are meaningful for the unconscious state of an observer. In such contexts, the probability of the realization of certain conscious states and their associated physical manifestations is influenced. But what exactly does meaningful mean here? In the discussion of the exploratory analyses, this problem was already touched upon when the connection between the importance of winning and meaning was considered. The concept of meaning is currently still difficult to grasp and can include a whole host of things. Moreover, no precise statements are made about the exact mechanisms underlying the induced correlations. What exactly determines which mental states are linked to which physical processes? Meaning? How significant does the result have to be for there to be an influence? Are there gradations of influence depending on the significance of the result? How great is the influence on probability in quantitative terms? At the moment, the theory only says that there are influences, but no further or quantitative statements are made.

The theory also predicts that the effects occur randomly if you look at the mean values, but nevertheless follow a non-random, systematic pattern over time. This is also very imprecise. No further statements are made as to what exactly the pattern looks like. If you assume an oscillation, what is the frequency? How strong is the amplitude? If the pattern is systematic, what is the underlying system? Answering these questions is anything but easy, as the theory itself postulates that the induced correlations are rare, fleeting and difficult to measure empirically. It is difficult to find a systematic approach when an inherent property of the concepts to be measured is that they appear and disappear again seemingly at random. Psychological theories are generally difficult to formalize mathematically and often tend to work with more open concepts.

Nevertheless, the quality of a theory is characterized, among other things, by its testable predictions. Finding an effect that then disappears again after a while is and remains very imprecise. For this reason, the theory is currently difficult to falsify, especially if displacement effects are used to explain effects that do not occur in the first place. With such imprecise predictions, an alternative explanation can almost always be found as to why no deviations from chance were found. For example, one could say that the situation was probably not significant enough, it was an unfavorable design or the effect was already in decline. Dechamps et al. (2021), for example, write themselves that their data do not completely falsify the validity of the *unus mundus theory* in combination with the MPI despite the lack of positive evidence. Admittedly, a strong initial effect was found in the first of the reported experiments and one can therefore certainly discuss the rejection, but that is precisely the point. How many null findings would be necessary before the theory can really be ruled out?

From the perspective of scientific theory, this is extremely problematic. Ideally, a good and well-developed theory would be able to predict the time of occurrence and disappearance of the effect, its strength and, ideally, statements about its exact course. Due to the apparent nature of the effects under investigation, such predictions are currently still a long way off, if they are possible at all, but that would be the goal to work towards. At this point, we do not want to discuss the basic concept of induced correlations or PSI effects, but rather the current elaboration of the explanatory approach. There is obviously still a lot of room for improvement in this respect.

Influences by several people

It becomes even more problematic when you consider another point. If we ignore the question of which of the seemingly infinite number of quantum mechanical processes a person is really linked to and how exactly this link looks or works, there is still another problem: there is more than one person. Can a quantum mechanical process be linked to more than one person? If not, how is it decided who can influence which process? Is it the person who sees the result first? Or the person for whom the result has the most significance? Here it is even more difficult to quantify the concept of meaning, since for two people one and the same thing can have three different meanings, if not more. If we were to answer yes to this question, we would also be faced with unresolved questions. Who influences the quantum mechanical process the most or is the influence of all persons the same? If there are differences, where do they come from? Again, about the degree of importance? Or do certain people have the ability to influence quantum mechanical random processes better than others?

In fact, there appear to be individuals who produce stronger effects than other people. For example, in the PEAR laboratories' benchmark experiment, there were two extreme outliers in the sample. These accounted for almost a quarter of the data and more than three quarters of the effect. The remaining 89 subjects had much lower scores (Cardeña et al., 2015). The question of a possible simultaneous influence has also been considered by various people. As mentioned in the theory section, Jung postulated a collective unconscious in which organizing factors or the archetypes are located (Atmanspacher, 2014). Sheldrake (2019) argues in favor of so-called morphic fields. According to this theory, it is possible, among other things, that people can access the skills that other people have learned and practiced before them via the morphic fields. Accordingly, people should, for example, learn faster if they use a QWERTY keyboard instead of a keyboard arranged alphabetically, for example. In fact, there are also research results that support this hypothesis (Norman & Fisher, 1982).

Of particular interest in this context is the *Global Consciousness Project*, which explicitly investigates the influence on an RNG. During predetermined periods of time when large numbers of people were in a common mental and emotional state, the data deviated from chance as predicted. The events studied included tragedies, celebrations, natural and man-made disasters and accidents. An example of such an event with a significant effect was the terrorist attack in New York and Washington on September 11, 2001. The average effect is small, but it has a high statistical power due to a high number of formal replications. It is currently assumed that the results of the *Global Consciousness Project* do not yet justify the conclusion that a collective consciousness is active. Nevertheless, the evidence points to an interaction between consciousness and the environment and the experiment thus provides interesting approaches for future research (Cardeña et al., 2015). Overall, it seems that there are initial indications that the questions raised above can be answered, although a clear and conclusive answer is still a long way off.

In this context, it is also easy to see that the problem of a possible experimenter effect must be taken into account. Researchers normally have an interest in obtaining certain results, and even in ordinary psychological experiments there are unintended subconscious influences.

psychological experiments can lead to unintentional subconscious influences. In the context described here, the influence would be even more direct. If the probability of a meaningful result can be influenced by induced correlations, it would be quite realistic that the project leaders are the cause of the effect. This possibility is discussed, for example, in the case of researcher Schmidt, who played an important role in micro-PK research for decades. Schmidt's research was very successful and delivered the strongest and most consistent results in this field of research. However, replications or studies inspired by him showed variable results ranging from almost equal effects to null findings. Schmidt's success can possibly be attributed to his methods and skills as a scientist, but his results could also be the result of his own PSI effects (Cardeña et al., 2015).

At this point, reference is made once again to Rabeyron (2020). Among other things, this article discusses the problems that arise from a possible PSI effect of the experimenter. In such a case, the boundary between the observer and the observed object becomes blurred. As a result, the scientific method usually used in the context of PSI research is flawed. The discussion of this problem is a debate in its own right and has only been briefly touched on here to illustrate once again that there are still fundamental difficulties within the methodology of PSI research.

Implied retrocausality

Another problematic aspect of the theory is the implied retrocausality of the experiments. The scenario has already been mentioned in which the qRNGs would also be influenced if the test subjects had only been told at the very end that there were robot clones of them and that they would be credited with their results.

At this point, however, the quantum mechanical random processes would already have been completed. Generally, by the time the subject is shown the result of the qRNG in this type of research, the process is already complete and retrocausal influence would occur. Does this mean that a person is connected to all quantum mechanical random processes since the Big Bang if their outcome is meaningful? Technically, retrocausality does not violate classical physics or QM, since the underlying math is time-symmetric. For individual particles it is unclear whether they move forward or backward through time and in QM a possible fundamental interconnectedness of past and future events is highly debated (Cardeña et al., 2015). However, mathematically not excluded and real are two completely different points. There are psychological studies and meta-analyses that report retrocausal effects, but there are also null findings. At this point, there appears to be preliminary, albeit weak, evidence for retrocausal effects in states of unconscious processing (Maier & Buechner, 2016). Retrocausality nevertheless remains a concept that is to some extent comparable to PSI phenomena: controversial, highly debated and far from conclusively clarified.

The theory does not necessarily rely on the use of retrocausality.

In the experiment presented here, for example, it was clear beforehand that the result of the qRNG would be meaningful for the test subject. However, as soon as you leave this strict setting, it quickly becomes very vague. One could argue that a wave function contains all possible states and that a person is therefore already linked to it before the actual measurement if the result is meaningful. However, this quickly brings us back to the problem of how exactly this link takes place. If a quantum-mechanical random process makes a minimal difference now, which in ten years' time will be responsible for the death of a person through chaos-theoretical processes ten years from now, is the person then linked to the result? Or is there no link because this specific process is irrelevant? Is there a limit to how far the influence of the future extends? In this context, it almost borders on other controversial concepts such as premonition[16]. Whether with or without retrocausality, the theory is simply not yet sufficiently developed in this aspect either.

Further points for discussion

A more general point of criticism is that although the theory refers to QM, it mainly uses highly debated concepts. The question of the
"correct" interpretation of QM is still unresolved and it is not ideal to focus precisely on this. The mathematical formalization of QM is hardly used, although that would be the part where there is no discourse. A more mathematical formalization of the *unus mundus theory* was done by Atmanspacher (2020), for example, and it would be advisable to continue working on this point.

One could also ask whether replacing the *hard problem of consciousness* and the *hard problem of free will* with a non-measurable entity in the form of the *unus mundus* offers any real advantage from a scientific point of view. While it is true that the *unus mundus* and the concrete process of an epistemic split are hardly or not sufficiently understood so far, the theory does make more precise and partially testable statements about the relationship between mind and matter. Some interesting empirical findings outside of PSI research can also be easily categorized within the framework of *the unus mundus theory.* For example, there are incompatible observables not only in QM, but also in psychology. In mental operations such as cognition and

[16]English term: presentiment.

perception, the order is relevant (Atmanspacher, 2020). This finding supports the idea of a parallel structure of mind and matter.

Another interesting finding is the optical interference experiments by Zou, Wang and Mandel (1991), in which the amount of available path information was also continuously varied by varying the transmissivity of a filter. If the sharpness of the interference pattern is represented as a function of the available path information, a linear relationship is obvious. The interference pattern therefore reflects not only (potentially) available information, but also only partially available knowledge (Greenstein & Zajonc, 2005). *The unus mundus theory* assumes a spectrum of boundaries between the mental or material domain and the *unus mundus*, which is consistent with the findings of Zou, Wang and Mandel.

Nevertheless, despite some advantages at this stage, the theory clearly still has a number of weaknesses that should be addressed. Consequently, if one is to take a drastic approach and instead claim that induced correlations and PSI effects do not exist, how are the existing data explained? The experiment described in this paper was based on the admittedly highly controversial assumption that PSI effects exist and can at least generally be measured by the research listed. Without this assumption, however, the results obtained are extremely confusing. The only difference between the experimental and control groups was the knowledge of the existence of the robots, or that their gains were counted as part of the subject's gains. From a skeptic's point of view, this should make no difference. However, the data indicate that there is indeed a difference. Whether it is the descriptive course, the statistical comparison with a Bayesian *independent-samples* t-test or the violated homoscedasticity, one would not expect these results. They are not overly large anomalies, but there are definitely anomalies.

It becomes even more striking when you also include other studies of this type such as Maier and Dechamps (2018) and Dechamps et al. (2021). As mentioned in the methods section, a high BF can only be achieved if the power of the sample is high enough and consequently there is no inadvertent measurement of an effect due to insufficient power. If the sequential effects are nevertheless to be attributed to statistical fluctuations, the question arises as to why these fluctuations lead to similar patterns. As already mentioned in the theory section, the first time the effect exceeds a BF of ten can vary greatly depending on the study, but the basic pattern of an effect that is present in the meantime and then disappears again remains consistent across the studies.

At this point, skeptics might argue that these sequential progressions are due to a systematic error in data processing or some other bias. Maier and Dechamps (2018) and Dechamps et al. (2021) were conducted by, among others, the same research group under whose supervision this master's thesis was written. Even with the best scientific research and the greatest care, an unnoticed systematic error can occur.
If the same qRNG is always used and similar programming and evaluation is carried out by the same group, this possibility should at least be considered. At the same time, however, this scenario seems extremely unlikely. As already reported in the methods section, the qRNG used passed the DIEHARD and NIST tests. Accordingly, it can be assumed that the numbers generated are sufficiently random.

The programs used for programming and evaluation are also used by other people. Although this does not rule out the possibility of an error, it minimizes its probability to an extreme degree. This leaves the possibility of an inadvertent error by the researchers. To the knowledge of the author of this paper, there are no other groups conducting comparable sequential analyses of the BF, but effects that appear and disappear over time or with replications can also be found in other PSI research studies. Such decline effects even occur in other areas of psychology and medicine (Rabeyron, 2020).

Consequently, at this point it no longer seems justifiable to deny possible influences on quantum mechanical random processes or PSI effects in general. There are a number of data that suggest otherwise. Science is based on data and aims to explain results. Other explanatory approaches such as pure error or bias no longer seem sufficient. However, there can and should still be a lot of discussion about the exact processes involved. Much more research is needed here in order to have a good theoretical basis. This experiment gives an indication that it may be possible to reduce the usually necessary sample sizes and thus find out more quickly what exactly the interaction between mind and matter looks like.

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Bibliography

Aspect, A., Dalibard, J., & Roger, G. (1982). Experimental Test of Bell's Inequalities Using Time-Varying Analyzers. *Physical Review Letters, 49*(25), 1804-1807. doi:10.1103/PhysRevLett.49.1804.

Atmanspacher, H. (2012). Dual-Aspect Monism a la Pauli and Jung Perforates the Completeness of Physics. *AIP Conference Proceedings, 1508*, 5-21. doi:10.1063/1.4773112.

Atmanspacher, H. (2014). 20th Century Variants of Dual-Aspect Thinking. *Mind and Matter, 12*(2), 245-288.

Atmanspacher, H. (2020). The Pauli-Jung Conjecture and Its Relatives: A Formally Augmented Outline. *Open Philosophy, 3*(1), 527-549. doi:10.1515/opphil-2020-0138.

Bartelmann, M., Feuerbacher, B., Krüger, T., Lüst, D., Rebhan, A., & Wipf, A. (2018). *Theoretical Physics 3 | Quantum Mechanics*. Berlin Heidelberg: Springer-Verlag.

Bear, M. F., Connors, B. W., & Paradiso, M. A. (2018). Past, present and future of neuroscience. In A. K. Engel (Ed.), *Neuroscience: A fundamental basic textbook for biology, medicine and psychology* (pp. 3-23). Berlin, Heidelberg: Springer Berlin Heidelberg.

Bell, J. S. (1964). On the Einstein Podolsky Rosen paradox. *Physics Physique Fizika, 1*(3), 195-200. doi:10.1103/PhysicsPhysiqueFizika.1.195.

Cardeña, E., Palmer, J., & Marcusson-Clavertz, D. (Eds.). (2015). *Parapsychology: A Handbook for the 21st Century*. Jefferson: McFarland & Company, Inc.

Chalmers, D. (1995). Facing up to the problem of consciousness. *Journal of Consciousness Studies, 2*(3), 200-219.

Dechamps, M. C., Maier, M. A., Pflitsch, M., & Duggan, M. (2021). Observer Dependent Biases of Quantum Randomness: Effect Stability and Replicability. *Journal of Anomalous Experience and Cognition, 1*(1-2), 114-155. doi:10.31156/jaex.23205.

Einstein, A., Podolsky, B., & Rosen, N. (1935). Can Quantum-Mechanical Description of Physical Reality Be Considered Complete? *Physical Review, 47*(10), 777-780. doi:10.1103/PhysRev.47.777.

Greenstein, G., & Zajonc, A. G. (2005). *The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics* (2 ed.). Sudbury: Jones and Bartlett Publishers.

Jahn, R. G., Dunne, B. J., Nelson, R. G., Dobyns, Y. H., & Bradish, G. J. (2007). Correlations of Random Binary Sequences with Pre-Stated Operator Intention: A Review of a 12-Year Program. *EXPLORE, 3*(3), 244-253. doi:10.1016/j.explore.2007.03.009.

Maier, M. A., & Buechner, V. L. (2016). Time and Consciousness. In M. Nadin (Ed.), *Anticipation Across Disciplines* (pp. 93-104). Cham: Springer International Publishing Switzerland.

Maier, M. A., & Dechamps, M. C. (2018). Observer Effects on Quantum Randomness: Testing Micro-Psychokinetic Effects of Smokers on Addiction-Related Stimuli. *Journal of Scientific Exploration, 32*(2), 261-293. doi:10.31275/2018.1250.

Maier, M. A., Dechamps, M. C., & Rabeyron, T. (2022). Quantum Measurement as Pragmatic Information Transfer: Observer Effects on (S)Objective Reality Formation. *Journal of Anomalous Experience and Cognition, 2*(1), 16-48. doi:10.31156/jaex.23535.

Meier, C. A. (Ed.) (1992). *Wolfgang Pauli and C.G. Jung. An exchange of letters 1932-1958*. Berlin Heidelberg: Springer-Verlag.

Norman, D. A., & Fisher, D. (1982). Why Alphabetic Keyboards Are Not Easy to Use: Keyboard Layout Doesn't Much Matter. *Human Factors, 24*(5), 509-519. doi:10.1177/001872088202400502.

Rabeyron, T. (2020). Why Most Research Findings About Psi Are False: The Replicability Crisis, the Psi Paradox and the Myth of Sisyphus. *Frontiers in Psychology, 11*. doi:10.3389/fpsyg.2020.562992.

Schlosshauer, M., Kofler, J., & Zeilinger, A. (2013). A snapshot of foundational attitudes toward quantum mechanics. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, 44*(3), 222-230. doi:10.1016/j.shpsb.2013.04.004.

Shariff, A., Schooler, J., & Vohs, K. (2008). The Hazards of Claiming to Have Solved the Hard Problem of Free Will. doi:10.1093/acprof:oso/9780195189636.003.0009.

Sheldrake, R. (2019). *The Memory of Nature: The Mystery of the Origin of Forms* (3 ed.). Frankfurt am Main: S. Fischer Verlag.

Turiel, T. P. (2007). Quantum random bit generators. *The American Statistician, 61*(3), 255-259.

von Lucadou, W. (1995). The model of pragmatic information (MPI). *European Journal of Parapsychology, 11*, 58-75.

von Lucadou, W., Römer, H., & Walach, H. (2007). Synchronistic Phenomena as Entanglement Correlations in Generalized Quantum Theory. *Journal of Consciousness Studies, 14*(4), 50-74.

Yu, S., & Nikolić, D. (2011). Quantum mechanics needs no consciousness. *Annals of Physics, 523*(11), 931-938. doi: 10.1002/andp.201100078.

Zou, X. Y., Wang, L. J., & Mandel, L. (1991). Induced Coherence and Indistinguishability in Optical Interference. *Physical Review Letters, 67*(3), 318-321. doi:10.1103/PhysRevLett.67.318

Appendix - text modules used

Instruction experimental group:

Study "Intuition and guessing behavior"

In this study, you will take part in a roulette game several times. As a reminder, the winnings that you win will be paid out to you afterwards. You cannot lose any money. You start with 1 euro in your account.
In the following, you can bet on red or black. You can win or lose 10 cents per round. You can change your choice every round. You may have to wait a few moments for the experiment to continue after your color choice. In this case, please be patient.
In addition to you, there are also "robot clones" of you. They choose the same colors as you, but play at their own tables. You will also be credited with the result of the robot clones and paid out at the end.

Example of an experimental group:

Here is an example. You have correctly chosen black and would have won €0.10 on top of your €1 starting capital. The robot clones would have won an additional €0.50 for you.

Instruction control group:

"Intuition and guessing behavior" study

In this study, you will take part in a roulette game several times. As a reminder, the winnings you win will be paid out to you afterwards. You cannot lose any money. You start with 1 euro in your account.
In the following, you can bet on red or black. You can win or lose 10 cents per round. You can change your choice every round. You may have to wait a few moments for the experiment to continue after your color choice. In this case, please be patient.

Example control group:

Here is an example. You have correctly chosen black and would have won €0.10 in addition to your €1 starting capital.

Final text:

Thank you for taking part!
Your winnings amount to
... €!
If your winnings are negative, you will unfortunately not be paid out anything.