Investigating Mind-Matter-Interactions

— An Empirical Approach to the Mind-Body Problem

Inaugural-Dissertation

zur Erlangung des Doktorgrades der Philosophie

an der Ludwig-Maximilians-Universität

München

vorgelegt von

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geboren in Deggendorf

2024

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Tag der mündlichen Prüfung: 13.05.2024

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1. Introductory Summary

1.1. Mind-Matter Interactions in Psychology

Psychology is defined as the science of human experience and behavior. The term originates from ancient Greek, literally meaning “study of the mind”. The subject of theories and empirical investigations is, accordingly, the psyche, the mental entity. Cartesian dualism, which is widespread in this discipline, makes a clear distinction between two independently existing substance classes: matter (“res extensa”) and mind (“res cogitans”). The entity “res extensa” is characterized exclusively by its extension in space. Thus, it can be fully described mathematically by the causal relations of its elements (Brüntrup, 2018). In contrast, the term “res cogitans” denotes the thinking, doubting, understanding, confirming, contradicting, willing, rejecting, fantasizing and perceiving entity. Descartes (1641) formulated the famous statement “Cogito ergo sum” (“I think, therefore I am”). Even if the objectivity of sensations and the correctness of certain thoughts can be doubted, the mere fact that a person is consciously aware and thus has the ability to question reality, proves existence inevitably.

Since mental processes are the topic of psychology, in contrast to other natural sciences, there is always a subjective component to consider. Nevertheless, psychology nowadays sees itself as an empirical science, which strives for objective, replicable results. Recently, it seems to have reached its limits in this respect. There is a so-called replication crisis, which means that, in many cases, significant effects cannot be reproduced. One of the triggers of this debate was the study conducted by Bem (2011), which found evidence for precognition (see Rabeyron, 2020). Since then, a large number of articles has been published on topics such as replicability of empirical outcomes and skeptical considerations of the methods used in (psychological) research.

A possible reason for these limitations could be the mind-body problem. Most of the investigated phenomena do not solely refer to the mental realm but rather to interactions

between mind and matter. However, starting from Cartesian dualism, the question arises how two essentially different classes of substances can interact with each other. In sum, there are two major issues: First, the "hard problem of free will" which asks how mental states can translate into physical events (Shariff et al., 2008), and second, the "hard problem of consciousness", which poses the question why and how a conscious mind that corresponds to the materialized reality evolves (Chalmers, 1995).

Radical emergence is a widespread dualistic model that assumes bidirectional causal interactions between mind and matter. It states that conscious experience emerges from the pure configuration of different material units in an inexplicable and unpredictable way. This concept contradicts the "genetic argument" that a certain substance class cannot create new elements with essentially different properties (Brüntrup, 2018). Nevertheless, current mainstream sciences tend to accept this logical weakness or put aside the "hard problems" of mind and body. Another approach to this issue is physicalism, which renounces a distinction between mind and matter in the sense of dualism, or limits the epistemic focus on the "material" dimensions of psychology (see Brüntrup, 2018). Important examples for this position in psychological research are e.g., traditional behaviorism (Watson, 1913), which advocated investigation of human behavior solely in terms of stimulus-response-patterns. This approach excludes the introspective study of processes within the organism (the so-called "black box") as well as the more recent paradigm of neuroscience, reducing all mental processes to brain activities. The advantage of the physicalist perspective is that it objectifies empirical psychology as demanded by the natural sciences. However, all aspects of the subjective experience are omitted as a trade-off. Thus, Descartes' epistemological foundation "Cogito ergo sum" is neglected. Furthermore, even a complete knowledge of all neuronal functioning does not put us in a position to understand if and how the brain generates consciousness at all (see Brüntrup, 2018). In modern psychology, despite a large number of studies and theoretical

concepts, the mechanisms behind many empirical findings remain unknown. Even in psychotherapy, whose effectiveness is considered convincingly empirically confirmed, the specific efficacy of interventions and the exact process variables still remain unclear. Kiesler (1966) referred to the question of how exactly developments are triggered in psychotherapy as "the missing link". Moreover, there are various frontier phenomena in scientific research, such as the occurrence of spontaneous exceptional experiences, e.g., psi-phenomena, meaningful coincidences or out-of-body experiences, which cannot be explained by any purely physicalist models of the mind and are therefore widely ignored by mainstream sciences (Atmanspacher, 2020). In consequence, a purely physicalist approach cannot be considered appropriate to the complexity of the human psyche and psychology as a science of human experience and behavior.

Over time, various models of mind-matter-interaction have been developed in different disciplines. Among them, theories of dual-aspect monism resolve the outlined contradictions by considering mind and matter as two different aspects of a common basis (e.g., Atmanspacher, 2014). Therefore, they do not interact directly with each other but are correlated due to their joint origin. One variant, psychophysical substance dualism, proposes that mind and matter exist as preforms (pre-conscious and pre-material) at a stage where they are not yet separate from each other. The idea of a pre-reality may seem daring at first glance, but it is an established concept of quantum theory. Therefore, quantum mechanics forms the basic theoretical framework for modern versions of psychophysical substance dualism, as for example the "Unus Mundus Model" (UMM) developed by C.G. Jung and W. Pauli in a letter exchange between 1932 and 1958 (see Atmanspacher et al., 2013; Atmanspacher, 2020), the "Orchestrated Objective Reduction" (Orch OR) theory by Nobel Prize winner Roger Penrose (e.g., Penrose & Hameroff, 2011) and the "Generalized Quantum Theory" (GQT; Atmanspacher et al., 2002; Filk & Römer, 2011).

1.2. Quantum-Based Models of Psychophysical Substance Dualism

Quantum-based models of psychophysical substance dualism share the basic concept that mind and matter originate from a common realm of potentiality on a deeper layer. Due to measurement processes, they manifest themselves as two separate entities, conscious experience and corresponding physical event, at a higher level of reality. Accordingly, quantum physics assumes that potential features of a quantum particle such as its exact location exist in a superposition of different possible states before measurement takes place.

The so-called double-slit experiment illustrates the essential role of the act of measurement in quantum mechanics (see Greenstein und Zajonc, 2006): In this experimental setup particles like, for example, photons are shot onto a fluorescent screen through a special grid with two slits. According to the laws of classical physics, macroscopic objects are expected to pass one of the two slits with equal probability. Microscopic particles like photons show the same behavior under registration of each slit passed. However, if it is not recorded which of the two slits the particles pass through, a wave-like interference pattern of alternating minima and maxima appears on the screen. This means that microscopic particles exist in several places at the same time before measurement. Schrödinger's wave function thereby describes the totality of all potential quantum states over time (Schrödinger, 1935). By interacting with another system such as an observer during the act of measurement, the interference pattern is disturbed and only one of the potential locations of the photon becomes observable. However, it remains unclear what exactly leads to the transition of the interference pattern to one particular outcome (e.g., the mere measurement apparatus vs. conscious observation), and what happens to the other superpositions (collapse vs. non-collapse of the wave function). The so-called "measurement problem" in quantum mechanics therefore goes beyond purely physical questions and thus reaches into the disciplines of philosophy and psychology.

In any case, even if experimental conditions are kept constant, no exact prediction can be made about the final outcome of the measurement. Therefore, the probability of each possible state to be observed can be calculated with the Born rule, which is represented by the squared amplitude of the wave function on this position (Born, 1926). Orthodox quantum physics assumes that the Born rule follows randomness in its nature, so that each potential outcome is equally likely to be measured and will therefore occur the same number of times over a large number of experimental runs (Bell, 1964; Greenstein & Zajonc, 2006). With respect to studies in the field of quantum mechanics, this perspective appears plausible since physical experiments are usually performed by neutral observers. For the experimenter, it has no consequences whether a particle passes the left or the right slit because no personal meaning is involved. Outside the laboratory, every person could be understood as an intentional observer of quantum measurement processes, since the events that happen in reality have immediate effects on us. Consequently, an extension of quantum physics is needed to include the influence of subjective meaningfulness and its effects on macroscopic reality.

Indeed, some authors (e.g., Mensky, 2014; Penrose & Hameroff, 2011; Stapp, 2007) allow an intentional observer to influence the quantum probabilities, making an outcome more likely than predicted by the Born rule. For example, the UMM (see Atmanspacher et al., 2013; Atmanspacher, 2014) and its mathematical formalization by the GQT (e.g., Filk & Römer, 2011; Atmanspacher et al., 2002) offer an elegant framework to explain psychophysical interactions during quantum measurements. The UMM implements a superposition-like collective and unconscious pre-reality of mind and matter. The transition into the dualistic reality of conscious experience and classical matter, referred to as “epistemic split”, occurs due to the act of knowledge-transition from unknown to known (Atmanspacher, 2020). From then on, mind and matter cannot interact directly anymore, as they appear as two distinct substances.

Nevertheless, they remain entangled due to their common foundation. Two different types of mind-matter correlations are distinguished:

Firstly, Structural Correlations (SCs) describe phenomena in which classical physical events are consciously perceived. They are unidirectional, as a certain aspect of Unus Mundus manifests itself in the material as well as in the conscious realm in parallel. This includes, for example, typical psychosomatic correlations such as increased blood pressure when experiencing mental stress (Atmanspacher, 2020). Thus, the mind acts rather reactively and has a passive observer role, not demanding the intentional agency of the individual (Maier et al., 2022). Therefore, SCs follow the Born rule during the transfer from pre-reality into the dualistic macroscopic world and are considered stable and reproducible.

Secondly, Induced Correlations (ICs) refer to bidirectional interactions of mind and matter. When personal meaning is attached to a manifest event, this leads to a change in consciousness and thus automatically also in the realm of pre-reality, where mind and matter are still intertwined. The change in the common underlying ground in turn must also influence physical reality. This means that autonomous individuals exert a mental impact on the creation of reality out of a quantum superposition within the Unus Mundus (see also Maier et al., 2022). Thus, ICs tend to create a bias in the Born rule along an observer's motivational state during observation. This includes frontier phenomena of mind-matter interaction like meaningful coincidences. Pauli and Jung (see also Atmanspacher et al., 2013) referred to such extraordinary relationships between meaning and time as "synchronistic events" emphasizing the elusive nature of these effects, which do not follow the classical principles of causality and locality. In contrast to SCs, ICs are therefore not considered reproducible.

This assumption is also supported by von Lucadou et al. (2007) in their "Model of Pragmatic Information" (MPI) stating that the novelty of a finding based on non-local entanglement correlations is complementarily related to its likelihood of confirmation (see also

von Lucadou, 2006; 2015). The authors argue that a violation of the Borns rule in quantum mechanics would contradict the no-signal theorem, which claims that nothing can travel faster than light. Being able to intentionally create reproducible and stable entanglement correlations would mean that one could use this method to send messages immediately over far distances even faster than the speed of light. This potential signal-use is prohibited by the laws of physics meaning that such effects must decline over the course of further confirmation attempts, like conducting systematic replication studies of a certain experiment (Atmanspacher et al., 2002). To continue this idea, Maier et al. (2018) drew parallels to the second law of thermodynamics, which states that entropy must always increase in closed systems to ensure that order does not emerge from chaos (or information from randomness). Therefore, they assumed a systematic counter-mechanism that eliminates the original IC as long as it can be recognized as a signal, leading to an oscillating pattern of appearance and disappearance across studies and participants over time. Furthermore, they argue that this interplay between effect and counter-effect reflects in a specific pattern of evidence across time that can possibly be displayed systematically.

1.3. Intentional Observation of Probabilistic Processes

A traditional experimental approach to investigate the influence of intentional observation on probabilistic processes like throwing dice, tossing a coin, or producing sequences of random bits by hardware Random Number Generators (RNGs) is called micro-Psychokinesis (micro-PK; see e.g., Jahn et al., 1987; Jahn & Dunne, 1997; Stanford, 1976; Stanford et al., 1975; Schmidt, 1974). Effects are recorded by analyzing deviations from randomness by statistical means (Varvoglis & Bancel, 2015). Through the use of Quantum-Based RNGs (QRNGs), it is possible to establish superpositions of binary quantum states for every experimental trail (Maier et al., 2022). Each quantum state potentially leads to the presentation of a certain stimulus, e.g. a lamp's cone of light turning to the left or to the right (Schmidt, 1970), the upward and downward movements of a random walk graph (Jahn et al.,

1997), or the presentation of a positive or negative image (Maier et al., 2018). After measurement, participants consciously perceive the selected stimulus. Furthermore, experimental designs differ in terms of whether there is an explicit or implicit task to mentally influence the random distribution of the respective system.

Several meta-analyses concluded that, within numerous studies, observers' conscious or unconscious motivational states could influence the outcomes of a QRNG in accordance with their motives or intentions through the sole act of observation (Bösch et al., 2006; Radin & Nelson, 1989). Moreover, Varvoglis and Bancel (2015) showed that publication bias is an unlikely alternative explanation for micro-PK effects by calculating that this would require an unrealistically large number of non-significant studies in the file drawer (see also Radin et al., 2006). Nevertheless, there is a lack of successful direct replications of these effects (e.g., Dechamps et al., 2021; Jahn et al., 2000; Dechamps & Maier, 2019). In consequence, skeptics argue that the initial effects are false positive findings within true random fluctuation, or the result of Questionable Research Practices (QRPs; e.g., Wagenmakers et al., 2011; Alcock, 2003).

However, there is another considerable reason for true initial effects and failed attempts of replications: Assuming the UMM (see Atmanspacher et al., 2013; Atmanspacher, 2020) and the MPI (von Lucadou et al., 2007) as theoretical basis for micro-PK studies, a decline in the effect over the course of subsequent replications must be inherent due to the laws of physics. At this point, a conflict arises between the elusive nature of IC phenomena and the demand for objectification of effects in empirical science. Regarding this controversy, Rabeyron (2020) suggested that unusual patterns in experimental research of frontier phenomena should be studied to learn more about the effects' true nature (see also Atmanspacher et al., 2002; von Lucadou et al., 2007; von Lucadou, 2015). The idea of a systematic interplay between effect and counter-effect that disturbs the forbidden signal character of ICs might enable researchers

to investigate not solely the average deviations from randomness but also the supposed oscillating pattern of evidence for the effect across time with appropriate statistical methods (Maier et al., 2018).

It is a repeatedly proposed interpretation of the evidence concerning intentional observer effects on QRNGs that the mind itself can create reality by means of intentional agency. This means that individuals influence the emergence of a reality that features their goal-orientations (Maier et al., 2022). Based on models of psychophysical substance dualism, Maier et al. (2018) argued that this cannot be a direct interaction of mind and matter but must be located within the realm of pre-reality, which exists before the measurement of a quantum state. They assume that a specific pre-conscious mental state biases the Born rule by increasing the likelihood of an equivalent physical state after measurement. Consequently, implicit motives rather than conscious deliberate intentions themselves are supposed to trigger micro-PK effects (Dechamps & Maier, 2019; Maier & Dechamps, 2018). This concept fits well to the findings in a previous study which suggested that directional psi effects also occurred within participants who were not aware of the micro-PK task at all and therefore did not consciously intend to produce deviations from randomness (Stanford, 1976; Stanford et al., 1975).

The process and the direction of the influence of intentional agency on the likelihood of quantum states to manifest can be described by the Emotional Transgression Model (ETM). The ETM extends established concepts of the functioning of psi regarding non-intentionality (Stanford, 1990) and goal-orientation (Schmidt, 1974) by assuming that the emotional impact of goals determines the directionality of intentional observer effects. In this respect, the emotional interpretation in turn depends on expectations regarding the chances to achieve a goal. These goal-expectations and the respective emotions are based on implicit core beliefs leading to (automatic) appraisal processes which attribute personal meaning to the stimuli. Fundamentally, motivational tendencies can be classified as approach and avoidance

orientations. Respectively, their accompanying emotions are hope for positive outcomes and fear of negative consequences (see Elliot, 2008). In fact, the key message of the ETM is that solely emotionally coded information of an intention is able to permeate from the consciousness to the pre-reality realm and thus impacts the Unus Mundus. Consequently, individuals influence physical reality according to their core beliefs mediated by their emotions like a self-fulfilling prophecy in the context of intentional observation. Thus, an individual's personality which comprises basic assumptions about themself and reality, as well as all motivational tendencies, can be considered a predisposition of the individual superpositions within pre-reality. Hence, micro-PK studies should investigate correlations between established and measurable Personality Traits (PTs) of participants representing implicit, affectively laden core beliefs and deviations from quantum randomness during intentional observation.

1.4. Empirical Considerations

The goal of this dissertation was to make an empirical contribution to the mind-body problem. Therefore, we designed three quantitative, highly-powered micro-PK studies to identify strong and measurable subconsciously active core beliefs that have the capacity to trigger measurable ICs according to the predictions of the ETM. Participants were presented with different stimuli on a screen, selected by a QRNG trail by trail, which appeared either neutral or meaningful to them, depending on whether they were referring to their affectively laden core beliefs. In Study 1, positive and negative stimuli (approach- vs. avoidance-orientation) in the form of words or pictures represented the participants' perceived incongruency of psychological basic needs. In Studies 2 and 3, Cluster C PTs were recorded and linked to meaningful sentences reflecting the typical anxieties of the respective PTs.

Furthermore, to address the outlined replicability issue of psychological experimental findings, a Bayesian approach was adopted to assess the plausibility of study results as well as to map the sequential changes of evidence. In psychological research, especially in the field of

micro-PK, a pattern of initially significant findings and subsequently failed replications or decreasing effect sizes (decline effect) has been repeatedly observed. Therefore, in the three studies presented herein, effects were analyzed not only based on the final outcome and the average deviation from the expectancy value, but also regarding the pattern of evidence over the data collection period. To this end, Higher-Level Analytical Strategies (HLASs) were performed: One variant of HLASs was originally introduced by Dechamps and Maier (2019) to differentiate between unsystematic and systematic micro-PK effect variation across time. The authors consider effect and decline of micro-PK tasks as systematic variations, which therefore should differ from truly random data produced by the same QRNG without a conscious mind observing the process. For this purpose, Change of Evidence (CoE) analyses developed by the research group in collaboration with Prof. Günter Schiepek (Institute for Synergetic and Psychotherapy Research) were conducted, comparing the sequential Bayes Factor (BF) across participants with randomly generated simulations. In Study 1 and 2, CoE analyses were exploratively performed to provide additional information on the supposed volatile nature of ICs. Aware of many failed direct replications in the past decades of research, a replication of a post-hoc re-analysis on a first subsample of the data from Study 2 by means of HLASs was attempted in Study 3. Thus, instead of predicting to reproduce a significant overall effect, a characteristic, systematic CoE pattern over time was expected to be repeated.

The co-author Dr. Moritz Dechamps (MD), the supervisor Prof. Markus Maier (MM) and the doctoral student Marissa-Julia Jakob (MJ), were involved in the design process and the implementation of all three studies. MD handled the programming of the experiments as well as the technical aspects generating the simulated datasets. MM provided the technical and financial resources for the studies, gave feedback on the research process as needed, and assisted with theory building. MJ carried out the data collection, analyzed and interpreted the data, and took the lead in drafting the ethics proposal for studies on human subjects, the

preregistration forms, the research reports, and the correspondences in each of the subsequent review processes.

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2. Research Paper 1:

You Attract what You Are: The Effect of Unconscious Needs on Micro-Psychokinesis[1]

Jakob, M. J.*, Dechamps, M. C.*, & Maier, M. A. (2020). You attract what you are: The effect of unconscious needs on Micro-Psychokinesis. *Journal of Parapsychology*, *84*, 227–253. http://doi.org/10.30891/jopar.2020.02.06[2]

[1] *Shared first authorship

[2] First published in the Journal of Parapsychology. Secondary publication with permission of the journal.

Journal of Parapsychology
2020, Vol. 84, No. 2, 227-253

http://doi.org/10.30891/jopar.2020.02.06

You Attract what You Are: The Effect of Unconscious Needs on Micro-Psychokinesis[1]

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Abstract: Quantum-based psychophysical correlation models offer an attractive framework for predicting mind-matter interactions. We report a test of such interactions in the form of observer effects on quantum-based random number generator (QRNG) outcomes. Specifically, we tested the influence of certain motive states on related stimulus presentations chosen by the QRNG. Deviations from randomness were expected among participants exhibiting high incongruence (HI) characteristics but not among those who exhibited low incongruence (LI). Our first experiment, testing the effects of three psychological needs—attachment, self-esteem protection, and control— with a Bayesian analysis yielded anecdotal evidence for H_1 only for self-esteem-related stimuli within the HI group. The second experiment was a selective continuation of the promising self-esteem protection condition, exploring the further sequential course of evidence for H_1 and its oscillation over time. Our criterion for confirming H_1 was initially reached in the target group. Shortly thereafter, a decline to a final result of anecdotal evidence for H_1 occurred. To test the systematic trend in the data against chance fluctuations, further post hoc analyses comparing the maximum Bayes Factor, the curve's energy, and frequency spectrum analysis between both groups to 10,000 simulations were performed. These analyses indicated that the HI subsample's data differed significantly from chance fluctuations, whereas the LI subsample's data did not. In sum, the results suggest that core affectively laden subconscious beliefs can manifest through volatile yet statistically detectable deviations from quantum randomness when precisely triggered by an adequate task.

Keywords: micro-psychokinesis, mind-matter, quantum measurement, intentional observation.

Various models describing the relation between mind and matter have been developed over time within different disciplines. The idea that these entities are different substances, as articulated by Cartesian dualism, poses two unsolved riddles regarding mind-brain interaction. First, the *hard problem of free will* concerns the question of whether phenomenal experiences can translate into physical events (Shariff et al., 2008). Second, the intricately related *hard problem of consciousness* (Chalmers, 1995) asks why and how a conscious mind that corresponds to the materialized reality evolves (Brüntrup, 2008). Thus, the core question is: How can two qualitatively different substances such as mind and matter interact with one another? Most current mainstream sciences tend to ignore this problem and seem to be

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satisfied with the position of radical emergence. In sum, they accept logical weaknesses, in particular its contradiction of the genetic argument, which states that conscious experience emerges from the pure configuration of different material units in an inexplicable and unpredictable way (Brüntrup, 2008).

By contrast, a possible means of avoiding these theoretical problems may lie in the consideration of dual-aspect monism theories, which consider mind and matter to be two distinct aspects of a common ground (e.g., Atmanspacher, 2014). One variant, psychophysical substance dualism, has a long tradition in philosophy, and can be found in Leibniz's monadology and Fechner's psychophysical theory (for an overview of this tradition in the Western culture see Skrbina, 2017). According to psychophysical substance dualism, interactions between mind and matter are located within a common ground, in which both aspects of reality exist as preforms (pre-conscious and pre-material), and, at this stage, are not yet separate from each other. This proposition of an existing pre-reality remained highly speculative until the advent of quantum theory. Newer versions of psychophysical substance dualism included quantum mechanics as their basic theoretical framework. Examples include the "unus mundus" theory developed by C.G. Jung and W. Pauli in a letter exchange between 1932 and 1958 (Atmanspacher et al., 2013), the "Implicate Order" theory (Bohm, 1985, 1990; Bohm & Hiley, 1982), and "Generalized Quantum Theory" (GQT) (Atmanspacher et al., 2002; Filk & Römer, 2011). Those approaches formalize the core idea that mind and matter form a unit on a deeper layer of potentiality and are separated only by measurement into the realms of conscious experience and corresponding matter at a higher level (for different approaches, see, Penrose & Hameroff, 2011; Pradhan, 2012; Römer, 2004).

The act of measurement constitutes a fundamental process in quantum physics in which a quantum system interacts with an outside system, a so-called observer. Before measurement takes place, specific features of a quantum particle, such as an electron's location, exist in a superposition of different states that are described by Schrödinger's wave function (Schrödinger, 1935). Upon measurement, one of these potential location states is determined with a probability reflecting the squared amplitude of the wave function on this position (Born, 1926). Orthodox quantum physics consider this random behavior to be ontic and inherent in nature (Bell, 1964; see Greenstein & Zajonc, 2006). Some authors (e.g., Mensky, 2014; Penrose & Hameroff, 2011; Pradhan, 2012; Stapp, 2007), however, allow an intentional observer to influence the quantum probabilities, making an outcome more likely than predicted by the Born rule (see also the correspondence between Jung and Pauli, but with the restriction that these effects can only be spurious and unsystematic; similar predictions are also made within GQT). In other words, a conscious observer's mind might play a more active role in the outcome selection than assumed within the original quantum theory framework (Schwartz et al., 2004).

With psychophysical substance dualism and dual-aspect monism in mind, Maier, Dechamps, and Pflitsch (2018) emphasized that such an influence must happen indirectly and emerge from the common ground prior to measurement. It is thus not the conscious deliberate intention itself that affects the emergence of materialization but, rather, the observer's pre-conscious (and therefore unmeasured) state of mind that impacts the becoming of conscious experience of a classical material result (Dechamps & Maier, 2019; Maier & Dechamps, 2018).

Micro-Psychokinesis

The influence of an intentional observer on deviations from quantum randomness during the process of measurement has been the subject of investigation for several decades. This area of research has been part of a wider field of research labeled micro-psychokinesis (micro-PK). Micro-PK effects are defined as "minute influences on inanimate, probabilistic systems, producing effects that can only be detected through statistical means. The target systems may include tumbling dice, coin tossing systems, or hardware random number generators (RNGs)" (Varvoglis & Bancel, 2015, p. 266). Several meta-analyses aggregated the results of hundreds of micro-PK studies involving a quantum-based true random number generator (QRNG), and observed significant overall effects (Bösch et al., 2006; Radin & Nelson, 1989). On average, intentional observation had an effect on the probabilities of quantum events. However, the rather unconventional high heterogeneity of effect sizes in these analyses left room for doubt (see, however, Radin et al., 2006). In addition, a large-scale study testing micro-PK with 12,571 participants also found no evidence of the effect (Maier et al., 2018). Furthermore, the "benchmark" experiment of the Princeton Engineering Anomalies Research (PEAR) program could not be replicated. The latter program consisted of over 2.5 million trials over twelve years, eventually yielding a remarkable *Z*-score of 3.8 (Jahn et al., 1987). Contrary to expectations, a direct replication attempt by a research consortium collecting 750,000 trials over three years failed, with an insignificant Z-score of 0.6 (Jahn et al., 2000). Although some of these discrepancies may be attributed to extreme outliers in the PEAR study and a subsequently underpowered design of the replication study (Varvoglis & Bancel, 2015), variable effects in micro-PK studies continue to challenge researchers (e.g., Maier & Dechamps, 2018).

Along with selective publication and enhanced study design, some authors attribute declining effects to individual psychological variables, such as the individual's motivation or stress level (Varvoglis & Bancel, 2015). This can be addressed by using fewer trials and working with paradigms that are less performance-based, in addition to applying study designs that work with effortless intention, rather than effortful, deliberate tasks (e.g., Braud & Braud, 1979; Debes & Morris, 1982). For that reason, in our study, we sought to subconsciously active implicit psychological variables to pair with the effect. However, psychological moderators can only account for declines concerning individual participants; they do not address declines over the course of a single study or more (Bierman, 2001).

Model of Pragmatic Information

A more global explanation for decline effects was originally proposed by von Lucadou, Römer, and Walach (2007) in their "Model of Pragmatic Information." It states that the novelty of a finding based on non-local entanglement correlations is complementarily related to its likelihood of confirmation (von Lucadou, 2006, 2015). The authors realized that a violation of the probability rule in quantum mechanics would also conflict with the "no-signal" theorem (or NT-Axiom in terms of the GQT), according to which no signal can travel faster than light. This could, in theory, be realized through a consistent and reliable occurrence of non-local entanglement correlations. Thus, the systematic detection of micro-PK effects and the potential signal-use of this effect must be prohibited (Atmanspacher et al., 2002). Replication of micro-PK effects, therefore, is highly unlikely, leading to a decline in the effect over the course of subsequent replications. Recently, Maier et al. (2018) modified this proposition somewhat, arguing

for a systematic counter-mechanism that eliminates the original micro-PK effect as long as it represents a signal, leading to an oscillating pattern of appearance and disappearance across studies and participants over time. This antagonistic force may also be related to the second law of thermodynamics, which states that entropy must always increase in closed systems, ensuring that order does not emerge from chaos (or information from randomness). This interplay between effect and counter-effect should manifest in a specific pattern of evidence for the effect across time, resembling a damped harmonic oscillation.

Directionality and Emotional Transgression of Micro-PK

In the studies presented herein, we tested observer effects on micro-PK using the participants' pre-conscious motive states as independent variables. Our focus on pre-conscious intentional states refers to the proposed origin (see Atmanspacher, 2014) of mind-matter interactions that locates them within the realm of the pre-reality that existed before the measurement of a quantum state. An increased likelihood of a specific pre-conscious mental state should find its correspondence after measurement in the increased likelihood of the equivalent physical state during conscious observation of the measurement's result. This means, micro-PK effects can only be congruent to implicit motives, rather than to deliberate goals. There is empirical evidence for this claim in studies that show directional psi effects of participants that were not consciously intending them.

The direction of the psychogenic influence may be derived by the Emotional Transgression Model (ETM)—a model for the emotional impact of motivational goals on unconscious behavior activation. According to this model, every motivational goal of an individual is based on an emotionally laden unconscious expectation grounded in a certain belief. Two emotions are primarily relevant here: hope and fear (see Elliot, 2008). When goals are based on approach-oriented expectations grounded in the aim to succeed during goal performance the driving emotion is hope for positive outcomes. On the other side, when goals are based on avoidance-oriented expectations grounded in the expectation of a negative outcome the underlying driving emotion is fear of loss. For example, if someone wishes to find a job an approach orientation would be characterized by the hope to find a perfect job pretty soon. Confidence in getting a desired job would be the underlying belief here as this is the core theme of hope. In the case of an avoidance orientation, the individual would anxiously desire to find a job. Fearful doubts about getting a desired job would be the underlying belief here as this is the core theme of fear. In both cases the individual's explicit goal is to find a job, but the emotional expectations that lay behind are completely different. We argue that micro-PK effects are dependent only on those emotional expectations. As is apparent in this example, they cannot be translated directly from explicit goals but depend on the emotional transcription that goes along with them. Thus, an avoidance-based goal should unconsciously lead to a negative self-fulfilling prophecy. Empirical evidence can be found in Stanford's work regarding his theory of "psi-mediated instrumental response". Studies showed the occurrence of a directional psi effect within subjects that were not consciously intending them (Stanford, 1976; Stanford et al., 1975). The ETM extends the non-intentionality (Stanford, 1990) and goal-orientation (Schmidt, 1974) postulates regarding psi effects and proposes that the directionality of the effect is directly dependent on the emotional interpretation of the goal shaped by a basic core belief. Our goal in this study was to identify

strong and measurable subconsciously active beliefs that may trigger either an approach- or an avoidance oriented micro-PK effect using the predictions of the ETM.

Consistency Theory

In view of the above, we selected Grawe's "consistency theory" (1998) as a model of basic motivational determinants measurable with reliable questionnaires like the "Inkongruenzfragebogen" (INK; "Incongruence Questionnaire") (Grosse Holtforth et al., 2004). According to Grawe's "functional model of the psychic event", the elementary function of adequate adaptation to an individual's environment is successful if the basic psychic needs are fulfilled. Similar to comparable concepts (e.g., the Cognitive-Experiential Self-Theory by Epstein, 1990), consistency theory considers "attachment/connection," "self-esteem enhancement/protection," "orientation/control," and "pleasure maximization/distress avoidance" as the four basic human needs. In our study we selected "attachment," "self-esteem protection," and "loss of control" to create a specific micro-PK task and excluded "pleasure maximization/distress avoidance" as it could not be operationalized sufficiently for our experiments. In the course of socialization, motivational patterns develop individually and are expressed through certain goals and behaviors that fulfill these needs. In consensus with other authors (e.g., Elliot et al., 1997) Grawe (1998) considers approach- and avoidance-motivation to be two distinct psychic systems for self-regulation. The approach system focuses on the maximization of need fulfillment, whereas the avoidance system aims to protect the individual from harmful experiences. If the basic psychic needs are frustrated, they become increasingly urgent and "energized" through their connection with strong emotions. This state is described as incongruence of needs. Therefore, high incongruence is more strongly associated with avoidance-oriented goals than with approach-oriented ones, as the approach system is more directly connected to need fulfilment. Furthermore, avoidance strategies develop from enduring experiences of need frustration, which also enhance expectations of not having enough. For example, if the need for attachment is frustrated by early experiences of social rejection, the individual may develop the emotional belief of not being likeable for others and corresponding motivational patterns like avoiding to openly engage with other people in order to protect oneself from further harmful experiences of exclusion. We consider incongruence to be a strong indicator for subconsciously active core beliefs, which should possess the capability to trigger a micro-PK effect distorting the results of random events according to the predictions of the emotional transgression model.

Hypotheses

In the first experiment, we expected an initial micro-PK effect for the target group of participants who exhibited high incongruence (HI) characteristics, but not for those who exhibited low incongruence (LI). Therefore, we hypothesized that the HI group would show significant deviations from randomness while observing stimuli addressing deprived needs vs. neutral ones selected by a QRNG. For micro-PK tasks involving targets designed to resemble an approach-motivated means of satisfying a need in this experiment through the presentation of positive, need-relevant pictures, we assumed that participants who exhibited HI (i.e., individuals who are generally unable to adequately satisfy those needs) would elicit fewer positive target stimuli than chance suggests. The ETM would predict an outcome of fewer positive pictures than would be expected by chance, as the HI group is more likely to have inner fearful doubts

of being rejected or left by others. Comparatively, for micro-PK tasks using negative need-relevant target stimuli designed to resemble an avoidance-motivated means of satisfying a need, we predicted that HI participants (i.e., individuals who are generally unable to adequately avoid such negative events) would show more negative targets than expected by chance. In the case of the need for self-esteem protection, this means according to the ETM that individuals exhibiting HI-characteristics are less likely to avoid derogatory stimuli as they are prone to have inner fearful concerns of not being good enough in any task or only deserving negative responses. When trying to avoid a loss of control, the ETM would predict a higher likelihood for participants who exhibit HI to attract experiences in which they lose control, as they are more likely to have inner fearful doubts of losing control of a situation or not being able to affect their environment at all instead of a hopeful feeling of self-efficacy. Furthermore, for the LI group, no significant deviations from chance were predicted, since unconsciously active beliefs should not be triggered by this micro-PK task (see Figure 1). From a wider perspective, we assumed the micro-PK effect to be volatile and to follow a systematic oscillating pattern across participants over time. Therefore, we expected to observe a decline in our second experiment, after strong evidence (*BF* = 10) had been obtained. The researchers' a-priori belief that the hypotheses in this study would be supported can be classified on a scale from 5 = "strong belief" to 1 = "strong non-belief" as 4 = "moderate belief".

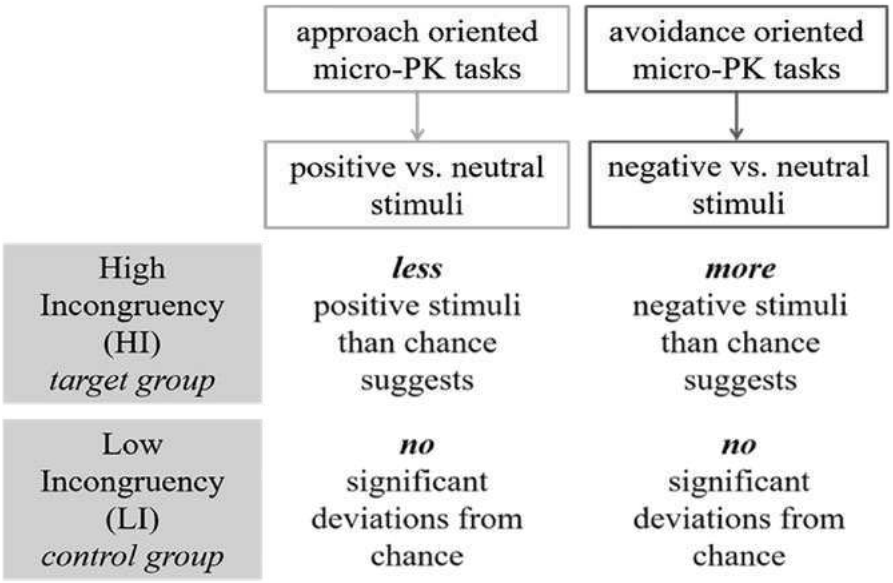

Figure 1. Predicted directions of the effect for both experimental groups concerning micro-PK tasks that resemble approach- vs. avoidance-motivated means of satisfying a need.

Method

This study was preregistered at the Open Science Framework (https://osf.io/xm4wf). The instructions did not reveal the study's purpose, but assured anonymization and emphasized the participants' right to withdraw from the experiment at any given time. Voluntarily participation was ensured by obtaining written consent. An explanation about the study's purpose was offered individually after the tasks were completed. This procedure and the experiment were approved by the ethical board of the Department of Psychology.

Design

For this study, we selected a between-subject design with two conditions. We conducted a quasi-experiment with LI and HI in basic psychological needs as independent variables. Participants were divided into these groups based on their individual average overall-incongruence score measured by the INK (Grosse Holtforth et al., 2004). The dividing point was the standardized average value for healthy individuals as detailed in the manual. Furthermore, we developed specific micro-PK tasks for the psychological basic needs "attachment," "self-esteem protection," and "orientation and control," testing various modes of operationalization concerning stimulus formats, tasks, and approach- vs. avoidance-motivated focus. Each micro-PK task comprised ten trials of stimulus presentation on a screen. For each trial, a QRNG chose between a need-related and a neutral stimulus. The number of need-related stimuli displayed served as a dependent variable (DV).

The first micro-PK task focused on the need for attachment, and implemented an approach-oriented design, using positive pictures of happy couples as targets and neutrally rated pictures as control stimuli. Participants were required to observe the pictures attentively. The DV was the number of positive target pictures selected by the QRNG tested against the expected value of five out of ten presentations under chance.

The second micro-PK task focused on the need for self-esteem protection, and implemented an avoidance-oriented design, using derogatory adjectives as targets and neutrally rated adjectives as control stimuli. Participants were instructed to read the words attentively. Again, the DV was the number of negative target words selected by the QRNG tested against the expected value of five out of ten presentations each under chance.

The third micro-PK task concerned the need for avoiding a loss of control. This task differed from the first two, as participants had to press a button after each trial. In every trial a repulsive picture was presented at the screen. Participants were either able to end the display of the picture as soon as it appeared, by pressing a button ("in-control trials") or it lasted 2500 ms regardless of a button being pressed or not ("loss-of-control trials"). A QRNG output for each trial decided whether a trial was an in-control or a loss-of-control trial. To create a strong feeling of loss of control, we chose a percentage of 75% "in-control trials" instead of 50% as baseline for the QRNG. This made the loss-of-control trials more outstanding and awkward since the usual experience was to be in control. The DV was the number of trials in which pressing a button did not end the display ("loss-of-control trials"). As the baseline probability for those trials was only 25%, we tested against an expectancy value of 2.5 out of ten instead of five like in the other two micro-PK tasks.

Materials

Hardware and Software. The lab study was conducted on a set of ten experimental computers, all of which had been prepared identically. The stimuli were presented on a black background at a size of 500 x 400 pixels. A presentation procedure was programmed in jsPsych, which translated the output of the random number generator into the selection of either need-related or neutral stimuli. For stimulus randomization, we used a hardware-based QRNG, the "BitBabbler Black" (BitBabbler, 2014–2015),

which passed all important tests for randomness (ENT, FIPS 140-2, Dieharder, NIST SP800-22, and TestU01). A truly random source during stimulus selection is essential to allow a state of superposition to emerge, which might enable an unconscious interaction between motivational patterns and quantum processes. The "BitBabbler Black" offers an external physical process, including quantum mechanical and semi-quantum mechanical procedures using different sources of electrical noise. These signals are reinforced and integrated in a way that none of the deterministic processes in the analog circuit can exert an influence on the outcome. During the transition from the analog to the digital circuit, the noise signals are transformed through a 3.3V logic into a binary output (Bit 1 and Bit 0), which serves as a quantum-based source for randomness for each experimental trial.

Stimuli. To ensure adequate emotional valence, all neutral pictures used as control targets in the task for attachment were obtained from OASIS (Kurdi et al., 2017), a picture set containing 900 validated stimuli. Furthermore, we conducted a pre-study to rate all other stimuli without sufficient empirical validation in the present literature with regard to the target pictures (all need-related pictures for "attachment" and "loss of control") and all word stimuli (negative and neutral) on the three dimensions of valence, arousal, and content-related association (see Table 1). For this evaluation the sample consisted of N = 26 students (25 females n = 25; age: M = 22.27 years, SD = 1.70) enrolled in a course on experimental psychology. All 80 stimuli were assessed on a seven-point scale with respect to emotional valence ("How does the induced emotion feel?"; from 1 = "very negative" to 7 = "very positive"), arousal ("How intense does the induced emotion feel?"; from 1 = "very weak" to 7 = "very strong") and content-related association (pictures: "How closely do you associate this picture with relationship/disgust"; words: "How strongly do you feel evaluated by this word?"; from 1 = "very weak" to 7 = "very strong").

To address the need for "attachment" in the first micro-PK task, the set of target stimuli contained 20 pictures of happy couples. The material was obtained from Shutterstock (www.shutterstock.com), a provider of royalty-free stock photographs. The mean subjective association with the concept "attachment" obtained from the pre-rating of the pictures was M = 5.41 (SD = 0.94) with a rather strong arousal (M = 4.94; SD = 0.73) and a positive valence (M = 5.39; SD = 0.98), indicating the pictures' on average clear attachment-relevant and emotionally loaded content. The neutral pictures used as control targets in this task were obtained from the picture set OASIS (Kurdi et al., 2017), with ratings with respect to valence and arousal on a seven-point-Likert-scale for each stimulus. Twenty pictures, each depicting everyday objects, rated very low on arousal (M = 1.98; SD = 1.37) and with neutral valence (M = 4.09; SD = 0.66), were selected.

For the self-esteem-protection task, all word stimuli were presented in Arial font with white letters on a black background. The 20 neutral adjectives with low arousal (M = 2.85; SD = 1.42) and a neutral valence (M = 3.99; SD = 0.19) focused on attributes that are not typically used to characterize a person and consequently do not possess any qualities associated with self-esteem (association: M = 2.52; SD = 1.38), namely geometric shapes and surface textures (e.g. "five-cornered," "dotted"). Twenty derogatory adjectives (association: M = 4.87; SD = 1.27) with a rather high arousal (M = 4.47; SD = 0.78) and a negative valence (M = 2.49; SD = 0.48) were generated, based on the dimensions of the "Feelings of Inadequacy Scale" (Janis & Field, 1959). This included words related to self-esteem ("useless," "boring." "inferior," "unimportant," "worthless"), to academic skills ("dumb," "unsuccessful," "incompetent," "weak,"

"bad") and to physical attractiveness ("unlovely," "off-putting," "ugly," "inexpressive," "disgusting," "unsightly," "unattractive," "nauseous").

To establish aversive trials for the simulation of a loss of control in the third task, participants were presented with unpleasant, nauseating pictures (association: *M* = 5.46; *SD* = 0.58) with rather strong arousal (*M* = 5.24; *SD* = 0.67) and a negative valence (*M* = 2.04; *SD* = 0.41) also obtained from Shutterstock. These typically involved scenes of environmental pollution, feces, dirty toilets, or similar.

Table 1
Descriptive results of the validation study.

		M	*SD*	Min.	Max.
attachment					
	association	5.41	0.94	2.80	6.75
	arousal	4.94	0.73	3.45	6.20
	valence	5.39	0.98	2.65	6.55
loss of control					
	association	5.46	0.58	4.45	7.00
	arousal	5.24	0.67	3.90	7.00
	valence	2.04	0.41	1.05	2.75
neutral adjectives					
	association	2.52	1.38	1.00	4.25
	arousal	2.85	1.42	1.05	4.55
	valence	3.99	0.19	3.55	4.40
derogatory adjectives					
	association	4.87	1.27	1.60	6,55
	arousal	4.47	0.78	2.50	5.90
	valence	2.49	0.48	1.70	3.50

Questionnaire. Incongruence in basic psychological needs was measured by the long version of the INK (Grosse Holtforth et al., 2004), which takes around ten minutes to administer. For interpretation, the manual contains standard tables with t-values. The standard sample varies in gender and age and was based on *n* = 707 healthy individuals and *n* = 569 patients from different psychotherapy settings. The questionnaire consists of 94 items, rated on a five-point scale. The first part concerns approach-goals and contains 57 items. Participants must assess whether they feel that the concrete needs were fulfilled "recently" (from 1 = "far too little" to 5 = "completely sufficient"). Because the questionnaire measures incongruence, these scales' ratings must be reversed. The particular scales are labeled "intimacy/attachment," "sociability," "helping others," "receiving help," "respect/appreciation" "being superior/impress," "autonomy," "performance," "control," "education/understanding," "belief/sense," "enjoyment of life," "self-confidence/self-esteem," and "self-reward".

Analogously, the second part captures the avoidance-goals by asking participants to rate how often aversive events have been experienced "recently" (from 1 = "not at all true" to 5 = "very true"). This includes the scales "loneliness/separation," "contempt," "humiliation/disgrace," "accusations/criticism,"

"dependence/loss of autonomy," "tensions with others," "vulnerability," "helplessness," and "failure". In addition to the individual scales, the questionnaire provides an incongruence value for approach- and avoidance-goals and an overall-incongruence score. This overall-incongruence score, split into a HI and a LI group, was used as an independent factor. The splitting criterion refers to the standard sample of healthy individuals based on a *t*-scale (with *t* = 50 as the average value and *SD* = 10). Participants with an overall-incongruence score of *M* = 2.2 or above were considered to exhibit HI characteristics (*t* = 51). The INK is an appropriate measure, as it guarantees high objectivity by providing standardized instructions, clear analytical guidelines, and *t*-values for interpretation. Internal consistency across the different standard samples ranges from acceptable to very good for most scales. For the approach-scales, the retest-reliability lies between *r* = .42 - .91, with an average of *r* = .68, and for avoidance-goals between *r* = .54 - .79, with an average value of *r* = .64.

Procedure

Participants were tested in the department's laboratory, which contained ten identically set-up testing computers separated by room dividers (see Fig. 2). The entire experiment took around 30 min. The experimenter read a standardized instruction text aloud explaining the procedure in a friendly but factual manner. When the participants had no further questions, the experimenter gave them the signal to begin the INK. After completing all questions, the participants were instructed to continue by clicking the "next" button and to initiate the image display by pressing any key as soon as they were ready. Participants attentively observed three consecutive series of ten trials each. The micro-PK tasks were performed in the following order: "attachment," "self-esteem protection," and "loss of control". After each task, the program advised the volunteers to remain focused and press the button again to confirm their attentiveness. In each trial, they looked at a fixation cue (700 msec) first, then at the stimulus (pictures: 400 msec; words: 800 msec), and, finally, at a black screen (inter-stimulus-interval: 400 msec). This process was repeated 30 times in total (see Figure 2). In every sequence, the QRNG decided whether the next image shown would be from a set of need-related or neutral images. BitBabbler's randomness function selected which of the stimuli in the selected set would be displayed. At the beginning of each trial, the QRNG chose a number corresponding to one of 20 stimuli in both sets. After the fixation cue, the sequence produced by the QRNG was completed to select the definite stimulus by determining the category. Stimuli were selected by sampling with replacement.

After the third task was completed, participants were asked to complete the post-task questionnaire, which asked to indicate how unpleasant the disgusting pictures were perceived (from 1 = "very unpleasant" to 5 = "not unpleasant at all") and to state their assumptions about the study's aim.

Data Analysis

Data collection and analyses were performed using Bayesian inference techniques for hypotheses testing, as recommended by Wagenmakers, Wetzels, Borsboom, and van der Maas (2011), and the strategy was preregistered. While the frequentist approach makes assumptions about theoretically repeated replications of the same study, the Bayesian method accumulates data concerning the effect, and repeatedly updates an effect's likelihood given additional data. In this framework, the strength of evidence for the effect is considered dependent on both the given data's support for H_0 and for H_1. To determine

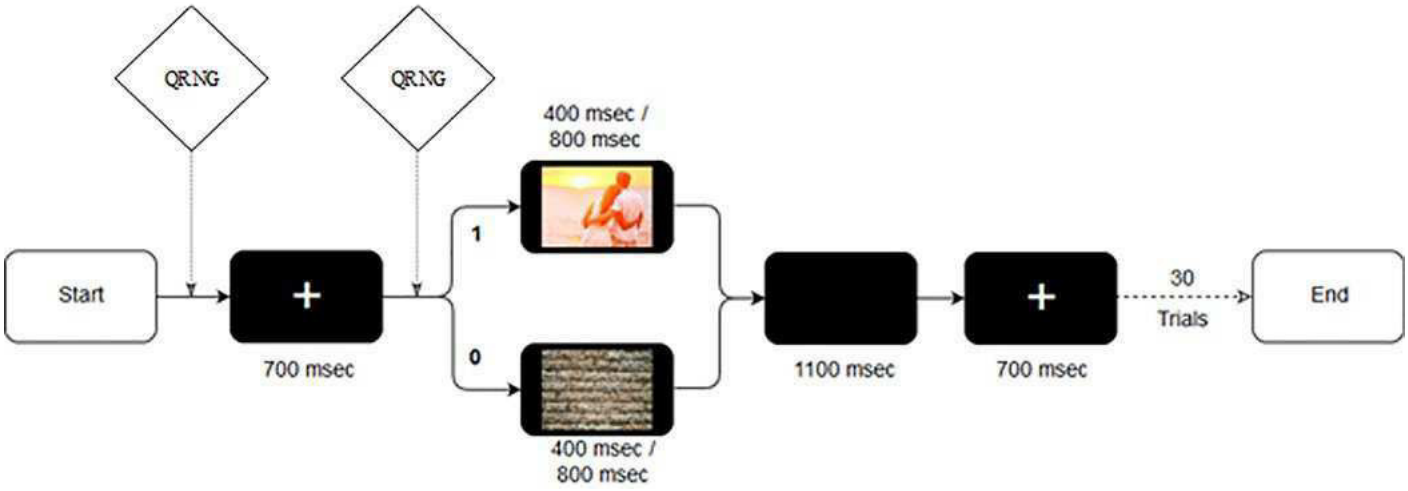

Figure 2. Each trial comprised the display of a fixation cue, a need-relevant or neutral stimulus, and a black inter-trial interval.

whether the data provide more evidence for H_1 or H_0, both likelihoods are pitted against one another. The resulting score is called the Bayes Factor (BF), and resembles the relative amount of evidence that the data provide for or against a postulated effect. A BF of 10 or higher is considered to indicate strong evidence for H_1 or H_0, respectively (see Jeffreys, 1961).

To calculate the BF, a probability distribution for the effect size must be specified a priori. Usually, a Cauchy distribution centered around zero with scale parameter *r* is used ($\delta \sim$ Cauchy (0, r)) to identify the prior. Wagenmakers et al. (2011) recommend that *r* equals 1. The statistic software JASP, designed to perform basic Bayesian analyses, uses a default *r* of .707. Other authors recommend a lower *r* of .5 (Bem et al., 2011) or .1 (Maier et al., 2014) The choice of the prior provides a degree of freedom within the Bayesian approach. We decided to use $r = .1$, i.e. $\delta \sim$ Cauchy (0, .1). This score was determined and preregistered before data collection commenced.

Bayesian hypothesis testing offers several valuable advantages. One is that the BF combines information about the effect and the sample power within its score. A high BF can only be reached when sufficient power is provided through sample size, whereas the frequentist approach might accidentally detect an effect within a severely underpowered study. Thus, the frequentist approach requires an a priori power analysis and pre-definition of sample size to compensate for this potential problem, which is unnecessary when applying Bayesian techniques. Moreover, the Bayesian approach allows for data accumulation, (i.e., additional participants can be tested and included in the dataset until a pre-specified BF criterion for H_1 or H_0 has been reached). This also permits optional stopping and is therefore more effective than the frequentist method. We decided to use a BF of 10 as a criterion. In the study preregistration, we therefore set either $BF = 10$ in all of the three micro-PK tasks or a target sample size of $N = 300$ - 352 as the stopping rule for the first experiment. To do so, data were analyzed on a regular basis for every new 5 participants as soon as 50 participants had been tested.

Since researchers in the psychology field are more familiar with the frequentist approach than with Bayesian hypothesis testing, we outline our reasons for using the Bayesian approach here in greater de-

tail, and *p*-scores are also provided. We used the Wilcoxon signed-rank test, as the population cannot be assumed to be normally distributed. The statistical software tool JASP (Version 0.8.2; JASP Team, 2017) was used for all Bayesian analyses.

Experiment 1

This first experiment was implemented and analyzed according to the preregistration with all three outcome variables as described above.

Methods

Participants. In the first experiment, 318 participants were tested, and the target sample size of *N* = 300 - 352 came into operation when our given testing period ended. Due to technical problems, 23 data files were excluded from analysis: The QRNG connection was deficient in five sessions, during which the stimulus selection did not work. For 18 participants, incorrect software settings produced 100 trials rather than 10 in each of the three blocks. Therefore, *N* = 295 datasets of test subjects fulfilling all inclusion criteria were viable (female *n* = 210, male *n* = 84, unspecified *n* = 1; age: *M* = 23.27 years, *SD* = 6.46). Participants were recruited through the department's announcement board, handouts distributed during class, Facebook groups, and direct contact with the experimenters. Undergraduate psychology students could acquire credits for participation. Inclusion criteria included a minimum age of 18 years and proficiency in German.

Experimenters. For this study, 32 informally trained students were used as experimenters as part of a practical course on empirical psychology. Their task was to identify participants fulfilling the inclusion criteria. They had no knowledge about the experiment's goal at the point of data collection and were advised to only interact with the participants in a friendly but also factual manner. The experimenters sent raw data to the study's supervisor after each testing session.

Results

Separate Bayesian *t*-tests were performed for each of the three micro-PK tasks for the HI (*n* = 133) and the LI (*n* = 162) subsamples. The prediction was that the HI group would show a higher-than-chance score for the neutral pictures in the attachment task, for the derogative adjectives in the self-esteem task, and for the loss-of-control trials in the control task. No deviations from chance were expected for the LI group.

We first report the analyses of the HI group: The score of self-esteem protection stimuli (number of derogatory adjectives displayed) yielded an anecdotal effect close to the threshold of moderate evidence for H_1. The other two Bayesian *t*-test analyses showed no substantial deviations from chance, either for the attachment or loss-of-control tasks (see Table 2).

Table 2
Descriptive and frequentist outcomes for the HI subsample. A small but significant deviation from chance is indicated for the micro-PK task concerning the need for self-esteem protection.

	N	M (SD)	BF	Z, p-score
attachment	133	5.08 (1.57)	0.70	0.39, .35
self-esteem	133	5.27 (1.59)	2.95	2.17, .02*
loss-of-control	133	2.60 (1.30)	0.92	0.65, .26

For the LI subsample, three two-tailed Bayesian one-sample t-tests were performed. A two-tailed approach was adopted since, for the control group, no substantial deviations from chance were expected in any direction. As expected, no substantial evidence for H_1 was found, nor were deviations from randomness detected in any of the three DVs, although the BFs confirmed no substantial evidence for H_0 either (see Table 3).

Table 3
Descriptive and frequentist outcomes for the LI subsample. No significant deviations from chance were observed.

	N	M (SD)	BF	Z, p-score
attachment	162	4.91 (1.47)	0.54	-0.56, .71
self-esteem	162	5.15 (1.57)	0.74	1.12, .11
loss-of-control	162	2.51 (1.58)	0.46	-0.30, .62

Discussion

In sum, the results from the first experiment revealed moderate evidence ($BF < 10$) in

the postulated direction within the HI group for the self-esteem protection task but not for the attachment- or the loss-of-control tasks. As hypothesized, no substantial deviations from randomness were observed within the LI group, but the H_0 was not confirmed either. Since we had reached the end of our given testing period, we followed the stopping rule even though our criterion for strong evidence ($BF > 10$) for H_1 or H_0 had not been satisfied at this point.

Several limitations concerning the operationalization of the attachment- and the loss-of-control tasks might explain why the effect failed to appear for these outcome variables. The results from the stimulus validation show that, despite the valence of the attachment-related pictures being positively rated on average, the minimum value lies within the negative range. Therefore, images of happy couples may not always be perceived as positive stimuli, but may also cause envy or sadness, particularly

in individuals experiencing HI of the need for attachment. The more complex and socially related the operationalized constructs become, the more the images might be prone to unconscious individual interpretations, which could be a source of confound for implicit micro-PK experiments of this nature. Furthermore, during the testing phase, the loss-of-control task design failed to create the intended impression of a key that is sometimes stuck. This may be due to the small number of trials, which may be insufficient to establish a feeling of control over the picture presentation and its loss during several trials. Oral reports from experimenters and participants confirmed this guess: this task was unclear to many test subjects, with some reacting by not pressing the button at all. Nevertheless, the operationalization of the micro-PK task for self-esteem protection appeared more suitable, as the words concretely and precisely addressed the need in question, without accommodating individual interpretations. Therefore, we selected this condition for further exploration.

Experiment 2

As none of the effects in Experiment 1 yielded clear evidence for H_1 or H_0, we continued collecting data until strong evidence for or against the postulated effect was obtained. We focused on the promising outcomes of the self-esteem-protection task, excluding the other two tasks for economic reasons. Otherwise, the procedure and analysis strategy remained unchanged. To maintain the original study duration, another separate experiment was added at the beginning.

In view of the non-replicability problem common within psi studies, the data collection continued beyond obtaining strong evidence ($BF > 10$), to investigate a potential decline effect in micro-PK experiments. We did not propose a concrete hypothesis concerning the volatility of the effect in the original preregistration, as decline effects were not expected within the target sample size of the first study. Because experiment 2 will enlarge the sample size considerably and has a replication character to some extent, we additionally assumed a decline for the further data collection in our second experiment after initial strong evidence ($BF > 10$) had been reached.

Methods

Participants. In the second experiment, 217 further participants were tested. QRNG connection was deficient in five of the sessions, so $N = 212$ (female $n = 155$, male $n = 57$, unspecified $n = 1$; *mean age* = 23.60 years, $SD = 7.13$) datasets of test volunteers fulfilling all inclusion criteria could be added, making a total sample size of $N = 507$ (i.e., previous study $n = 295$ plus this study $n = 212$).

Experimenters. Three informally trained undergraduates (female $n = 2$, male $n = 1$) were responsible for recruiting and testing. Again, they had no knowledge of the study goal at the time of data collection and received the same instructions for interacting with the participants according to the standardized protocol. The two females experimenters ranked their attitudes towards psi by self-assessment of their belief on a scale from 5 = “strong belief” to 1 = “strong non-belief” as 4 = “moderate belief.” Unfortunately, we could not obtain this information from the other two experimenters.

Results

Sequential Bayesian analyses. Individual Bayesian one-sample *t*-tests of the micro-PK tasks on self-esteem protection were conducted for the HI and the LI subsamples. The graphs below represent a sequential analysis of the BFs for the HI (see Figure 3) and LI group (see Figure 4).

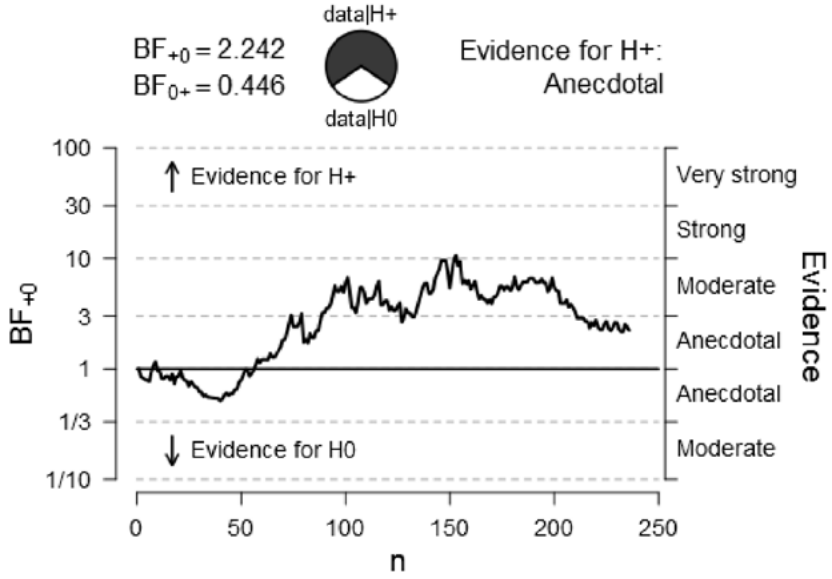

Figure 3. Sequential analysis of the BFs within the HI subsample. Shortly after the significance criterion of *BF* = 10 had been reached at *n* = 153, evidence declined again to a final result of *BF* = 2.24.

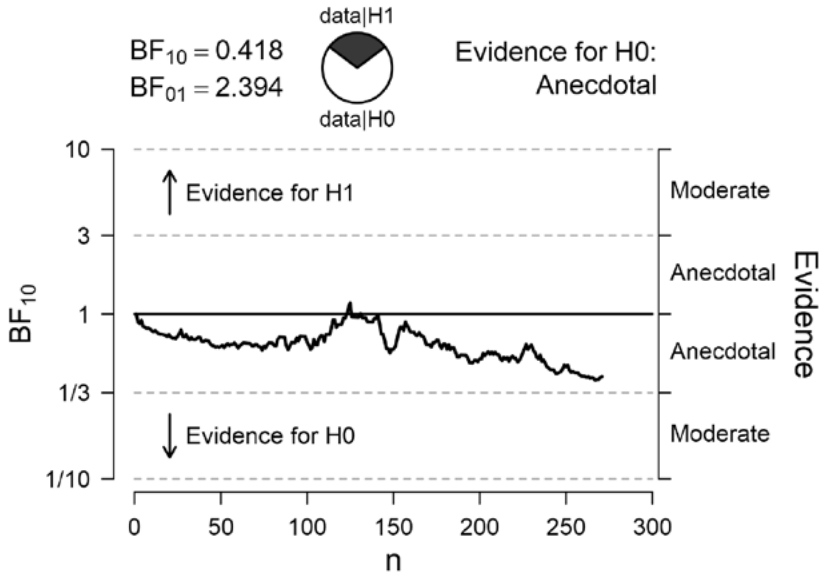

Figure 4. Sequential analysis of the BFs within the LI subsample. The graph shows a null curve, which almost always runs under the mark towards evidence for H_0.

In the HI subsample of *n* = 236, results reached the significance criterion of *BF* = 10 at *n* = 153 (*BF* =

10.72), and declined shortly thereafter to a final result of *BF* = 2.24, which can be classified as anecdotal evidence. In the LI subsample, there was no substantial deviations from chance at any time (see Table 4).

Table 4
Descriptive and frequentist outcomes for the HI and the LI subsample.

	N	M (SD)	BF	Z, p-score
HI	236	5.18 (1.58)	2.24	1.86, .03*
LI	271	5.04 (1.54)	0.42	0.43, .67

Exploratory analyses. Concerning the selective continuation of the self-esteem protection task, the course of the effect across participants over time differed considerably between the experimental groups. The curve of the target group seems untypical of chance fluctuations, whereas the control group's sequence does not. To test the likelihood that such a sequence would be produced by chance, we performed post hoc exploratory analyses based on Dechamps and Maier (2019). These analyses were not included in the preregistration, as we were unaware of these methods at that point. Encountering frequency analyses as a procedure for capturing differences in evidence sequences on a quantitative level led to the post hoc adjustment of our hypotheses. Doing so, we looked at the sequential Bayesian analyses of both the HI and LI group and compared them to 10,000 simulations (see Figure 5). For a better comparison, the graph of the control group was also based on a one-tailed Bayesian one-sample t-test in the same direction as in the target group for this analysis. These simulations consist of 2710 random bits each (271 subjects * 10 trials) that were aggregated in the same manner as the experimental data. Subsequently, a sequential Bayesian t-test with the same parameters as for the experimental data (one-tailed; δ ~ Cauchy (0, .1)) was conducted for data points 10 to 271. These simulations represent an experimental null-effect dataset.

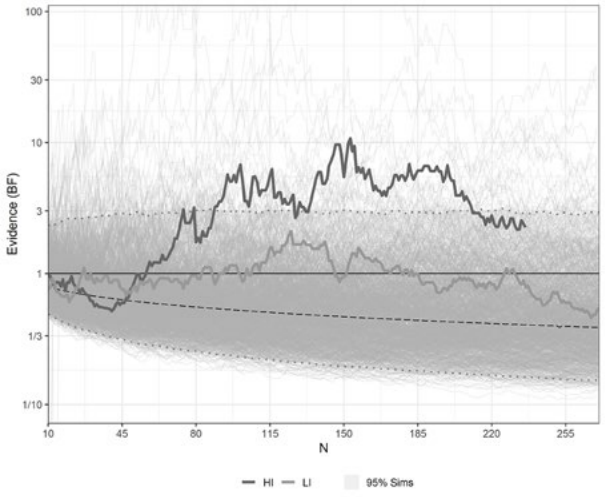

Figure 5. Sequential one-tailed Bayesian analyses of the HI and LI group in comparison to 10,000 simulations (1,000 depicted in the figure), the median of the simulations (dashed line) and the Confidence Interval of 95% for the BF (hatched area between the dotted lines).

Maximum BF. First, we compared the subsamples' highest BFs to those of the simulations. The highest BF in the HI group is 10.72 at *n* = 153. Only 3.3% of all simulations reached a higher BF at any point. LI group's highest BF equals 2.10 at *n* = 125, which is surpassed by 26.1% of simulations.

BF energy. Next, we examined the overall orientation of the BF curve, calculating the area between the curve and the borderline of evidential power between H_0 and H_1 at *BF* = 1. A positive value of this area—also called the curve's *energy*—means an overall tendency for the BF to be directionally positioned toward H_1. The HI group's energy is 564.13, which is surpassed by only 1.9% of simulations. By contrast, the LI group's energy lies at -7.06, and is surpassed by 17.7% of simulations. The typical energy of a null-effect simulation was found to be *M* = -41.85 (*SD* = 647.40).

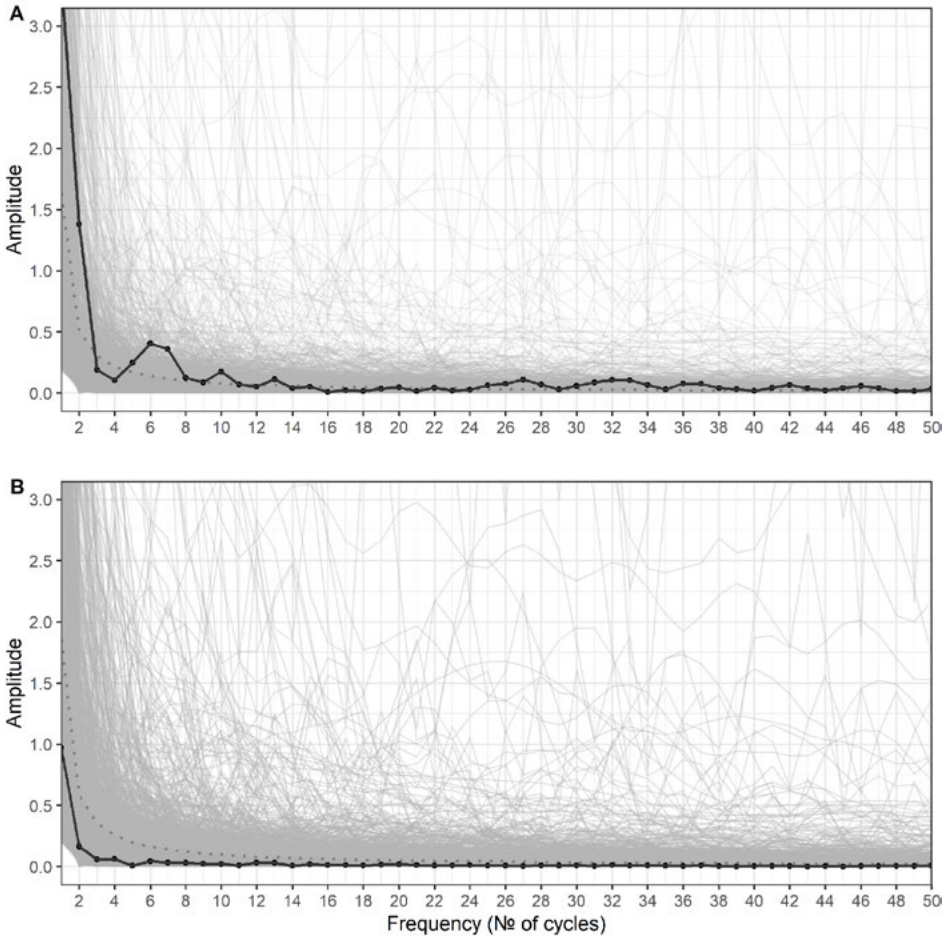

Figure 6. Fast Fourier transformation (FFT) on the sequential Bayesian analyses of the HI (A) and the LI (B) subsamples, and of all 10,000 simulations with the 95% Confidence Interval for the amplitudes (hatched area under the dotted line).

Bierman, Spottiswoode, and Bijl (2016) argue that "Pilot to Confirmation (PtoC)" should be considered a questionable research practice (QRP), as it increases the alpha error. This is the case when studies using frequentist statistical approaches are considered. Bayesian approaches, however, permit the selective continuation of a promising study, even when other, fewer promising studies are dropped. Because sufficient incremental evidence for H_1 can only be obtained with sufficient power in Bayesian

statistics, analyses of this nature rarely fall into alpha error traps. Furthermore, we preregistered all three micro-PK experiments concerning confirmatory hypotheses about the BF using an a priori set criterion of *BF* = 10 for significance. This degree of evidence was reached in one out of three experiments, and remains unlikely to be produced by chance fluctuations. Nevertheless, to examine the robustness of our post hoc exploratory analyses, we performed a further 10,000 simulations, which this time began immediately after the first experiment's end result (BF_{10} = 2.86). In other words, the sequential BF curve of the study's first part was combined with each simulation, and those 10,000 data sequences were then compared to the sequential BF curve of the complete experimental data keeping the first part of the data constant. As expected, the target group's curve is not as outstanding in comparison to simulations as it was in the original analyses (see Figure 7).

Frequency spectrum analysis. Adding toward the summation of all BFs, we examined the oscillatory pattern of the sequential analysis. Any input signal can be converted to a representation of its composited frequencies via a Fourier transformation, which indicates the amplitudes of all frequencies comprising the input sequence. For a random sequence, none of the frequencies should stand out. Noticeable spikes indicate the presence of a periodic element. A fast Fourier transformation (FFT) was conducted on the sequential Bayesian analyses of both subsamples and all 10,000 simulations. Simulations for the HI group were cut after *N* = 236 data points, to ensure comparability to the experimental data. Sampling rate was 1/N in each case. Since the resulting transform was symmetrical, only the first half was considered in the analysis. As Figure 5 indicates, the transforms of both subsamples differ systematically in most aspects. In comparison to the simulations' transforms, the HI subsample shows 81 amplitudes (68.6%) in the top 5% of all frequencies. Comparison to 1,000 further simulations indicates that the probability of such a proportion or above is 4%. By contrast, no frequencies show significant amplitude size at any frequency in the LI group (see Figure 6A and B).

Discussion

HI in basic psychological needs is shown to be promising as a subconsciously active motive state for triggering a micro-PK effect. The threshold of strong evidence for a non-random deviation of several words was reached over the course of further data collection in the self-esteem protection condition. Still, since we were well aware of the non-replicability common among psi studies (e.g., Jahn et al.,2000; Maier & Dechamps, 2018) we continued data collection to further investigate the nature of decline effects in micro-PK experiments, although our stopping rule was met and a Bayesian approach would have allowed the cessation of data collection. A decline became noticeable in the HI subsample (*N* = 507), leading to a drop in the BF to mere anecdotal evidence (despite a significant *p*-value).

Our explanation for the decline follows the reasoning of Lucadou et al. (2007) and Maier et al. (2018), who claim that systematic detection of micro-PK effects and a potential signal-use of this effect and, respectively, a decrease in entropy over time, cannot occur. Thus, Maier et al. (2018) argue for a systematic counter-mechanism that will eliminate the original micro-PK effect, leading to an oscillatory pattern of appearance and disappearance across studies and participants over time. The introduced explorative sequential Bayesian analyses of target and control groups, in comparison to 10,000 simulations, as suggested by Dechamps and Maier (2019), facilitated the investigation of non-random temporal data structures independent of the final score. All exploratory analyses revealed significant results in their ability to distinguish between

the HI and the LI subsample. Dechamps and Maier (2019) state that the close examination of the development of the BF for effects that are volatile in their strength may be fruitful. The performed analyses show that the energy of the HI subsample's curve, as well as its highest reached BF, are unlikely in purely random data, in contrast to the LI subsample. Furthermore, a remarkable difference is evident when the FFT is applied to the sequential Bayesian analyses of both subsamples and their corresponding simulations. The frequencies' amplitudes—meaning their significance in comprising the input signal—are higher in the HI subsample. When compared to 10,000 simulations, this transform features amplitudes in the top 5% of simulations for more than two thirds of all frequencies, suggesting a BF curve characterized by prominent harmonic patterns. Thus, the frequencies seem to follow a volatile dynamic rather than a pattern of decline effects and recoveries. Comparatively, the LI curve possesses no exceptional characteristics.

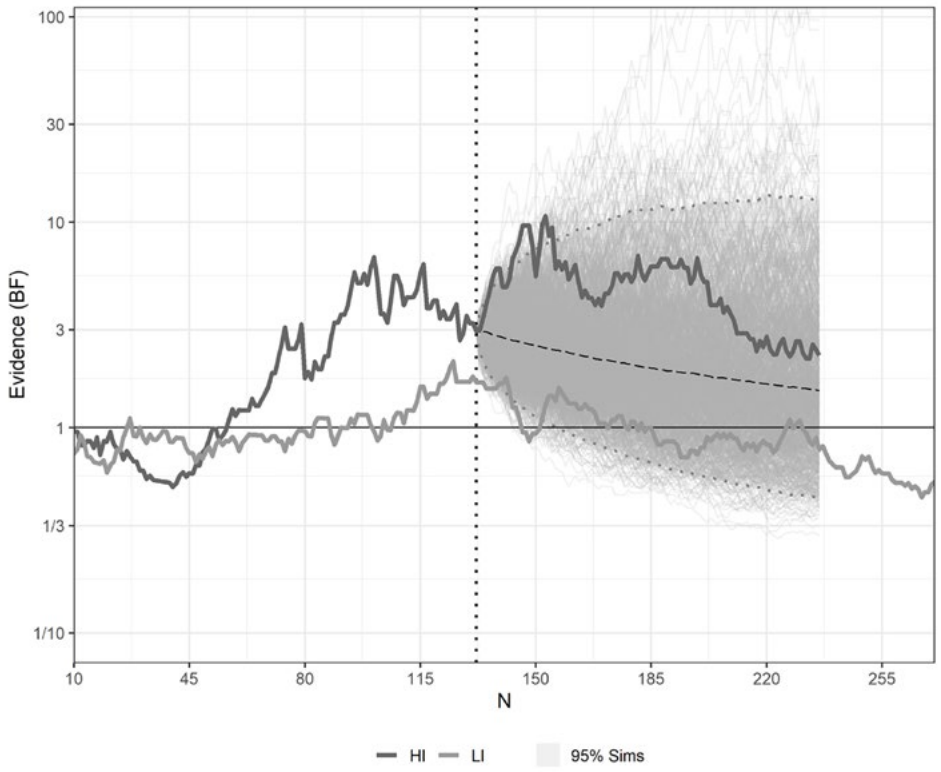

Figure 7. Sequential Bayesian analyses of the HI and LI group in comparison to 10,000 simulations (1,000 depicted in the figure) and the Confidence Interval of 95% for the BF, when the sequential evidence of the first experiment is kept as a constant.

This time, 11.8% (compared to 3.3%) of all simulations reached a higher BF than *BF* = 10.72 at *n* = 153, at any point**,** and the BF's energy of the HI group of 564.13 is now surpassed by 10.6% of simulations, rather than 1.9%. In comparison to the simulations' transforms, in the HI subsample only 13 (compared to 81) frequencies (11%) show amplitudes in the top 5% of all frequencies. Comparison to 1,000 further simulations indicates that the probability for this proportion or higher is 9.1%. A significant probability (< 5%) would require a minimum of 33% of amplitudes in the top 5% of all frequencies (see Figure 8). Nonetheless, for a random sequence, no frequencies should stand out, yet noticeable spikes indicate the presence of a periodic element.

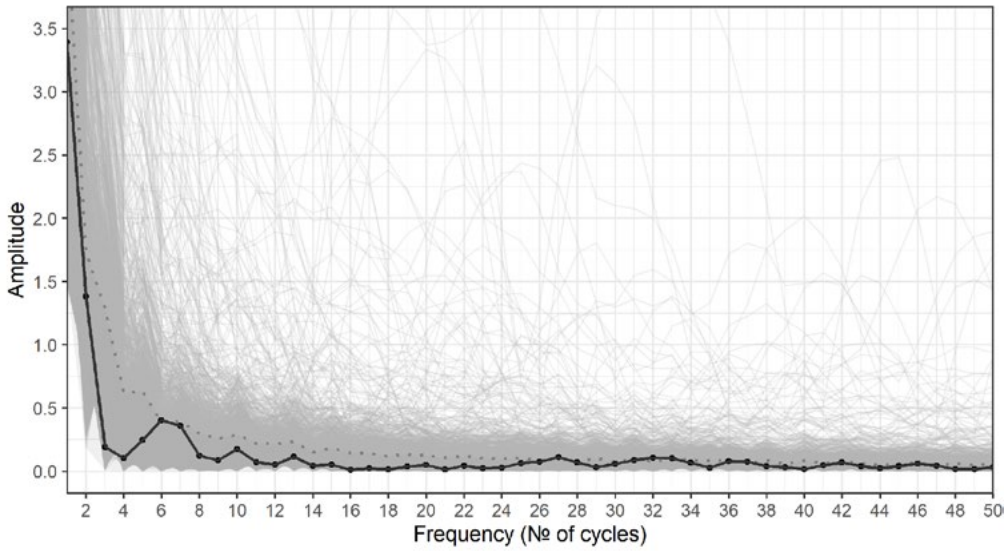

Figure 8. Fast Fourier transformation (FFT) on the sequential Bayesian analyses of the HI subsample and of all 10,000 simulations with the 95% Confidence Interval for the amplitudes (hatched area under the dotted line).

In sum, by controlling for the initial, more extreme data obtained in the first study on the need for self-esteem protection, less outstanding but still marginally significant results were obtained with the FFT. This specific study indicates a non-random variation of the effect across time, but the selective continuation may also be partly responsible for its outstanding course. Therefore, an exact replication of the micro-PK task on the need for self-esteem protection with preregistered hypotheses, including the sequential time course analyses, is required to ensure robust, confirmatory conclusions.

As the sharp decline of the BF to the final level of 2.24 occurs within the last fifth of the target subsample, varying sample characteristics of other external factors that are confounded by the date of data collection could serve as an alternative explanation. However, these possible influencing factors neither show up in noticeable differences in demographic variables nor in the sum score of incongruence of needs (freshmen: M = 2.25, SD = .50; others M = 2.20, SD = .49).

General Discussion

The study's aim was to tackle the problem of mind-matter interaction by investigating micro-PK effects as support for quantum-based models of psychophysical substance dualism. Therefore, we tested observer effects on quantum-based RNG outcomes using the participants' pre-conscious motive states of incongruence in basic psychological needs as an independent variable. We assumed that higher activation of an individual's specific pre-conscious mental state should, during the perception of a QRNG outcome meaningfully related to this pre-conscious state, result in a higher likelihood of the appearance of a corresponding material state and a corresponding conscious observation of a quantum measurement's result. Hence, we expected substantial evidence for deviations from randomness in the HI group but not in the LI subsample. The direction of the effect was predicted by the ETM, which is claiming that the core affectively laden belief of subconsciously active motives would determine the more likely out-

come for an individual. For targets resembling an approach-motivated means of satisfying a need, this would mean a display of less positive stimuli than chance suggests, as participants exhibiting HI characteristics are generally unable to adequately satisfy this need in their everyday lives. By contrast, for target stimuli resembling an avoidance-motivated means of satisfying a need, we predicted several negative stimuli above chance, as individuals exhibiting HI are generally unable to avoid negative experiences.

To test our assumptions, we first conducted a preregistered experiment with a specific micro-PK test for three of Grawe's (1998) four psychological basic needs—"attachment," "self-esteem enhancement/protection," and "orientation/control"—testing various ways of operationalization concerning stimulus formats, tasks and approach- vs. avoidance-motivated focus. The avoidance-oriented design of the need for self-esteem protection using negative vs. neutral word stimuli revealed anecdotal evidence close to the threshold for the moderate classification for H_1 in the predicted direction within the HI group. As hypothesized, no significant deviations from chance were observed within the LI group. Significant deviations from randomness were not found for the attachment and the loss-of-control tasks in any of the groups. As discussed, considering several weaknesses in the operationalization of these conditions, methodical explanations seem most plausible to us. Furthermore, these results raise the question of whether incongruence with basic psychological needs is conceptually the best indicator for micro-PK effects on self-related adjectives, since the need for self-esteem protection/enhancement is merely one aspect of this construct. Therefore, our future research will investigate other, similar psychological variables connected to inner core beliefs about the self, such as self-biases measured by the implicit-association test (IAT) or personality styles.

In the second experiment, we focused on further observation of the sequential evidence for absolute deviations from quantum randomness in the self-esteem-protection task, and investigated oscillatory changes overtime. Our significance criterion of $BF = 10$ was initially reached at $n = 153$ within the HI group by attracting more presentations of derogative target words than chance suggests in comparison to neutral words. Shortly thereafter, a decline to a final result of almost moderate evidence occurred, similar to the results of other experiments in this field (e.g., Jahn et al., 2000; Maier et al., 2018). Explorative sequential Bayesian analyses of the target and control groups, in comparison to 10,000 simulations suggest that the data of the HI subsample are highly unlikely to be produced by chance. This contrasts with the LI subsample, in which no significant deviations from randomness were observed.

Our finding of an initial micro-PK effect in the context of the basic need for self-esteem protection supports implicitly motivated observers' systematic influence on probabilities, as suggested by other proponents (e.g. Mensky, 2014; Penrose & Hameroff, 2011; Pradhan, 2012; Stanford, 1990; Stapp, 2007), at least for sessions within a certain period. For participants whose need for self-esteem protection is frustrated, the effect's direction can be explained by the ETM. This assumes that individuals who are unable to adequately avoid everyday experiences that reduce their self-worth will also attract the corresponding negative targets above chance during the testing phase. Thus, the unconscious fear of "being devalued" or "not being good enough" leads to a self-fulfilling prophecy. Consequently, this study's findings suggest that mind-matter interactions may occur according to quantum-based theories of psychophysical substance dualism on a common ground, in which both exist as pre-conscious and pre-material forms.

Moreover, a decline was observed in this study after strong evidence for the postulated micro-PK effect had been reached. Nevertheless, the introduced methods of sequential Bayesian analyses with simulations still enabled statistical detection of non-randomness in the data structure as well as differentiation between the target and control groups independent of the final average value. Furthermore, the frequency analysis suggests a volatile dynamic within the data sequence rather than a decline effect. Future projects will include predictions for these analyses with a priori set criteria for significance in our preregistrations. However, the mechanisms behind the frequently observed volatile effects remain unknown. Maier et al. (2018) argue for a systematic counter-mechanism that eliminates the original micro-PK effect, leading to an oscillatory pattern of appearance and disappearance across studies and participants over time, to compensate for initial violations of the second law of thermodynamics. Therefore, such volatility might be inherent in the nature of some effects and demands methods of evidence collection that transcend conventional modes of replication. Moreover, it is important to notice, that the results were checked on a regular basis during data collection as it is common for the Bayesian approach. Nevertheless, this procedure might allow observer effects on the course of evidence. This open question could be addressed by a replication of the study without any analyses during data collection but checking the data only in the end.

Furthermore, assuming a systematic volatile effect across participants would mean the entanglement of the entire sample. Consequently, an individual's outcome in the experiment would depend on the results of predecessors unknown to the participant. As both experiments were performed as group testing with up to ten individuals within one session, participants completed the micro-PK tasks simultaneously on identical computers separated by dividers in the same laboratory room. Thus, this situation is open to non-local interactions. The collected data do not comprise information on the exact grouping of participants and, therefore, analyses on this topic cannot be provided. Nevertheless, it is interesting to consider this possibility concerning the interpretation of the given results. However, it is important to acknowledge that all interpretations of the current results refer only to the group level: the community of individuals with a certain shared motivational pattern, such as HI in the basic needs, might be more likely overall to attract events that confirm their inner core beliefs. Taking possible entanglements into account, no predictions on the level of individual participants are possible. Single-case studies with similar experimental setups, performed on a daily basis over several weeks, could help in exploring the meaning of such micro-PK effects for individuals in the future.

Conclusion

In this study, we identified HI within the basic psychological needs as a strong and measurable subconsciously active set of beliefs that can be addressed in a way that triggers a volatile micro-PK effect using the predictions of the EMT. Testing different ways of operationalization in the first preregistered experiment with a specific micro-PK test for each of the three of Grawe's (1998) four basic needs—attachment, self-esteem enhancement/protection, and control—the design of the need for self-esteem protection using derogatory vs. neutral adjectives revealed significant anecdotal evidence close to the threshold of the moderate classification in the predicted direction only in the target group, whereas significant deviations from randomness were not shown in any group for the attachment and the control task. Based on these results, we decided post hoc to focus on the further observation of the

sequential evidence for absolute deviations from quantum randomness in "self-esteem protection" and to investigate oscillatory changes overtime in a second experiment. Our significance criterion of *BF* = 10 was initially reached in the HI group, yet no significant deviations from randomness were observed in the control group at any time. Shortly thereafter, a decline to a final result of anecdotal evidence occurred. As volatility may lie in the nature of micro-PK effects (Maier et al., 2018), three different explorative sequential Bayesian analysis strategies were added post hoc in an effort to distinguish systematic sequences from random fluctuation (see Dechamps & Maier, 2019). All three procedures significantly indicate systematic variation, which is highly unlikely to be produced by chance, in the target group's sequence, but random fluctuation within the control group, in comparison to 10,000 simulations. This means, that the observed micro-PK effect might systematically oscillate around a random baseline, as has been observed in previous studies within this research field (e.g., Maier & Dechamps, 2018).

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Tu Attires ce que Tu Es: Les Effets des Besoins Inconscients sur la Micro-Psychokinèse

Résumé : Les modèles de corrélation psychophysique basés sur la physique quantique offrent un cadre alternative pour prédire les interactions esprit-matière. Nous relatons le test de tells interactions sous la forme d'effets observateurs sur les résultats d'un générateur de nombres aléatoires quantique (QRNG). Plus spécifiquement, nous avons testé l'influence de certains états motivationnels sur les présentations de stimuli choisis par le QRNG. Les déviations du hasard étaient attendues chez les participants montrant des caractéristiques de forte incongruence (HI) mais nous chez ceux qui montraient une faible incongruence (LI). Notre première expérience, testant les effets de trois besoins psychologiques – l'attachement, la protection de l'estime de soi et le contrôle – avec un analyse bayésienne ont montré des résultats anecdotiques pour H1, seulement pour les stimuli relatifs à l'estime de soi dans le groupe HI. La seconde expérience était une poursuite sélective de la condition prometteuse de protection de l'estime de soi, explorant les preuves favorables à H1 et leurs oscillations au cours du temps. Notre critère pour confirmer H1 était initialement atteint dans le groupe cible. Peu après, nous

avons constaté un déclin pour aboutir à un résultat final anecdotique pour H1. Pour tester la tendance systématique des données par rapport aux fluctuations du hasard, d'autres analyses post-hoc ont comparé le Facteur Bayes maximum, l'énergie de la courbe et l'analyse spectrale de fréquence entre les deux groupes sur 10.000 stimulations. Ces analyses indiquent que le sous-échantillon de données de HI diffère significativement des fluctuations du hasard, tandis que le sous-échantillon LI ne le fait pas. En somme, les résultats suggèrent que les croyances subconscientes affectivement chargées peuvent se manifester à travers des déviations volatiles mais statistiquement détectables du hasard quantique, lorsqu'elles sont précisément déclenchées par une tâche adéquate.

Du ziehst an, was Du bist: Die Wirkung unbewusster Bedürfnisse auf die Mikro-Psychokinese

Zusammenfassung: Quantenbasierte psychophysikalische Korrelationsmodelle bieten einen attraktiven Rahmen für die Vorhersage von Wechselwirkungen zwischen Geist und Materie. Wir berichten über eine Untersuchung solcher Interaktionen in Form von Beobachtereffekten auf quantenbasierte Zufallsgeneratoren (QRNG). Insbesondere testeten wir den Einfluss bestimmter motivationaler Zustände auf entsprechende Reizdarbietungen, die vom QRNG ausgewählt wurden. Zufallsabweichungen wurden bei denjenigen Teilnehmern erwartet, die Merkmale einer hohen Inkongruenz (HI) aufwiesen, aber nicht bei solchen mit einer geringen Inkongruenz (GI). Unser erstes Experiment, in dem wir die Auswirkungen von drei psychologischen Bedürfnissen - Bindung, Selbstwertschutz und Kontrolle - mit einer Bayesschen Analyse prüften, ergab anekdotische Evidenz für H_1 für die mit dem Selbstwertschutz zusammenhängenden Stimuli innerhalb der HI-Gruppe. Das zweite Experiment war eine selektive Fortsetzung der vielversprechenden Bedingung Selbstwertschutz, womit der weitere sequentielle Verlauf der Evidenz für H_1 und seine Oszillation über die Zeit untersucht wurde. Unser Kriterium für die Bestätigung von H_1 wurde in der Zielgruppe zunächst erreicht. Kurz danach zeigte sich ein Decline-Effekt bis zum Endergebnis der anekdotischen Evidenz für H_1. Um den systematischen Trend der Daten gegen Zufallsschwankungen zu testen, wurden weitere Post-Hoc-Analysen durchgeführt, bei denen der maximale Bayes-Faktor, die Energie der Kurve und die Analyse des Frequenzspektrums zwischen beiden Gruppen mit 10.000 Simulationen verglichen wurden. Diese Analysen ergaben, dass sich die Daten der HI-Teilstichprobe signifikant von Zufallsfluktuationen unterschieden, während dies bei Daten der GI- Teilstichprobe nicht der Fall war. Zusammengefasst deuten die Ergebnisse darauf hin, dass sich zentrale affektiv aufgeladene unbewusste Überzeugungen mittels flüchtiger, aber statistisch nachweisbarer Abweichungen vom Quantenzufall manifestieren können, wenn sie durch eine geeignete Aufgabe präzise getriggert werden.

Atraes lo que Eres: El Efecto de las Necesidades Inconscientes en la Micropsicoquinesis

Resumen: Los modelos cuánticos de correlación psicofísica ofrecen un marco atractivo para predecir las interacciones mente-materia. Reportamos una prueba de tales interacciones en forma de efectos de observación en los resultados del generador cuántico de números aleatorios (QRNG). Específicamente, evaluamos la influencia de ciertos estados de motivación en la presentación de estímulos relacionadas elegidos por el QRNG. Esperábamos desviaciones de la aleatoriedad entre los

participantes con características de alta incongruencia (HI) pero no entre con baja incongruencia (LI). Nuestro primer experimento, evaluó los efectos de tres necesidades psicológicas (apego, protección de autoestima, y control) con un análisis Bayesiano que mostró evidencia anecdótica de H1 solamente para estímulos relacionados con la autoestima dentro del grupo HI. El segundo experimento fue una continuación selectiva de la prometedora condición de protección de la autoestima, explorando el curso secuencial de evidencia adicional para H1 y su oscilación a lo largo del tiempo. Nuestro criterio para confirmar H1 se alcanzó inicialmente en el grupo objetivo. Poco después, se produjo un descenso a un resultado final de evidencia anecdótica de H1. Para valorar la tendencia sistemática en los datos contra las fluctuaciones al azar, se realizaron análisis post hoc adicionales comparando el factor de Bayes máximo, la energía de la curva, y el análisis del espectro de frecuencia entre ambos grupos con 10,000 simulaciones. Estos análisis indicaron que los datos de la submuestra HI difirieron significativamente de las fluctuaciones fortuitas, mientras que los datos de la submuestra LI no. En resumen, los resultados sugieren que las creencias subconscientes cargadas afectivamente pueden manifestarse a través de desviaciones volátiles pero estadísticamente detectables de aleatoriedad cuántica cuando se activan con precisión en una tarea adecuada.

3. Research Paper 2:

Testing the Effects of Personality-Related Beliefs on Micro-PK[1]

Jakob, M. J.*, Dechamps, M. C.*, & Maier, M. A. (2024). Testing the Effects of Personality-Related Beliefs on Micro-PK. *Journal of Anomalous Experience and Cognition, 4*(1), 34-59. https://doi.org/10.31156/jaex.23809[2]

[1] *Shared first authorship

[2] First published in the Journal of Anomalous Experience and Cognition (open access).

Open Data
P-R

Testing the Effects of Personality-Related Beliefs on Micro-PK[1]

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Abstract: *Objective.* This preregistered study investigates mind-matter interactions by testing observer effects on quantum random number generator (QRNG) outcomes mediated by implicit intentions. *Methods.* We evaluated participants' personality traits (PTs), and presented them with goal-related or neutral stimuli based on QRNG outputs. We predicted deviations from chance, with high PT scorers expected to observe more PT-related sentences. We conducted three micro-psychokinesis (micro-PK) experiments for Cluster C's PTs: dependent, avoidant, and obsessive-compulsive. *Results.* The results revealed strong evidence (Bayes Factor > 10) for a micro-PK effect in the dependent PT group, with high scorers observing more sentences addressing their concerns than expected by chance. We did not find strong evidence for the other PT groups or low scorers. *Conclusion.* These findings suggest that intentional observation biases QRNG outcomes related to individuals' implicit concerns, potentially leading to self-fulfilling prophecies. The study's implications are discussed within the Unus Mundus model and the Model of Pragmatic Information.

Keywords: micro-psychokinesis, mind-matter interaction, quantum measurement, intentional observation, personality traits, Unus Mundus, Model of Pragmatic Information

Highlights

- Quantum-based psychophysical correlation models provide an extension of QM in which intentional observations contribute to the formation of macroscopic realities.

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https://doi.org/10.31156/jaex.23809

- In three preregistered micro-PK experiments, a task for three Cluster C PTs (dependent, avoidant, and obsessive-compulsive) evaluated observers´ biases on QRNG outcomes.

- The study partially confirmed the existence of a micro-PK effect in the data: Concerning the PT group "high-dependent," strong evidence for H_1 was found.

Following years of psychical research, the psychologist/philosopher William James concluded that extraordinary phenomena "can never be fully explained away, they can also never be susceptible of full corroboration" (in Wilson, 1985, p. 158). Wilson (1985) subsequently derived James's Law, claiming that the evidence is sufficient "to convince those who are willing to be convinced, but never enough to win over the sceptics" (p. 158–159). This law still applies to various frontier phenomena in scientific research. One particular group of exceptional phenomena involves the emergence of realities based on observers' specific motivational states not mediated by behavioral interactions between individuals and their environments. These purely mind-induced effects on physical settings challenge the causal closure of accepted theories regarding physical reality. One area of research called "micro-psychokinesis" (micro-PK; see Varvoglis & Bancel, 2015) is devoted to a subset of these mind-matter interactions.

Micro-PK applies various experimental settings to tackle the mind–matter relation by investigating intentional observers' influence on deviations from randomness, more recently with a focus on observer effects during quantum measurements. This research has a long tradition (e.g., Jahn et al., 1987; Stanford, 1976; Stanford et al., 1975; Schmidt, 1974) and has shown significant effects: observers' conscious or unconscious motivational states seem to influence the outcomes of a quantum number generator (QRNG) in accordance with their motives or intentions through the sole act of observation. Meta-analyses have supported the efficacy of intentional observations on the probabilities of quantum-based events (Bösch et al., 2006; Radin & Nelson, 1989).

When the unconventionally high heterogeneity of effect sizes in these analyses raised criticism, Varvoglis and Bancel (2015) calculated that an unrealistically large number of non-significant studies would be required in the file drawer if micro-PK effects were merely a phenomenon of publication bias (see also Radin et al., 2006). However, many original results could not be replicated directly or declined over time (e.g., Dechamps et al., 2021; Jahn et al., 2000; Dechamps & Maier, 2019*;* but see Mossbridge & Radin, 2021). These ambiguous findings with regard to direct replications and within-study robustness of micro-PK effects lead to different interpretations: skeptics argue that the initial effects are artifacts of error, random fluctuation, or based on questionable research practices (QRPs; e.g., Alcock, 2003; Wagenmakers et al., 2011), while proponents evaluate the findings as providing sufficient evidence (Cardeña,

2018; Cardeña et al., 2015; Radin, 2006). This debate and the actual status of the empirical evidence both reflect the validity of James´s Law in this field.

As a solution to this debate, Rabeyron (2020) suggested that unusual patterns in experimental psi research should be regarded not as impediments or random fluctuations but opportunities to investigate these effects' true nature (see also Atmanspacher et al., 2002; von Lucadou et al., 2007; von Lucadou, 2015). He specifically argued that preregistrations within psi research might enhance the results' confirmatory value. The present study was preregistered to determine whether psi effects can occur under these circumstances.

Quantum-Based Models of Psychophysical Correlations

Although the indeterminacy principle (quantum randomness, Born, 1926) during quantum measurement is considered an ontic principle in orthodox quantum physics (Greenstein & Zajonc, 2006), several authors (e.g., Mensky, 2014; Pradhan, 2012; Penrose & Hameroff, 2011; Stapp, 2007; Stanford, 1990) propose that intentional observers might be able to influence these quantum probabilities during measurement operations, making an outcome more likely than predicted by the Born rule (Born, 1926). Such quantum-based psychophysical correlation models may be understood as an extension of quantum mechanics, considering intentional observations and their effects on macroscopic reality.

One specific variant, the *Unus Mundus* Model (UMM), proposed by Pauli and Jung (see Atmanspacher, 2014; Atmanspacher et al., 2013), offers an elegant framework to explain psychophysical interactions during quantum measurements. In contrast to alternative observational quantum theories, the dual-aspect feature of the UMM provides a solution to the existing mind–matter gap (see Chalmers, 1995). Pauli and Jung propose that mind and matter form a unity on a deeper level of reality called *unus mundus*. The UMM considers this reality to be pre-conscious and pre-material as well as collective, merging unconscious (supra-)individual information and its corresponding quantum states. It overcomes and precedes the classical subject–object distinction. By implementing such a pre-reality as an interface between the two substances mind and matter, this approach allows us to describe different types of observer-dependent mind–matter interactions. The Cartesian dual realities, conscious experience and classical matter, become two distinct aspects of the world through an act of knowledge transition (from unknown to known), referred to as epistemic split (Atmanspacher, 2020).

According to general quantum theory (GQT, Filk & Römer, 2011), a mathematical formalization of the Pauli-Jung conjecture, conscious observation is the key process to initiate an epistemic split. Prior to this, mind and matter are believed to form acausal and non-local correlations of their pre-conscious and pre-material states in the *unus mundus*. After performing an epistemic split through conscious observation, both substances emerge as distinctive forms—the conscious mind and the macroscopic matter. They cannot interact directly anymore, as they now appear as two different substances. Still, they remain related to each other because of their common ground. To describe the specific nature of this indirect relation between the conscious mind and the corresponding macroscopic physical environment, Atmanspacher and Fach (2013) suggested two types of interactions: structural and induced correlations (see also Atmanspacher, 2020).

Epistemic splits based on structural correlations (SCs) form dual realities through passive, conscious registrations of classical physical occurrences. SCs are considered reactive in nature, such as in conscious perceptions of ongoing physical events, since they follow the Born rule during the transfer from the pre-material quantum states from the *unus mundus* into the classical state and its conscious experience. Psychosomatic correlations exemplify such SCs. This type of entanglement correlation is considered stable and reproducible (Atmanspacher, 2020), likely due to its reactive and passive nature, since such manifestations do not demand the intentional agency of the individual (Maier et al., 2022).

By contrast, epistemic splits caused by induced correlations (ICs) distort the balance between mental and physical reality typical of SCs (Atmanspacher, 2020). They are at least rudimentarily based on some form of intentional agency. ICs include active, goal-based formations of physical realities that bias the Born rule along an observer's motivational state during observation. That is, autonomous individuals exert a mental impact on reality creation out of a quantum superposition (see also Maier et al., 2022). Micro-PK phenomena are a prototypical example of such correlations, whereby the observers' goals form corresponding realities. Pauli and Jung (see Atmanspacher et al., 2013) labeled such phenomena "synchronistic events" and emphasized the unifying principle of meaning in their occurrence. Owing to the autonomous, non-deterministic aspect of personal meaning, they also emphasized the elusive nature of these effects, which cannot be described with deterministic laws or demonstrated objectively. Consequently, in contrast to SCs, ICs are not considered exactly reproducible across studies. The reason for this is that the psyche, as a driving force of reality creation in this context, adds an active, subjective component not captured by purely passive, objective descriptions of physical laws (Maier et al., 2022; see also Bierman, 2001; Jahn & Dunne, 1997). Atmanspacher (2020) and von Lucadou et al.

(2007) provided formal models to support this view. According to them, ICs violate the "no-transmission theorem" (von Lucadou et al., 2007) and therefore cannot be stable and reproducible. Any effects based on ICs, including micro-PK, must decline over the course of further confirmation attempts. In sum, Pauli and Jung's UMM and the model of pragmatic information (MPI; von Lucadou et al., 2007) form the theoretical basis for this study's predictions regarding micro-PK.

An experimental micro-PK design should provide the following conditions that allow ICs to be studied scientifically: 1) The mind, as the causal source of an IC, must involve—among conscious thoughts—unconscious mental processes to affect physical systems (QRNG outcomes), since its impact is transferred through the pre-conscious and pre-material realm into the physical world. 2) A meaningful connection between the mental impulse and the quantum-based RNG outcome must be established. That is, the stimulus material to be selected by the QRNG must include subjectively relevant information. 3) Regarding the effect's replicability, an initial appearance in a first study demonstrating the existence of the effect might most likely be followed by a decline of the effect during replication attempts. This is the consequence of the effect's elusive nature, as described in the UMM and mathematically formalized in the MPI. The present study aimed to address the first two pre-conditions using a quasi-experimental setup and for now set aside the replicability issue. Nevertheless, the confirmatory value of the study was intended to be maximized by using preregistration and a Bayesian testing approach, setting the evidence criterion for the confirmation of an effect (H_1) to strong evidence ($BF_{10} \geq 10$).

The Central Role of Emotions in Intentional Agency

Because human intentions, ICs' core driving factors, must exert their impact on reality formation via pre-conscious processes, they are presumably shaped by their emotional content (Jakob et al., 2020). At their deepest level, intentional goals can be conceptualized as implicit approach or avoidance orientations, and their accompanying emotions are hope and fear, respectively (Elliot, 2008). For example, in an achievement setting, an individual might strive for a certain end state (e.g., passing an exam). In an approach orientation, the agent seeks a positive result (e.g., success in an exam), and the underlying emotion is hope for success. The actor implicitly expects to be able to succeed. Consequently, the hope that success will be achieved is the basic information encapsulated in this goal.

Conversely, avoidance orientation is characterized by a tendency to avoid failure (e.g., avoid failing an exam), and the underlying emotion is fear. The fear that failure will occur is the basic information encapsulated in this goal. These expectations of behavioral outcomes are pre-conscious and can differ from deliberate goals. Thus, although individuals overall wish to pass the exam, their implicit appraisal of the likely future scenario might contain completely opposite expectations and corresponding emotional consequences. Accordingly, hope will promote success-related realities, and fear will make failure-related realities more likely in this context (Elliot, 2008).

With regard to micro-PK, our assumption was that ICs bias micro-PK outcomes in line with an observer's motivational goals, whereby the affective part of the goal orientation, including implicit expectation, will primarily cause its outcome. This conjecture is based on the emotional transgression model (ETM; Jakob et al., 2020), which proposes that the emotionally coded information of an intention exclusively passes the border between the conscious, intentional mental realm from which an IC starts off and the pre-reality realm of the *unus mundus*. There, it increases the quantum probabilities of the affectively expected states. In this way, observers' expectation encoded in their emotions act like differential self-fulfilling prophecies in the context of micro-PK. During intentional quantum state observations, physical outputs whose content matches the observers' emotional states underlying their intentions will be more likely to emerge.

In the present study, we focused on avoidance-oriented goals driven by the emotional dynamic of fear. We aimed to identify individual differences based on certain personality traits (PTs) related to specific avoidance-oriented patterns. The corresponding fearful outcome expectations should induce a correlation with QRNG-selected stimuli (ICs) that express and confirm those fears.

Personality Traits

To assess individual differences in our participants' fear-based motivational patterns, we used PTs, which reflect specific implicit expectations of behavioral outcomes and tend to cause high emotional activation when triggered (Sachse, 2001). Dysfunctional personality tendencies are described in the DSM taxonomy and can be measured reliably and validly using the self-report VDS-30 questionnaire (Sulz, 2000).

We focused on Cluster C, consisting of three fearful and anxious personality types: dependent, avoidant, and obsessive-compulsive. These three are most common in a normal population. Individuals with dependent PT (DE-PT) exhibit significant fear of separation and strong need to feel secure, welcome, and guilt-free in rela-

tionships. They may neglect the need for autonomy by avoiding making decisions or being alone, always agreeing in conversations, and engaging in even unpleasant activities to satisfy those around them. The key process is the fearful expectation of separation from others.

Individuals with avoidant PT (AV-PT) also exhibit fear of loss of love and an intense need to be welcome and free of guilt. To avoid criticism and rejection by others, they act reluctantly and are distant in company or even move away from conversations and social activities. The crucial process is the fearful expectation of rejection or humiliation by others.

Individuals with obsessive-compulsive PT (OC-PT) appear less anxious than those scoring high on the other two traits described above (Sulz & Müller, 2000) but also exhibit a need to feel welcome and a fear of losing control. To avoid mistakes, they tend to hold onto details and are very persistent. This trait can cause problems in finishing tasks, making decisions, or delegating responsibility. Consequently, the key process is the fear that loss of control will occur.

Hypotheses

A micro-PK task was designed using target sentences as outcomes that mirrored the typical concerns for the Cluster C PTs, in addition to neutral sentences. The micro-PK task comprised three independent consecutive blocks of stimuli, with each block's stimulus material addressing one of the three PTs. We hypothesized that individuals with pronounced PT characteristics (expressed by high scores on the respective scale = target group) would influence the QRNG to produce outcomes that match their implicit expectations within each block. That is, we predicted the presentation of more meaningful PT-specific target stimuli than expected by chance for high scorers. Individuals with low scores on the respective PTs (control group) should show no or weaker deviations from chance.

We tested a specific preregistered hypothesis for each of Cluster C's three PTs:

A) DE-PT: Participants with high scores on the DE-PT performing a micro-PK task will observe more relevant target stimuli that address their fears (e.g., "Will we part in dispute?") than neutral stimuli (e.g., "We see a forest").

B) AV-PT: Participants with high scores on the AV-PT performing a micro-PK task will observe more relevant target stimuli that address their fears (e.g., "What should I say?") than neutral stimuli (e.g., "The shirt is white").

C) OC-PT: Participants with high scores on the OC-PT performing a micro-PK task will observe more relevant target stimuli that address their fears (e.g., "Did I miss a mistake in my work?") than neutral stimuli (e.g., "Digital watches are common").

We hypothesized that no strong evidence for H_1 would be found for the three control subsamples (low PT scorers), and we predicted on a confirmatory level in the preregistration that at least one of the target groups (high scorers) would reach a $BF_{10} \geq 10$ indicating strong Bayesian evidence for H_1 during data collection.

The researchers' a priori belief that the hypotheses would be supported can be classified on a scale from 5 = "strong belief" to 1 = "strong non-belief" as 4 = "moderate belief." This study was implemented and analyzed according to the preregistration uploaded to the Open Science Framework (https://osf.io/gw98t). The data and analyses can be found at the OSF project´s repository (https://osf.io/qxu3s). In addition, some exploratory analyses have been proposed in the preregistration that will not be reported in this article but a summary of the analyses and results can be found at OSF (https://osf.io/qxu3s).

Method

Consent

All research was conducted in accordance with the ethical requirements of the American Psychological Association (APA). The instructions did not reveal the study's purpose but assured anonymization and emphasized the participants' right to withdraw at any time. Voluntary participation was ensured by obtaining informed consent from all participants. The procedure and experiment were approved by the ethical board of the Department of Psychology at the LMU Munich.

Design

We selected a two-group design and conducted a quasi-experiment with high and low scorers on Cluster C's PTs as independent variables. Participants were divided based on their individual scores measured by the VDS-30 (Sulz, 2000), as detailed below. We applied specific micro-PK task blocks for the DE-, AV-, and OC-PT presented in randomized order across participants. Each micro-PK block comprised of 30 on-screen stimulus presentation trials. For each trial, a QRNG selected from be-

tween trait-related and neutral stimuli with a baseline 50/50 probability. The number of trait-related stimuli displayed in each block served as the dependent variable.

For each PT, the sample was divided into control and target subsamples based on individual scores (low vs. high scorers). This was done for each of the three scales measured by the VDS-30. We used the norms for N = 166 non-clinical individuals from Sulz et al. (2009) (DE-PT: M = 0.45, SD = 0.66; AV-PT: M = 0.58, SD = 0.84; OC-PT: M = 0.47, SD = 0.82) and data from our own pre-study for stimulus validation on N = 138 students (102 females, 36 males; age: M = 23.41 years, SD = 7.95; DE-PT: M = 1.01, SD = 0.46; AV-PT: M = 1.11, SD = 0.65; OC-PT: M = 1.13, SD = 0.50) to derive a cut-off value of mean ≥ 1.00 as high for each PT. We deemed this score to adequately represent both the average of the norms provided by Sulz et al. (2009) and our pre-sample's average. Because this criterion's selection implies a certain degree of freedom, the specified cut-off value was preregistered in advance.

Participants

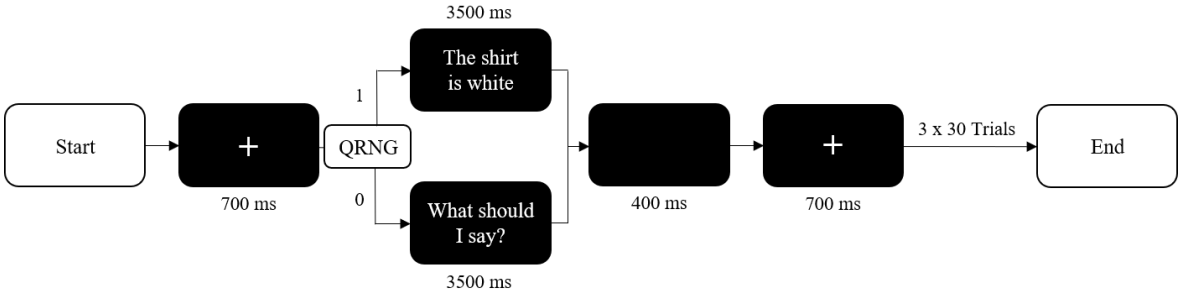
Overall, N = 2,403 participants were tested (56% females, 44% males, 0.2% unspecified; frequency of age categories: 18 – 27 years 62%, 28 – 37 years 17%, 38 – 47 years 8%, 48 – 57 years 9%, > 57 years 3%). Participants were recruited through the department's announcement board, handouts distributed in psychology classes, university Facebook groups, and the online recruiting platforms Mturk and Prolific. Students enrolled in the university's bachelor's psychology classes were awarded credits for participation. Out of all participants, n = 545 (23%) were recruited from Mturk, and n = 120 (4%) were recruited from Prolific and were paid $1.5 or 1.80 GBP respectively for their participation. Inclusion criteria were an age between 18 and 65 years and excellent knowledge of the German language. To ensure that participants paid attention to the stimuli on the screen during the three stimulus presentation blocks, we implemented an "attention check" later on in the course of data collection (at n = 1,105). During each block, a written request to press a "next" button appeared once at random occasions on the screen. Participant's response speed was assessed as an indirect indicator of compliance to the task. The attention check variable data were not part of the preregistration and will be used for exploratory analyses to check for any moderating effects.

Materials

Procedure. The participants were tested in an online study comprising two experiments in fixed order. The present study was the second. Together, both studies took around thirty minutes. Participants first confirmed their agreement on a digital consent form. The present study began by assessing demographic data and the three Cluster C PT scales. Participants subsequently progressed to the experiment, comprising of three blocks, with 30 trials each. The blocks' order was randomized across participants using a quantum based random number generator (QRNG; "Quantis" by idquantique). Each block used experimental stimuli (short sentences) closely semantically related to one of the three Cluster C PTs, in addition to neutral control stimuli. The instruction was to pay full attention to the different sentences being presented on the screen. Participants then passively observed three consecutive series of 30 trials (no manual response required). After each block of 30 trials, the program advised the test participants to maintain focus and press a button to confirm their readiness. The volunteers looked first at a fixation cue (700 msec), then at the stimulus (3500 msec), and finally at a black screen (inter-stimulus interval: 400 msec). Immediately before the stimulus presentation, the QRNG determined whether the next stimulus sentence shown on the screen would be out of the trait-related or neutral stimulus set. This process was repeated 30 times per block (see Figure 1). Three blocks with 30 trials each were presented, each using target sentence stimuli relating to one of the three PTs.

Figure 1

Overview of a Prototypical Trial Sequence Including Presentation Times.



Hardware and Software. This study was conducted online. The stimuli were presented on a black background with a size of 500 x 400 pixels. For QRNG-based stimulus generation, a presentation procedure was programmed in jsPsych (v 5.0.3; de Leeuw, 2015), which translated the QRNG's numerical output into either trait-related stimuli or neutral sentences during each trial. The QRNG used in this study produces quantum

states using photons sent through a semi-conductive mirror-like prism. The photon is equally likely to be deflected in one direction or another, producing a superposition of both states. The photon's location on either path with 50% probability is then transformed into a numerical score such as 0 or 1, depending on the track on which it was located (Quantis transforms 8 such bits into 1 byte). Thus, this procedure follows the structure of a double-slit quantum experiment. This hardware passed all serious tests of randomness, including the DIEHARD and NIST tests, and is among the most effective QRNGs (Turiel, 2007). This QRNG does not use a post-correction procedure during this standard process (confirmed via personal conversation with an idquantique representative). Consequently, a true quantum source for randomness was provided for each experimental trial.

Assessment of Personality Traits. The Cluster C PTs were measured using the VDS-30 (Sulz, 2000), which takes around ten minutes to administer: norms are given in Sulz et al. (2009). The standard sample varies in gender and age and represents 166 healthy individuals and 945 patients from psychotherapy settings. The questionnaire consists of ten items per PT, rated on a four-point scale. Participants indicate how adequately they feel described by the presented items (from 0 = "not" to 3 = "very"). The scales refer to Cluster C's three PTs (DE, AV, and OC). These scores were split into a target group (high scorers) and a control group (low scorers)—based on our preregistered cut-off (mean ≥ 1.00)—and used as independent factors. Internal consistency for the non-clinical sample can be considered good for all scales, with Cronbach's alpha ranging from $\alpha = .72$ to $\alpha = .86$. Retest reliability lies between $r = .70$ (good) and $r = .83$ (very good), with $r = .81$ (very good) on average (Sulz et al., 2009). The questionnaire's construct validity was confirmed by comparing it to the Munich Personality Test (Zerssen, 1993) and the Personality Traits and Disorders Inventory (Kuhl & Kazén, 1997) by Sulz et al. (1998, 2009).

Stimuli. For each of the three PTs, five target stimuli were created. Their content was related to the original items of the VDS-30 questionnaire (Sulz, 2000). The questions were designed to trigger inner doubts in individuals exhibiting the respective PT. For example, for the DE-PT, one experimental sentence was "Is she mad at me?" For each set of five experimental sentences, five neutral control sentences were selected from a greater set created out of neutrally rated words provided by Ben-David et al. (2011) or were self-designed in the same manner.

To ensure that each final set of experimental sentences closely matched the content of the respective PT, we conducted an online pre-study in which for each

PT, ten potential experimental and ten neutral sentences had to be rated on valence for each PT. For each stimulus, participants were asked how pleasant they perceived the sentences to be (1 = "very unpleasant" to 7 = "very pleasant"). The mean rating obtained for each sentence was then correlated with the respective PT of the raters assessed using the VDS-30 (see Tables 1 and 2). For this evaluation, the sample comprised *N* = 107 undergraduate students (88 females, 19 males; age: *M* = 22.30 years, *SD* = 6.83) in total.

As a first step, we collected data from *n* = 73 participants (58 females, 15 males; age: *M* = 23.10 years, *SD* = 7.67), assessing gender, age, and Cluster C's PTs. Sixty sentences—ten target questions and ten neutral sentences for each PT—were presented to each participant in randomized order. In addition, to avoid a general mood shift toward negative emotionality and confusion within participants while rating several sentences of negative valence, we randomly added 15 filler sentences of positive valence. As expected, all neutral sentences were barely rated as unpleasant, and their mean pleasantness scores showed no significant correlation with the individuals' PT scores (for further information see https://osf.io/qxu3s). For the DE- and AV-PT, four of the ten target sentences showed adequate trait-specific correlation (see Table 1). As the study design required at least five targets for each trait, one further target question was created without renewed evaluation for both PTs semantically closely related to one of the four already selected stimuli (DE-PT: "Is he disappointed in me?"; AV-PT: "Do the others see my nervousness?"). None of the given target sentences showed significant correlations with the OC-PT trait and, in many cases, the correlations with the other traits were significant. Thus, none of the 10 target sentences showed sufficiently high specificity for this PT.

We thus created ten new target sentences and tested them in a second pre-study for this PT only with *n* = 34 additional participants (30 females, 4 males; age: *M* = 20.59; *SD* = 4.16). The targets for the other two PTs were not included in this rating for economic reasons. In addition, five filler sentences, each comprising neutral and positive valences, were kept in the rating set. The results of this second pre-rating study showed that four out of ten target sentences correlated sufficiently with the participants' OC-PT scores and were thus selected for use in the micro-PK task (see Table 1). Again, one more missing target question ("Can I simply live from day to day?") was constructed without further evaluation based on an already-validated stimulus.

Table 1

Descriptive Results of the Stimulus Validation Study for the Selected Trait-Related Target Stimuli

Target Stimulus	*M*	*SD*	DE		AV		OC	
			r	*p*	*r*	*p*	*r*	*p*
DE (*n* = 73)								
"Is she mad at me?"	2.32	0.91	-.32**	<.01	-.12	.15	-.07	.29
"Will we part in dispute?"	2.11	0.92	-.26*	.01	-.08	.24	-.03	.39
"Will nobody help me?"	2.52	1.23	-.10	.20	.03	.40	-.10	.21
"Do I get back as much as I give?"	3.47	1.08	-.20*	.04	-.13	.14	-.12	.15
AV (*n* = 73)								
"Will I blush in front of everyone?"	2.78	1.90	-.08	.25	-.23*	.03	-.09	.22
"Can I be myself in front of others?"	4.45	1.56	-.14	.11	-.31*	<.01	-.09	.22
"What should I say?"	2.86	1.92	-.12	.17	-.27*	.01	-.18	.07
"Can I show self-confidence?"	4.38	1.39	-.12	.15	-.27*	.01	.01	.46
OC (*n* = 34)								
"Did I miss a mistake in my work?"	2.26	1.02	-.04,	.41	-.08	.32	-.11	.26
"Have I allowed myself too much free time?"	2.79	1.04	-.41**	<.01	-.40**	<.01	-.31*	.04
"Did I waste my time?"	1.91	0.75	-.06	.38	-.08	.34	-.26	.07
"Did I really work enough?"	2.35	0.92	-.23	.09	-.27	.06	-.32*	.03

Note. *M* = Mean pleasantness; *SD* = Standard Deviation; *r* = correlation (one-tailed). *p < .05, **p < .01.

Finally, fifteen of all neutrally rated sentences—five for each block—were randomly selected for application in the micro-PK tasks (see Table 2).

Table 2

Descriptive Results of the Stimulus Validation Study for the Final Neutral Stimuli

Neutral Stimulus	*M*	*SD*	*r*	*p*
DE (*n* = 73)				
"He is on deck"	4.15	0.72	-.01	.48
"There are magnets on the fridge"	4.29	0.66	-.01	.47
"We see a forest"	5.11	1.16	-.06	.31
"Some tablecloths are in the basket"	4.14	0.51	.01	.46
"Her book is under the bed"	4.04	0.77	-.05	.35
AV (*n* = 73)				
"The shirt is white"	4.27	0.71	.05	.35
"There is a pillow on the sofa"	4.64	0.98	.07	.29
"The spoon is on the table"	4.12	0.47	.08	.24
"The year has twelve months"	4.30	0.78	-.02	.42
"This is a trash can"	3.88	0.58	-.09	.22
OC (*n* = 73)				
"Red pipes are metal"	3.85	0.54	-.07	.28
"The room has many buckets"	3.67	0.69	.04	.38
"The cabinet has four drawers"	3.95	0.92	.01	.47
"The container has a blue lid"	3.99	0.31	-.02	.44
"Digital watches are common"	3.93	0.33	-.06	.30

Note. *M* = Mean pleasantness; *SD* = Standard Deviation; r = Pearson correlation (one-tailed). *$p < .05$, **$p < .01$.

Data Analysis

As recommended by Wagenmakers et al. (2011), the data were analyzed using Bayesian inference techniques with a preregistered strategy (for further details, see Jakob et al., 2020). The BF resembles the relative amount of evidence that the data provide for or against a postulated effect. For the three target groups with high scores on the PTs, each hypothesis was tested individually using a one-sided Bayesian one-sample *t*-test with the number of trait-related targets as the outcome variable, testing for more than 50% probability of occurrence.

For the control subsamples with low PT scores, we performed two-sided Bayesian one-sample *t*-tests against a probability of 50%. As 30 stimuli were presented for each trait, the expectation value under chance was 15. Based on previous findings (Jakob et al., 2020), we a priori decided on a narrow informed prior of δ ~ Cauchy (.05, .05). In the preregistration, an informed prior δ ~ Cauchy (0.5, 0.5) was erroneously mentioned. This was a typo. We address this error in the limitation section of our discussion and provide evidence there that this was a typo. Our a priori defined evidence criterion (stopping rule) was *BF* = 10, classified as strong evidence in any direction (H_0 or H_1). We predicted that a $BF_{10} \geq 10$ in favor of H_1 would occur during data collection for at least one of the micro-PK tasks (i.e., one of the three PTs' high groups). Since frequentist approaches are more common than Bayesian hypothesis testing in psychology, the *p*-scores of frequentist *t*-values are also provided. In addition to the BF stopping rule a maximum n of 1,000 participants was preregistered in case that at this sample size no clear trend towards BF = 10 in the data of at least one of the targets groups could be observed.

Results

Analyses of Total Deviations

As a basis for the preregistered sequential analyses reported later, six Bayesian one-sample *t*-tests were performed within the target and control subsamples for each PT, assessing whether the mean number of the target sentences was greater than 50% (target subsample) or differed from 50% (control subsample)[2]. We expect-

2 Results of the exploratory analyses for the subsample with the attention check (n = 1,059): Mean reaction time over all three tasks *M* = 7.30 s (*SD* = 59.96 s; Min = 0.70 s; Max = 2,884.50 s). Therefore, the average reaction time can be considered acceptable for an online study. The standard deviation of almost

ed to reach strong evidence for H_1 for at least one of the three target subsamples. No strong evidence for H_1 was expected for the control subsamples of individuals.

We first report the analyses of the target groups: A Bayesian one-tailed *t*-test analysis of the mean number of trait-related stimuli for the DE-PT-high scorers (n = 1,400) yielded a final BF_{10} = 10.41 (M = 15.18; SD = 2.68), indicating strong evidence for H_1 (cf.: $t(1399) = 2.51$; $p < .001$). The other two Bayesian one-sample *t*-test analyses showed a final BF_{01} = 2.01 (M = 15.06; SD = 2.71) for the AV-PT-high scorers (n = 1,308) (cf.: $t(1307) = 0.78$; $p = .22$) and a BF_{01} = 2.41 (M = 15.05; SD = 2.74) for the OC-PT-high scorers (n = 1,462) (cf.: $t(1461) = 0.68$; $p = .25$), representing anecdotal evidence for H_0. The sequential Bayesian analyses for these three tests can be seen in Figure 2.

Two-tailed Bayesian one-sample *t*-tests were performed for the three control subsamples. A two-sided approach was adopted since, for the control group, no deviation from 50% in either direction was expected. As postulated, no strong evidence for H1 was found, although the BFs did not confirm H0 either. The control subsample for the AV-PT-low scorers (n = 1,095) showed with BF_{10} = 3.27 (M = 15.17; SD = 2.74), indicating moderate evidence for H_1 (cf.: $t(1094) = 2.08$; $p = .04$). The Bayesian *t*-test analyses for the DE-PT-low scorers (n = 1,003) yielded a BF_{01} = 2.17 (M = 15.06; SD = 2.69), indicating anecdotal evidence for H_0 (cf.: $t(1002) = 0.73$; p =.47), and for the OC-PT-low scorers (n = 941), a BF_{01} = 2.84 (M = 14.88; SD = 2.64) was obtained, indicating anecdotal evidence for H_0 (cf.: $t(940) = -1.37$; $p = .17$).[3]

Further Preregistered Exploratory Analyses

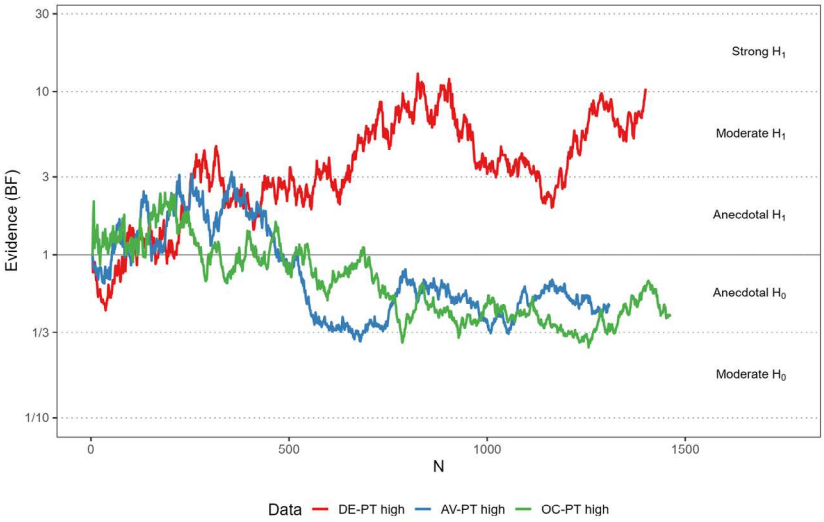
In the preregistration form, several further exploratory analyses regarding the influence of demographic variables (age, gender), the investigation of trait-specificity of the effect, Change of Evidence Analyses, and a test of a regression model with all PTs included at once as predictors were preregistered. These exploratory analyses have been performed but will not be reported in detail here. However, an overview of these results can be found at: https://osf.io/qxu3s.

one minute and the maximum response times of more than three quarters of an hour indicate that the sample included some inattentive participants.

3 Results for the erroneously preregistered prior δ ~ Cauchy (0.5, 0.5): DE-PT-high BF_{01} = 1.31, AV-PT-high BF_{01} = 30.19, OC-PT-high BF_{01} = 35.83; DE-PT-low BF_{01} = 29.04, AV-PT-low BF_{01} = 4.18, OC-PT-low BF_{01} = 16.37.

Figure 2

Sequential Bayesian One-Sample t-Test Analyses



Note. Red line: DE-PT-high, blue line: AV-PT-high, green line: OC-PT-high. Tests are one-tailed.

Discussion

This study aimed to provide empirical evidence of quantum-based psychophysical correlation models by investigating the micro-PK effects produced by QRNG. We tested hypotheses derived from Pauli and Jung's UMM and from von Lucadou's MPI. With reference to the UMM, we considered the activation of an individual's specific pre-conscious mental state while perceiving a QRNG outcome—meaningfully related to the observer's implicit goal orientations—as a type of IC. For specific fear-related motivational patterns, we predicted a non-local correlation between mind and matter, resulting in a higher likelihood of the appearance of a corresponding observation of a quantum outcome, that is, fear-related stimuli presentations. According to the ETM (see also Jakob et al., 2020), this bias can be explained by the individual´s pre-conscious outcome expectations. Only the affective content of an intention can pass the boundary from the conscious to the unconscious pre-reality realm and thus instigate changes in the quantum probabilities of the goal-related pre-material states. This motivational impact should bias the likelihood of a corresponding macroscopic manifestation. The observers' pre-conscious motive states were operationalized as Cluster C's PTs serving as an independent factor. These PTs mirror specific subjective theories about oneself and others and are strongly affectively laden. Moreover, they are grounded in unconscious fear-based expectations of need frustration. Therefore,

the ETM predicts a higher probability that these trait-specific concerns will be realized within the macroscopic material reality—that individuals tend to attract in life that which they are afraid of.

Consequently, we predicted strong evidence for deviations from randomness in a micro-PK task operating with fear-related (and neutral) stimulus presentations within subsamples of individuals expressing high PT levels but not for participants with low scores on these traits. Our primary prediction was confirmed: Within the target group for the DE-PT-high scorers, we found strong evidence ($BF > 10$) for our hypothesis (H_1). Participants scoring high on the DE-PT observed more fear-related target stimuli than chance. These findings can be considered a temporary confirmation of one of the tested hypotheses supporting the conjectures derived from the UMM and the MPI. Analyses of the micro-PK data of any other target and control groups found no strong evidence for the effects. Note that hypothesizing at least one of three tests performed with the target groups to show a result is a relatively weak postulate.

In sum, this study provided confirmatory evidence for a preregistered micro-PK effect for one out of three PTs. This evidence for a micro-PK effect within a subsample of participants expressing high extents of the DE-PT, if further substantiated in future studies, would support the assumption of a systematic influence of an implicitly motivated observer on quantum probabilities (von Lucadou et al., 2007; see also Mensky, 2014; Pradhan, 2012; Penrose & Hameroff, 2011; Stapp, 2007; Stanford, 1990). According to the ETM, individuals who fear losing security in relationships and others' support tend to attract such experiences at a macroscopic level. Thus, the pre-conscious, fearful expectation of abandonment might lead to a self-fulfilling prophecy. Such experiences might further confirm the individuals' expectations of behavioral outcomes, leading to a vicious circle of fear and fear-confirming realities that support the persistence of negative and psychopathologically relevant PTs. These findings corroborate earlier studies, including Jakob et al. (2020) or Maier and Dechamps (2018). It is unclear why no evidence for H_1 was found for the other two target groups. Design characteristics such as testing three different micro-PK effects within separate blocks in one study or sub-optimal target sentences' features might provide potential explanations.

One apparent limitation of this study is that the prior was incorrectly reported in the preregistration form. Instead of an informed prior with $\delta \sim$ Cauchy (.05, .05) used for the analyses reported above, $\delta \sim$ Cauchy (0.5, 0.5) was proposed. We would like to emphasize that this was due to a typo, and in fact, the $\delta \sim$ Cauchy (.05, .05) was meant. From our and others' previous micro-PK research, we knew that the overall effect size

for such effects is small, usually in the range of d = .1 or even lower. This is what we also expected for our study, as mentioned in the preregistration text. A small effect size of d = .1 translates into an informed prior of Cauchy (.05, .05) or an uninformed δ ~ Cauchy (0, .1). In our own micro-PK research, we almost exclusively use these two priors (e.g., Jakob et al., 2020; Dechamps et al., 2021). There was no reason to expect any different effect size for the study here. Given that a small effect size was expected and proposed for the present study, and a Cauchy (0.5, 0.5) would imply a medium effect size and given the fact that a Cauchy (.05, .05) was adequately and successfully applied in our past research, the scores mentioned in the preregistration should be interpreted as a typo. We are aware that the choice of a prior provides a degree of freedom in Bayesian analyses. Therefore, it is of the utmost importance to specify and potentially preregister the prior in advance. Admittedly, such a typo, although ruled out by the additional information presented above, diminishes the empirical strength of the data presented here.

Furthermore, we checked the results regularly during data collection, consistent with the Bayesian approach. However, this procedure might allow observer effects of the experimenters on the course of the study. The data analyst may be considered another observer on a level above the participants. An interim result with a certain degree of evidence for or against one's own hypotheses represents meaningful information for the observer, potentially leading to affectively laden expectations. As the analysis did not include masking, the analyst's unconscious intention could cause another IC, biasing the likelihood of a certain outcome along with the analyst's own belief in micro-PK (see Rabeyron, 2020). Our research group was characterized by a moderate belief, and this experimenter psi effect might have contributed to the results reported here. This additional or alternative explanation should be investigated in the future, perhaps by dispensing with intermediate analyses or deploying masked analyses. It should be mentioned in this context that the maximum N = 1,000 criterion as specified in the preregistration was ignored due to the fact that a clear trend in the data of the high-DP scorers was observed at n = 1,000. This conditional stopping rule was mentioned in the preregistration and is in line with the Bayesian testing approach.

Another limitation of the study was that the attention check was not implemented from the beginning but rather during the course of data collection. The subsample's results showed an acceptable mean reaction time of M = 3.19 s (SD = 7.08 s), indicating that most people were attentive during the online study. However, the variance in the speed of responses suggests that some participants were distracted (e.g., 8% participants showed reaction times larger than 10 seconds). Due to the reduced experimental control within online studies, it cannot be excluded that some participants were less attentive to the study content. Our theory assumes that conscious ob-

servation of stimuli is essential to establishing a meaningful connection between the individual's mind and the quantum process. It may, however, be sufficient if a certain portion of the stimuli is consciously perceived. Nevertheless, for further online studies on micro-PK, we suggest a change in the task so that the selected stimuli should not only be observed attentively without any further action but also rated respectively in their valence. In this way, the participants' continuous attention could also be guaranteed through online experiments.

Finally, the high correlation among Cluster C's three PTs prompts the question of whether a combined index averaged across all three personality scales would deliver a more adequate independent factor. Further exploratory analyses and, if necessary, renewed confirmatory investigations are planned.

This study's objective was to test intentional observer effects on deviations from quantum randomness during the process of measurement to provide evidence concerning quantum-based psychophysical correlation models (e.g., the UMM and the MPI). As predicted in the study's preregistration, in one of the three target groups (DEPT), we found strong evidence (BF_{10} > 10) for our hypothesis. By contrast, we observed no strong evidence for H_1 in the control groups. Overall, our findings align with earlier studies documenting evidence for the influence of unconscious observers' intentions on a QRNG (e.g., Jakob et al., 2020; Maier & Dechamps, 2018). In conclusion, an extension of quantum mechanics allowing intentional observers to contribute to the formation of macroscopic realities is worth considering as an alternative model for mind–matter interaction. This extension should also include ways to specify the degree to which the results can be objectified.

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Tester les Effets des Croyances Liées à la Personnalité sur le Micro-Psychokinèse

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Résumé: Cette étude préliminaire examine les interactions entre l'esprit et la matière en testant les effets de l'observateur sur les résultats du générateur quantique de nombres aléatoires (QRNG), médiés par les intentions implicites. Les traits de personnalité des participants (PT) ont été évalués et des stimuli neutres ou liés à un objectif leur ont été présentés en fonction des résultats du QRNG. Des écarts par rapport au hasard ont été prédits, les participants ayant obtenu un score élevé à l'évaluation des traits de personnalité étant censés observer davantage de phrases liées aux traits de personnalité les concernant. Trois expériences de micropsychokinèse (micro-PK) ont été menées pour les participants présentant des traits de personnalité appartenant au groupe C: dépendants, évitants et obsessionnels-compulsifs. Les résultats ont révélé des preuves solides (facteur de Bayes > 10) d'un effet de micropsychokinèse dans le groupe des personnalités dépendantes, les personnes ayant obtenu un score élevé ayant observé plus de phrases traitant de leurs préoccupations que ce qui était attendu par hasard. Aucune preuve solide n'a été trouvée pour les autres groupes de traits de personnalité, ou chez les personnes ayant obtenu un score faible. Ces résultats suggèrent que l'observation intentionnelle biaise les résultats QRNG liés aux préoccupations implicites des individus, ce qui peut conduire à des prophéties auto-réalisatrices. Les implications de l'étude sont examinées dans le cadre du modèle *Unus Mundus* et du modèle de l'information pragmatique.

Translation into French by Antoine Bioy, Ph. D.

Zur Prüfung der Auswirkungen von persönlichkeitsbezogenen Überzeugungen auf Mikro-PK

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Zusammenfassung: Diese vorabregistrierte Studie untersucht Geist-Materie-Interaktionen, indem sie Beobachtereffekte auf die Ergebnisse eines Quantenzufallszahlengenerators (QRNG) testet, die durch implizite Absichten vermittelt werden. Die Persönlichkeitsmerkmale (PTs) der Teilnehmer wurden eingeschätzt, und diese wurden mit zielorientierten oder neutralen Stimuli auf der Grundlage der QRNG-Ergebnisse präsentiert. Abweichungen vom Zufall wurden unter der Erwartung vorhergesagt, dass Teilnehmer mit hohen PT-Werten mehr PT-bezogene Sätze beobachteten. Drei Experimente zur Mikro-Psychokinese (Mikro-PK) wurden für die PTs von Cluster C durchgeführt: abhängig, vermeidend und zwanghaft. Die Ergebnisse ergaben eine starke Evidenz (Bayes-Faktor > 10) für einen Mikro-PK-Effekt in der Gruppe der abhängigen PTs, wobei Personen mit hoher Punktzahl mehr Sätze beobachteten, die ihre Probleme ansprachen, als zufällig erwartet. Für die anderen PT-Gruppen oder für die Personen mit niedrigen Punktzahlen wurde kein starker Nachweis gefunden. Diese Ergebnisse deuten darauf hin, dass die absichtliche Beobachtung die Ergebnisse von QRNG in Bezug auf die impliziten Bedenken von Personen verzerrt, was möglicherweise zu sich selbst erfüllenden Prophezei-

ungen führt. Die Implikationen der Studie werden im Rahmen des *Unus Mundus*-Modells und des Modells der Pragmatischen Information diskutiert.

Translation into German by Eberhard Bauer, Ph. D.

Testando os Efeitos das Crenças Relacionadas à Personalidade na Micro-PK

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Resumo. Este estudo pré-registrado investiga as interações mente-matéria testando os efeitos do observador sobre os resultados do gerador quântico de números aleatórios (QRNG em inglês) mediados por intenções implícitas relacionadas à personalidade. Os traços de personalidade (PTs em inglês) dos participantes foram avaliados, e apresentados com estímulos relacionados a metas ou neutros, com base nos resultados do QRNG. Desvios em relação ao modelo foram previstos, com pontuadores altos de PT esperados, para se observar mais sentenças relacionadas a PT. Três experimentos de micro-psicocinese (micro-PK) foram conduzidos para os PTs do Cluster C: dependentes, evitativos e obsessivo-compulsivos. Os resultados revelaram forte evidência (Fator de Bayes > 10) para um efeito de micro-PK no grupo de PT dependentes, com pontuadores altos observando mais frases abordando suas preocupações do que o esperado ao acaso. Não foram encontradas evidências fortes para os outros grupos de PT ou pontuadores baixos. Essas descobertas sugerem que a observação intencional influencia os resultados do QRNG relacionados às preocupações implícitas dos indivíduos, potencialmente levando a profecias autorrealizáveis. As implicações do estudo são discutidas dentro do modelo *Unus Mundus* e do Modelo de Informação Pragmática.

Translation into Portuguese by Antônio Lima, Ph. D.

Una Evaluación de los Efectos de las Creencias Relacionadas con la Personalidad en Micro-PK

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Resumen. Este estudio pre-registrado investigó las interacciones mente-materia evaluando los efectos del observador en los resultados de un generador cuántico de números aleatorios (QRNG), mediados por intenciones implícitas. Evaluamos los rasgos de personalidad de los participantes y les presentamos estímulos relacionados a objetivos o neutros basados en los resultados del QRNG. Predijimos desviaciones con respecto al azar, y esperabamos que los participantes con altas puntuaciones en PT observarían más frases relacionadas con PT. Realizamos tres experimentos de micropsicoquinesis (micro-PK) para los rasgos de personalidad del Grupo C: dependiente, evitativo, y obsesivo-compulsivo. Los resultados revelaron pruebas

sólidas (Factor de Bayes > 10) de un efecto micro-PK en el grupo de TP dependientes, en el que las personas con puntuaciones altas observaron más frases relacionadas con sus preocupaciones de lo que cabría esperar al azar. No encontramos pruebas sólidas para los otros grupos de TP ni para los de puntuación baja. Estos resultados sugieren que la observación intencionada sesga los resultados del QRNG relacionados con las preocupaciones implícitas de los individuos, lo que puede conducir a profecías autocumplidas. Discutimos las implicaciones del estudio dentro del modelo *Unus Mundus* y el Modelo de Información Pragmática.

Translation into Spanish by Etzel Cardeña, Ph. D.

4. Response to Comment on Research Paper 2:

Response to Comment on Jakob et al.: How to Read a Paper[1]

Jakob, M. J.*, Dechamps, M. C.*, & Maier, M. A. (2024). Response to Comment on Jakob et al.: How to Read a Paper. *Journal of Anomalous Experience and Cognition*, *4*(1), 79-87. https://doi.org/10.31156/jaex.25782[2]

[1] *Shared first authorship

[2] First published in the Journal of Anomalous Experience and Cognition (open access).

Response to Comment on Jakob et al.: How to Read a Paper

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Abstract: We thank Peter Bancel for highlighting the potential strengths and weaknesses of our study and for the intensive examination of the applied methods in order to improve our understanding of the reported effect and support future attempts to scientifically study micro-PK effects. Many arguments put forward in the Comment deserve a deeper examination and we appreciate the discussion raised by Bancel, but we do not agree with the main points of his criticism. In the following, we briefly address the central arguments provided against our analysis strategy and our interpretation of the data and present our view on this matter.[1]

1. Evidence claims not adjusted for multiple testing

Bancel first discusses the issue of multiple testing and its impact on the validity of our claims about Bayesian evidence. One argument was that our claim of strong evidence is flawed because adjustments for multiple testing should have been performed due to the dependence of the tests conducted in the study that used three different micro-PK tasks within one sample.

As Bancel acknowledges, within Bayesian testing approaches adjustments for multiple testing are only mandatory when the tests performed are dependent (Sjölander & Vansteelandt, 2019). This is usually the case when some kind of interrelations between the three micro-PK measurements are present in the data. However, in our view, the fact that the same sample is tested across the three measurements does not automatically imply statistical dependence. We agree that evidence for an effect in all three hypotheses should be based on a common mechanism that is an unconscious belief about the self. However, we argue that the hypotheses can be interpreted

1 Shared first authorship.

Journal of Anomalous Experience and Cognition
2024, Vol. 4, No. 1, pp. 79-87

https://doi.org/10.31156/jaex.25782

as independent because they are based on three highly specific psychological beliefs about someone's reality that should only produce micro-PK effects when the stimuli used in the respective task match the content of the relevant belief. In addition, it is possible that the "dependent" personality trait is elicited significantly better than the others because of a better match between this belief and its corresponding stimuli, which would lead to strong evidence for only one of the tests, independent of the evidence obtained for the others. Since we did not know beforehand whether the stimulus material used in the three DVs sufficiently matched the beliefs tested in the study, we consequently formulated our main hypothesis less strictly: We predicted that we would find strong Bayesian evidence for H_1 for at least one of the three micro-PK tasks performed. In addition, we counterbalanced the order of the micro-PK tasks used in the study to control for any order effects between tasks.

Bancel goes on to argue that the data sets for the three PT groups are also dependent, because the groupings are highly correlated. Although this is true, we would like to point out that it is not the correlation of personality traits that is relevant here, but a possible systematic relation between the correlated PT scores and the three micro-PK tasks. From a theoretical point of view, statistical dependence in this context would imply that any (group-related) performance on one micro-PK task should have an impact on performance on any of the other micro-PK tasks included in this study. This assumed interrelation of QRNG outcomes would in itself constitute a micro-PK effect. The micro-PK performance in our study is based on QRNG outputs that involve a true random mechanism.

In any textbook of statistics, the core example of statistical independence is true random events. Regardless of whether different random events are produced by different individuals or by the same individual, they are always considered to be statistically independent. Thus, in theory, one should assume a priori that such measurements are statistically independent. Otherwise, the a priori assumption of statistical dependence between truly random events would not only a priori claim the existence of micro-PK, but would also, in the case of using quantum-based RNGs, question the validity of the Bell theorem and lead to violations of the locality assumption in macroscopic domains. This in turn would make it impossible to document objectively (for which locality would be required) the existence of any effects under study. In other words, the empirical documentation of micro-PK effects to accepted scientific standards would become impossible or even unnecessary, since the effect to be demonstrated is already defined a priori as existing.

Despite this theoretical paradox, which we encounter when the statistical dependence of true random events is postulated a priori, let us assume for a moment that Bancel's argument is valid. Our theoretical background is consistent with his view. We assume that micro-PK exists and that it affects our three different micro-PK results. Furthermore, since the three PT groups are empirically correlated, the three micro-PK measures may (or may not) also be related in some way. If they were related, they would have to be considered statistically dependent and multiplicity controls would have to be performed. Thus, Bancel's argument is empirical rather than theoretical. To address this empirical argument, we will next provide empirical tests of the statistical independence of our three micro-PK measures. If the three measures were statistically independent, then an above-chance score (hit) or a chance and below-chance score (miss) on one of the tests should be indicative of a hit or a miss on the other tests. We tested this assumption with three separate Pearson's chi-squared tests of independence. The results indicated that the likelihood of scoring a hit or a miss was not significantly associated with any outcome (hit or miss) on the other tasks (dependent vs. avoidant χ^2 (1, N = 2,403) = 0.43, p = .51; dependent vs. obsessive-compulsive χ^2 (1, N = 2,403) = 1.08, p = .30; avoidant vs. obsessive-compulsive χ^2 (1, N = 2,403) = 0.13, p = .72). These analyses indicate that hits or misses are completely randomly distributed across the three tasks and they empirically document that statistical independence can be assumed between the three micro-PK tasks. The power to detect even small violations (w = .1) of statistical independence was 99% in each χ^2 test.

Since statistical independence exists across the three micro-PK measurements multiplicity control for our Bayesian tests did not need to be performed (Sjölander & Vansteelandt, 2019) and the strong Bayesian evidence (BF_{10} > 10) reported for the micro-PK effect found within the dependent PT-group can still considered to be valid.

Finally, if one still prefers to maintain the statistical dependence assumption, one needs to perform multiplicity controls, and these would affect expectations about the prior model probabilities. One possibility is to adjust the model probabilities in such a way that not each (of the three) null hypotheses has a probability of ½ (leading to the a priori statement that the probability of finding no effect in all three tests is $½^3$= .125), but that the total prior probability of finding no differences in all three tests combined is ½ (null control method; Williams et al., 2016). Following de Jong (2019), this could be achieved by changing the prior model probability for the H_0 from 0.5 to $0.5^{¾}$ = 0.63 (see Westfall et al., 1997). It is important to note that this does not change the individual Bayes factors for each test, but changes the posterior probability of an effect when considering the entire study by a factor of 0.37/0.63=0.59 as seen in (1).

$$\frac{P(H_1|D}{P(H_0|D} = \frac{P(H_1)}{P(H_0)} \times \frac{P(D|H_1)}{P(D|H_0)} (1)$$

$$Posteriorodds = Priorodds \times BF$$

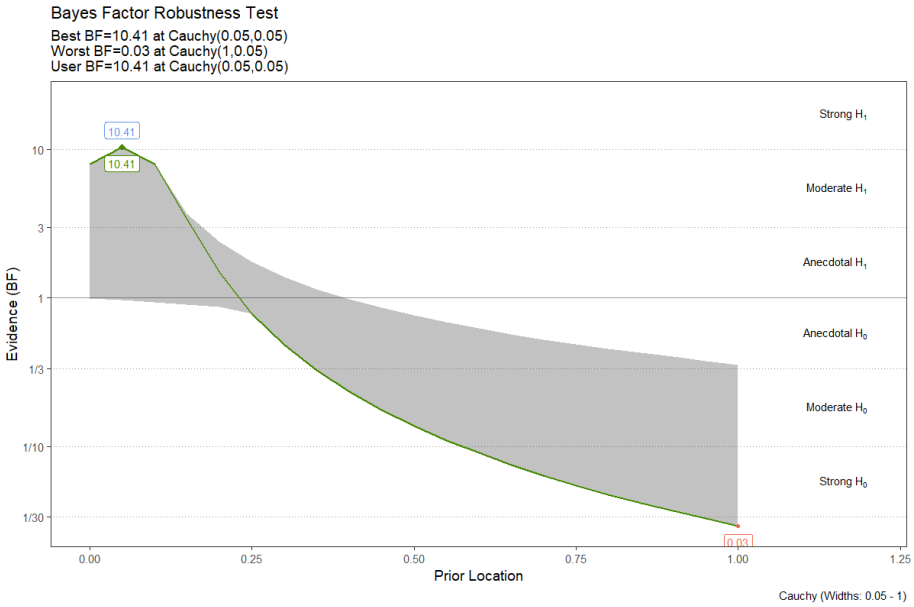
2. Lack of Context for Bayesian *t* Tests

Bancel emphasizes the importance of conducting sensitivity checks in Bayesian analysis, especially when using informed priors and dealing with small effects. He argues that an a priori justification for the prior based on the results of previous studies does not justify overlooking the sensitivity of the results to parameter choices, and links this issue to experimenter psi in psi research. We agree that the choice of the prior involves a degree of freedom for the experimenter. In Bayesian analysis, this is considered a strength, since it is advantageous to specify a test for the expected effect directly. It is therefore good practice to use these features of Bayesian statistics when they can be applied with some confidence. This is the case here, as we had a fairly certain expectation of the expected effect size for this type of micro-PK experiment based on previous studies and the literature. This deliberately translated expectation was pre-registered a priori, eliminating the degree of freedom in the analysis, and was ultimately confirmed by parts of the results of the study that showed an effect size of *d* = .07, which fits well with our a priori estimate.

Not surprisingly, a sensitivity analysis shows that this effect is not very robust to parameter changes (see robustness analysis in fig. 1 below). This is to be expected, since a very small effect can only be detected with a reasonable sample size if the test used is sensitive to that effect size. This is partly why we prefer Bayesian methods in this line of research, and is not a problem as long as the parameters are registered in advance.

Figure 1

Robustness analysis of the effect in the dependent sample. It can be seen that the BF has its highest value for the a priori chosen informed Cauchy parameters. The evidence transitions into pointing towards H0 for a very narrow prior (green line) at around Cauchy(0.25, 0.05). The gray area shows the BFs for different prior widths.



3. An Undetermined Type I Error Rate of the Primary Hypothesis

Bancel criticizes a lack of discussion of the study's false positive error rate (FPE) and its relation to a frequent testing of sequential evidence. He argues that the three tests are interdependent and therefore the FPE in this case is approximately 15%. We appreciate the effort put into the false positive error rate (FPE) analysis. Bancel cites Schönbrodt and Wagenmakers (2018), who provide a simple way to calculate the FPE in Bayesian designs and provide comparable but slightly lower results. This analysis shows an FPE of 3.8% for a sequential design with n-start = 100, n-max = 1,400, and a step size of 10 participants, which are conservative estimates. This shows that the alpha error for each test is well below the generally accepted threshold of .05.

Following the argument above that the data (the micro-PK trials corresponding to the specific personality trait) of the three tests are independent, it is not necessary to control for the experimental error rate (EER), which is typically done with corrections when testing multiple frequentist comparisons simultaneously. The power of each test is not affected by the outcome of the other tests, and the stopping criteria are based on each test individually reaching a specific BF threshold, not on a combination of tests. Therefore, the Type I error rate remains as reported for each hypothesis evaluated individually.

It can also be seen that the FPE changes only slightly with different step sizes (i.e., test intervals), and that the sequential Bayesian designs are usually quite robust to over-testing errors when a minimum N is used for the first test (e.g., changing the step-size to 50 reduces the FPE to 2.8%).

4. Failure to Follow the Pre-Registered Procedure

Bancel criticizes a deviation from the pre-registered stopping rule during data collection, leading to an undefined degree of experimenter freedom in the protocol. Specifically, the data collection was not stopped when the BF > 10 criterion was met for the first time.

We agree that some deviations from the pre-registered protocol were made. All deviations are explicitly mentioned in the original article. However, they do not compromise the evidence of the studies, since Bayesian evidence only becomes more precise as more data are added. According to the protocol, data collection should have stopped when the evidence criterion of BF > 10 was reached for the first time at n = 820. In the analysis process, we missed this exact point and observed a decrease in evidence shortly thereafter. Therefore, we decided to collect more data until a conclusive result was reached, as suggested by Schönbrodt et al. (2017). In Bayesian statistics, it is always possible to continue collecting data while updating the data analysis, as Bayes factors are consistent because they converge either to zero (if H_0 is true) or to infinity (if an effect is present) for one-tailed designs (Bayarri & Berger, 2004; Morey & Rouder, 2011). Schönbrodt et al. (2017) showed that sequential Bayesian designs have a lower long-term rate of misleading evidence than frequentist procedures with 5% Type I and 20% Type II error rates, while most errors occur at small sample sizes. Unlike p-values, the interpretation of Bayes factors does not depend on stopping rules (Rouder, 2014). Therefore, adding data to a Bayesian analysis is never an issue, and stopping criteria are rather a means to design studies efficiently. This was the case here, and the stopping rule of N = 1,000 participants in the absence of evidence was implemented for economic reasons. With the narrowly informed prior we chose, obtaining strong evidence for H_0 would require a very large sample size. At the time we uploaded the pre-registration, our resources were limited to 1,000 participants. As the process progressed, more resources became available to continue data collection beyond N = 1,000.

Furthermore, we never intended to perform a frequentist overall test of the three micro-PK tasks. Instead, we view them as three independent experiments, each with its own independent and dependent variables. This was emphasized in the pre-reg-

istration form, which allowed us to stop data collection as soon as any of the three experiments reached our statistical evidence criterion. It is up to the research community to continue data collection if they are interested.

5. Inadequate Treatment of the Control Group Analysis

Finally, Bancel notes the lack of a direct comparison between the target and control groups and criticizes the use of one-tailed tests for the former and two-tailed tests for the latter, which makes the tests inappropriate for comparison. As explained in the pre-registration form, we deliberately chose a one-sample *t*-test design against the expected value under chance rather than a direct group comparison for theoretical reasons. Our main point is not that the two groups are different, but that there is a micro-PK effect due to intentional observation within the PT-high group.

The group split can be seen as a sample pre-selection of individuals with pronounced traits (PT-high groups) that favor the micro-PK effect. A direct comparison of the groups is not meaningful, because the chosen splitting criterion is based on a continuous measure (VDS-30 questionnaire). Therefore, it is possible that the control group also shows (weaker) micro-PK effects in the same or in the opposite direction as the experimental group, since they can also be considered as motivated observers. Consequently, a two-tailed *t*-test was performed for the control group, since a non-random, less-than-chance result does not fit H_0 either. In contrast, the hypotheses for the experimental group were formulated as one-tailed, following the predictions of the Emotional Transgression Model as our theoretical background. Note that the group differences are not explained by the one-tailed vs. two-tailed setting variation, which can be checked with the data set and analysis scripts provided at OSF.

In summary, some of the criticisms in the comment are valid, but we disagree with the conclusion that they lead to nonconfirmatory results and reduce the significance of the strong evidence for the micro-PK effect found in one of the three experiments. Note that the analyses of all PT-high data suggested by the author of the comment yielded $p = .06$, which just barely exceeds the convention of .05. As noted in the Discussion section of our paper, further analyses of the combined score of the three tasks will be included in another paper we are currently working on. In addition, we disagree that the citation of "Jahn et al. (2000)" was misused in our paper. We mentioned this study as an example of an initial micro-PK effect that could not be replicated. However, our claim was not that the replications failed due to a decline effect. Moreover, we believe that such minor complaints should be part of a review process rather than raised in a comment.

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Response au Commentaire sur Jakob et al.: How to Read a Paper (Comment lire un article)

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Résumé: Nous remercions Peter Bancel d'avoir souligné les forces et les faiblesses potentielles de notre étude et d'avoir examiné en profondeur les méthodes appliquées afin d'améliorer notre compréhension de l'effet rapporté et de soutenir les futures tentatives d'étude scientifique des effets des micro-PK. De nombreux arguments avancés dans le commentaire méritent un examen plus approfondi et nous apprécions la discussion soulevée par Bancel, mais nous ne sommes pas d'accord avec les principaux points de sa critique. Dans ce qui suit, nous abordons brièvement les principaux arguments avancés à l'encontre de notre stratégie d'analyse et de notre interprétation des données, et nous présentons notre point de vue sur la question.

Translation into French by Antoine Bioy, Ph. D.

Antwort auf den Kommentar zur Jakob et al.: Wie man eine Arbeit liest

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Wir danken Peter Bancel für das Aufzeigen möglicher Stärken und Schwächen unserer Studie und für die intensive Überprüfung mit den angewandten Methoden, um unser Verständnis des berichteten Effekts zu verbessern und zukünftige Versuche, Mikro-PK-Effekte wissenschaftlich zu untersuchen, zu unterstützen. Viele der in dem Kommentar vorgebrachten Argumente verdienen eine eingehendere Prüfung, und wir schätzen die von Bancel geführte Diskussion, stimmen aber nicht mit den Hauptpunkten seiner Kritik überein. Im Folgenden gehen wir kurz auf die zentralen Argumente ein, die gegen unsere Analysestrategie und unsere Interpretation der Daten vorgebracht wurden, und legen unsere Meinung dazu dar.

Translation into German by Eberhard Bauer, Ph. D.

Resposta ao Comentário sobre Jakob et al.: Como Ler um Artigo

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Resumo: Agradecemos a Peter Bancel por destacar os potenciais aspectos positivos e fragilidades de nosso estudo e pela rigorosa análise dos métodos aplicados, visando melhorar nossa compreensão acerca do efeito relatado e apoiar futuras tentativas de estudar cientificamente os efeitos micro-PK. Muitos argumentos apresentados no Comentário merecem uma análise mais profunda, e agradecemos a discussão levantada por Bancel, porém, não concordamos com os principais pontos de sua crítica. A seguir, abordamos brevemente os argumentos centrais sugeridos contra nossa estratégia de análise e nossa interpretação dos dados e apresentamos nossa visão sobre o tema.

Translation into Portuguese by Antônio Lima, Ph. D.

Respuesta al Comentario sobre Jakob et al.: Cómo Leer un Artículo

Marissa-Julia Jakob Moritz C. Dechamps Markus A. Maier

Resumen: Damos las gracias a Peter Bancel por señalar los posibles puntos fuertes y débiles de nuestro estudio y por el examen intensivo de los métodos aplicados con el fin de mejorar nuestra comprensión del efecto mencionado y apoyar futuros intentos de estudiar científicamente los efectos micro-PK. Muchos de los argumentos expuestos en el comentario merecen un examen más profundo y agradecemos el debate planteado por Bancel, pero no estamos de acuerdo con los puntos principales de su crítica. Abordamos brevemente los argumentos centrales aportados contra nuestra estrategia de análisis y nuestra interpretación de los datos y presentamos nuestra opinión al respecto.

Translation into Spanish by Etzel Cardeña, Ph. D.

5. Research Paper 3 (Preprint):

Spooky Actions Cannot Be Tricked:

Exploring the Nature of Micro-Psychokinesis with Higher-Level Analytical Strategies[1]

Jakob, M. J.*, Dechamps, M. C.*, & Maier, M. A. (2024, June 8). Spooky actions cannot be tricked: Exploring the nature of micro-Psychokinesis with higher-level analytical strategies. DOI: 10.31234/osf.io/j6euv[2]

[1] *Shared first authorship

[2] Preprint, full text can be retrieved from osf.io/preprints/psyarxiv/j6euv

6. Overall Discussion

6.1. Summary and Interpretation of the Empirical Findings

The aim of this dissertation was to investigate mind-matter-interactions during intentional observation of quantum randomness processes as an empirical contribution to the mind-body problem (see e.g., Brüntrup, 2018) by means of three highly-powered micro-PK studies. Starting from quantum-based models of psychophysical substance dualism as a theoretical framework, i.e. the UMM (see Atmanspacher et al., 2013; Atmanspacher, 2014) and its mathematical formalization by the GQT (e.g., Filk & Römer, 2011; Atmanspacher et al., 2002), we expected participants' affectively laden core beliefs to form entanglement correlations with the outcomes of a QRNG during the observation of the measurement process. Thus, we predicted deviations from the randomness distributions produced by the QRNG for participants whose subconscious motives were addressed by the stimuli used in the respective micro-PK task. In contrast, no significant deviations from quantum randomness were expected for subjects without the corresponding PTs. Furthermore, we expected the direction of intentional agency's influence to be directly dependent on the emotionally coded information of observers´ intentions, following the predictions of the ETM.

In Study 1, participants were sequentially presented with neutral vs. positive or negative stimuli on a screen, each of which represented a tendency towards approach or avoidance, respectively. Specifically, three micro-PK tasks were designed to represent the psychological basic needs attachment, self-esteem protection, and control. According to their perceived incongruence of these basic needs, subjects were divided into a High Incongruence (HI) group and a Low Incongruence (LI) group. In sum, for the self-esteem protection task, our criterion for confirming H_1 (BF = 10) was reached within the HI group. Participants who were unable to adequately avoid everyday experiences that reduce their self-worth were presented more derogative target words by the QRNG during the experiment than expected under chance. For

the attachment and the control micro-PK task, anecdotal evidence for H_0 was found within the respective HI subgroups against our assumptions. As predicted, no micro-PK effects were detected within any of the LI groups. To take into account the well-known phenomenon of declining evidence within micro-PK research, we did not stop data collection when the evidence criterion for the self-esteem protection task was reached, but continued data collection and tested the systematic trend in the data against chance fluctuations with further post-hoc CoE analyses in comparison to 10,000 simulations. Within the HI group, a decline to a final result of anecdotal evidence for H_1 occurred, shortly after the evidence criterion was reached. Still, the CoE analyses indicated that the HI subsample's data differed significantly from chance fluctuations, whereas the LI group's data did not. We interpreted these results as confirmation of the assumptions made by the ETM: Implicit motivational tendencies can bias quantum randomness during intentional observation when precisely triggered by an adequate micro-PK task. Furthermore, we concluded that the effects of such ICs show volatile evidential patterns due to their elusive nature, but are yet statistically detectable by means of CoE analyses.

In Studies 2 and 3, participants attentively observed the onscreen presentations of neutral vs. meaningful sentences, reflecting the typical anxieties of Cluster C's PTs—dependent, avoidant, and obsessive-compulsive. For each of the three traits, participants were divided into a PT-high and a PT-low group.

For Study 2, we expected strong evidence at least for one out of three experiments. Within the dependent PT-high group, our prediction was confirmed ($BF \geq 10$). Participants scoring high on the dependent PT observed more target stimuli related to the fear of abandonment and loss in relationships than chance suggested. These findings can be considered to support the ETM according to which individuals´ subconscious, fearful expectation of losing security and support in relationships increase the likelihood for corresponding experiences to happen on a macroscopic level. However, anecdotal evidence for H_0 was found in the other two

PT-high groups (avoidant and obsessive-compulsive). According to our predictions, no significant effects were detected within any of the PT-low groups.

In Study 3, we reported an additional post-hoc re-analysis on a first subsample of the data from Study 2. Since, in clinical research, the three PTs are usually clustered due to their similar characteristics and showed high intercorrelations within our own data, we conducted further analyses with the combined score of the three PTs as an independent variable. The analyses yielded strong evidence for H_1 within the PT-high group, which declined to a final outcome of moderate evidence for H_1. Moreover, CoE analyses differed significantly from a simulated data set in all three measures, indicating that the evidential pattern of the empirical data is highly unlikely due to chance fluctuations. No deviations from chance were observed within the PT-low group. To take into account the outlined reproducibility issue, we decided to conduct a preregistered replication attempt of the post-hoc analysis. As a solution to the assumed elusive nature of ICs according to the MPI (von Lucadou et al. 2007; von Lucadou, 2006; 2015) on the one hand and the objective standards required by natural science practice on the other, we applied a variant of HLASs as proposed by Dechamps and Maier (2019). We did not expect to replicate total deviations from chance, but rather the non-random pattern of evidential change of the sequential BF characterized by an initial effect ($BF_{10} \geq 10$) and a subsequent decline ($BF_{10} \leq 3$) within the PT-high group. Moreover, we predicted to reproduce the significant outcomes of all three CoE analyses for the target group, but not for the control group. As a final outcome, the PT-high group only showed anecdotal evidence for H_1, while none of the three CoE indicators of the empirical data set differed significantly from the simulations. As predicted, no significant deviations from chance were found for the PT-low group. In conclusion, the replication attempt by means of HLASs failed.

In sum, Study 1 and 2 showed significant effects of different PTs indicating the influence of observers' pre-conscious motivational states on deviations from quantum

randomness, at least for a certain period of data collection. Thus, the results support interpretations of quantum mechanics suggesting an intentional observer to influence quantum probabilities (e.g., Mensky, 2014; Penrose & Hameroff, 2011; Stapp, 2007) by making an outcome more likely than predicted by the Born rule (see Born, 1926). Furthermore, our findings align well with the mentioned versions of quantum-based psychophysical substance dualism locating mind-matter interactions on a common pre-conscious and pre-material realm of reality. As suggested by the ETM, in Study 1 and 2, affectively laden expectations grounded in implicit core beliefs increased the likelihood for the respective outcomes to happen on a macroscopic level. In consequence, such experiences further confirm individuals' core beliefs about behavioral outcomes according to their PTs, leading to fearful expectations and therefore to experiencing more fear-confirming realities like a self-fulfilling prophecy. Therefore, these findings support the idea that intentional agency influences reality creation during quantum measurement, resembling the results of previous micro-PK studies such as Maier and Dechamps (2018), Stanford (1976), and Stanford et al. (1975).

Also, the post-hoc re-analysis reported in Study 3 revealed an initially strong, even though instable, micro-PK effect according to the predictions of the ETM. Exploratory CoE analyses enabled us to discriminate the experimental data pattern from simulations, although evidence decreased over data collection after the significance criterion was reached. However, the findings of Study 3 could not be reproduced within a preregistered replication attempt like in numerous previous studies (e.g., Dechamps et al., 2021; Dechamps & Maier, 2019; Jahn et al., 2000). Similar to Study 3 reported in Dechamps et al. (2021), the replication attempt by means of CoE analyses as one variant of HLASs failed. In consequence, this approach does not provide reproducibility on a higher level of analysis. As well, another type of HLASs—the Correlation-Matrix Method (CMM)—proposed by von Lucadou (2006), was not able to circumvent a decline of evidence within the confirmation process. Although the first replication

attempt with this approach was successful (von Lucadou, 2006), three following independent direct replications failed (see Walach et al., 2019; 2021). In conclusion, none of the HLASs proposed so far resulted in reproducible micro-PK effects. Thus, a possible conclusion is that any attempt at systematic reproduction of micro-PK effects must lead to declining evidence at some point in the process, as it increases the confirmatory strength and therefore violates the no-signal theorem. The concept of replication in natural sciences refers to the investigation of stable, local and causal effects (Walach et al., 2021). However, ICs are defined as lawful but non-local and acausal by nature according to the MPI. In consequence, no type of HLASs can circumvent these principles to fulfill the demand for direct replications of micro-PK effects. Nevertheless, as outlined above, it is indispensable for psychology to resign from studying mental phenomena involving subjective meaning. Therefore, further research in this field should accept the limits of objectification investigating ICs. Recently, Maier et al. (2022) have made progress by conducting a pre-registered micro-PK study, systematically varying the degree of objectification in applied measurements (participants' subjective memory vs. computer-stored objective data). According to their predictions, participants biased the QRNG output along their preconscious intentional states within the experimental condition in which only the reported subjective memory was analyzed and the objectively measured data set was deleted. No effects were found for the computer-stored data. These results can be considered as first evidence for a transfer of pragmatic information during intentional observation under reduced scientific objectification. In conclusion, this "Sobjective" approach should be continued within future research projects to further investigate the true nature of mind-matter interactions.

6.2. Limitations

A major limitation concerning Study 1 and 2 is that only one out of three micro-PK experiments each yielded the predicted outcome. Concerning Study 1, this can be plausibly

explained by the different design characteristics of the three micro-PK tasks, i.e. concerning stimulus material (words vs. pictures) and instructions (attentive observation vs. key pressure). Accordingly, we came to the conclusion that attentive observation of word-stimuli is most capable to precisely trigger PT-related ICs according to the predictions of the ETM. Therefore, in Study 2, all three tasks were designed in a similar fashion using word-based stimuli derived from the items of the scales for Cluster C´s PTs given by the VDS-30 questionnaire (Sulz, 2000). Nevertheless, it cannot be excluded that, also in Study 2, features of sub-optimal target sentences among other unknown reasons determined the absence of micro-PK effects in two of the three HI groups. Moreover, one could speculate that sentences referring to the dependent PT are associated with particularly strong affectively laden motives according to the well-established "need to belong"-theory by Leary & Baumeister (1995), supposing that the wish to be part of the social community is innate and universal in human beings. The authors assume that this need originated from phylogenetic development, as close relationships among humans provided evolutionary advantages. Therefore, the fear of the former life-threatening social exclusion might be intense and deeply anchored within the UMM and might therefore have the potential to form strong ICs when triggered by a respective micro-PK task. However, the three PTs themselves do not seem to represent the investigated construct ideally. Consequently, we decided to perform a post-hoc re-analysis with the combined score for PTs of Cluster C as an improved indicator reported in Study 3.

Furthermore, the analysis process was unmasked, while data were checked on a regular basis following a Bayesian approach. Thus, observer effects of the experimenters cannot entirely be excluded. Data analyses might be considered as observation on a higher level as an interim outcome with a certain degree of evidence for or against the analyst's hypotheses involves personal meaning. Thus, experimenters' expectations themselves might form an IC biasing the likelihood of a certain result along with their own belief in micro-PK (see Rabeyron,

2020). Concerning all three studies presented herein, our research group was characterized by a moderate belief in micro-PK effects. Accordingly, experimenter psi effects could have unconsciously biased the studies´ outcomes. However, this possibility does not diminish the evidence for a micro-PK effect but limits the interpretability of the results concerning conclusions about the relationship between micro-PK effects and participants' PTs.

Another limitation of the generalizability of the outcomes is that all interpretations must refer only to the group level, i.e. the population of individuals with a certain shared motivational pattern, such as HI in the basic needs or pronounced PTs. The studies' findings indicate, that such subgroups might have a higher overall probability to attract events that match their shared affectively laden expectations. As the observed evidential patterns over data collection suggest entanglements between participants' outcomes, predictions on an individual level are not permissible so far. Thus, single case design studies are needed to validly generalize the results for application on a personal level, e.g., in the field of clinical psychology. However, first studies have already indicated that intentional observer effects also apply to individuals (personal communication).

Last but not least, there is still a lack of sufficient reproducibility of the findings presented herein. For Study 1 and 2, experimental replication was not conducted. In Study 3 replication by means of HLASs was attempted but failed. Against our expectations, CoE analyses did not enable the reproduction of stabile micro-PK outcomes on a higher level. Further research is needed to account for the question whether the results presented herein are robust and objectifiable. Therefore, according to the current standards of empirical science, a careful interpretation of the results is necessary at this point.

6.3. Future Directions and Implications

On the whole, our findings suggest that an influence of intentional observations on macroscopic reality formation during quantum measurement processes is possible consistent

with previous studies (e.g., Maier & Dechamps, 2018; Stanford, 1976; Stanford et al., 1975). Thus, this project provides empirical contributions to the measurement problem arising from quantum mechanics, which has so far been discussed mostly theoretically. Consequently, the results advocate an extension of the Born Rule for the case of observers with intentional agency, including the role of subjective meaning. Therefore, quantum-based models of psychophysical substance dualism like the UMM (see Atmanspacher, et al., 2013; Atmanspacher, 2020) and the GOT (Atmanspacher et al., 2002; Filk & Römer, 2011) are substantiated by the data presented herein. These theories of mind-matter interaction also stress the non-local and acausal nature of ICs. According to the MPI (Lucadou et al., 2007), such effects cannot be stable and reproducible due to the laws of physics. In line with this verdict, the CoE analyses applied herein as one type of HLASs (see also Dechamps & Maier, 2019) failed to replicate the micro-PK effect. Nevertheless, CoE analyses can be considered as useful tools to discriminate systematic patterns of effect and decline from random fluctuations and therefore provide important additional information for investigating volatile effects. To reproduce ICs' experimental effects, alternative methods like the "Sobjective" approach suggested by Maier et al. (2022), which reduce the degree of objectivation within micro-PK studies, seem more fruitful. To follow this new path, psychological research has to let go of the idea of full objectification. The reduction of scientific knowledge to the purely objectively measurable has brought research very far. However, it has reached its limits as standard approaches provide insights from a narrow perspective on reality, but cannot shed light on the whole truth. Quantum randomness is a well-proven, valid physical law that applies in most cases (Bell, 1964; Greenstein & Zajonc, 2006) as long as observers do not have intentional agency. Subjective experience is per definition an essential part of psychology and therefore needs further investigation. If the current methods do not allow this adequately, one should consider other ways. Approaches complying to the true nature of mind-matter-interactions require theoretical frameworks open to quantum-based models of psychophysical substance dualism as well as the

development of research methods involving “Sobjectivity”. This does not diminish the value of common objective standards in natural science. Rather, subjectivity and objectivity should be considered as two sides of the same medal. Instead of rivalry, different procedures should be regarded as complementary to each other.

Furthermore, future research projects should focus on the implications of ICs on individuals (not only groups with certain shared PTs) to harness the insights about mind-matter interactions. Therefore, single-case micro-PK designs and intervention studies are needed to explore whether processes of emotional transgression during reality creation can be influenced on an individual level. If ICs are further confirmed at the individual level and the evidence for the ETM is corroborated in future research, this might have an impact on many disciplines, among them, clinical psychology. To take a speculative look into the future of psychotherapy: Possibly, ICs are part of the “missing link” (see Kiesler, 1966) and can therefore help to improve the understanding of therapeutic processes. If individuals influence the emergence of a reality that features their goal-orientations (see Maier et al., 2022) and thereby confirm their inner core beliefs again and again like a self-fulfilling prophecy, psychotherapy could help to identify the underlying mechanisms described by the ETM, and offer tools to modify the relevant maladaptive PTs. In consequence, such changes in patients’ basic assumptions could lead to different predispositions of their superposition-like unconscious mental states within pre-reality, which may in turn influence the Born rule by increasing the probability for corresponding physical outcomes. In this way, patients could escape from the pathogenic vicious circle of negative expectations and belief-confirming events into an upward spiral of personal growth by new, positive learning experiences. In the following section, examples of how interventions could address the ETM in the therapeutic process are given for each of the three psychotherapy treatments approved in Germany—Psychodynamic, Systemic and Cognitive-Behavioral Psychotherapy:

Psychodynamic approaches were developed as a procedure to make unconscious motives and feelings transparent in the therapeutic process. The therapists' abstinent, neutral attitude towards the patient and their equilibrated attention to all verbal expressions provide ideal conditions to freely associate whatever comes to the mind (see Bion, 1970/1977). This helps the unconscious to express itself during the psychotherapeutic process. The requirements of this setting could be used to identify the ETM's key processes, comprising implicit motives (see Maier et al., 2018; 2022) and the respective unconscious affectively laden expectations (not solely the conscious deliberate intentions expressed by the patient in first place). Furthermore, Psychodynamic Psychotherapy provides strategies to analyze cyclical maladaptive relationship patterns based on the deeply-anchored assumptions about oneself and others (Strupp & Binder, 1984). This diagnostic tool describes circular dynamics, in which the patients' expectations are confirmed again and again due to reproducing similar social contexts by unconscious behavioral patterns. This aligns very well with the ETM describing a vicious circle of negative core beliefs and their reiterating confirmation by increased probabilities for corresponding events to happen in physical reality. Therefore, the analysis of central relationship conflict topics could be extended to describe individual emotional transgression circles. Speculating a bit further, the ETM's dynamics may be modified in the psychotherapeutic process, similar to inner conflicts, by consciously observing and reflecting the implicit motives behind certain behaviors. Understanding the development over the life span, starting from childhood, can enable patients to re-attribute their current feelings to biographical imprints and to disempower problematic experiences from the past. Thus, the emotional impact of certain appraisals reaching out to the UMM could be changed, causing a shift within the Born rule towards new, therapeutically valuable experiences.

Systemic Psychotherapy focuses on the relations between different elements of a client's system on the outside, like others or physical objects, and on the inside, such as motives,

feelings and different aspects of personality (for an overview, see Haken & Schiepek, 2006). Therapists are well aware that the process of observation itself already has the capacity to change the system. Accordingly, this approach fits to the concepts of quantum-based models of psychophysical substance dualism. The therapeutic process aims to identify and change the clients' narratives which stabilize the dysfunctional system (see e.g., Schlippe & Schweitzer, 2016). The self-fulfilling prophecies arising from a client's ICs based on the ETM could be described as such narratives. Systemic Psychotherapy offers tools to change the client's attitude towards the problem and the relevant elements of the system, often starting from a desperate view towards a solution-focused perspective (e.g., deShazer & Dolan, 2008). By creating positive, optimistic beliefs, corresponding feelings of hope instead of fear are supported (see Elliot, 2008). In consequence, approach-orientation is promoted, which might possess the capacity to transform reality creation by attracting helpful experiences according to the ETM (see also Maier et al., 2022).

Cognitive-Behavioral Psychotherapy originally focused on the impacts of cognitions on emotions and behavior. Therefore, proponents of the "Cognitive Turn" (see e.g., Bandura, 1994; Beck et al., 2010; Ellis, 1997) developed interventions like cognitive restructuring to modify dysfunctional inner core beliefs. In addition, the so-called "Third Wave" of Behavioral Therapy introduced techniques to involve emotional schemes and unconscious affective patterns (e.g., Linehan, 2007; Young et al., 2008). Especially the latter seem suitable for the ETM. Firstly, interventions could aim to identify and change the patients' inner core beliefs and the underlying processes of emotional transgression. In this regard, it is important not only to focus on conscious, automatic thoughts, but also to work out deeper, possibly unconscious cognitive-affective schemes to achieve a transformation in the associated ICs. Secondly, Cognitive Behavioral Psychotherapy could take the emotional impact of certain thoughts into account. One example is standard approaches like exposure to avoided feelings such as anxiety. As the

ETM claims fearful expectations to form ICs with the dreaded physical events, reducing the amount of experienced anxiety via habituation might enable patients to break through the vicious circle. Moreover, better emotional regulation abilities themselves might be helpful to gain more self-determination as solely the affective information of messages has the capacity to reach out to the UMM and influence reality creation. Another approach that has gained more and more importance in psychotherapy recently is mindfulness (see e.g., Linehan, 2007). By practicing mindfulness, patients learn to observe sensory impressions and mental processes like thoughts and feelings without judging them. Emotion theories, e.g., the peripheral theory of emotions by James (1884) and Lange (1885), assume that it is not the events themselves that trigger emotions, but that the interpretation of a situation and the resulting physical arousal is attributed to certain feelings. In consequence, automatic appraisal processes could be reduced, which would lead to fewer unintended emotional responses and thus in turn might help to avoid ICs confirming dysfunctional convictions.

In conclusion, our findings suggest that it is worthwhile to consider quantum-based models of psychophysical substance dualism in (psychological) research and to continue the investigation of mind-matter interactions empirically by means of intentional observation studies. A better understanding of ICs holds great opportunities for significant applications, e.g., in the field of clinical psychology. This includes diagnostic tools, interventions and the improvement of the credibility of treatments by determining the "missing link" (see Kiesler, 1966). From a wider, interdisciplinary perspective, it addresses the measurement problem as well as the "hard problems" of mind-matter interaction (see e.g., Chalmers, 1995; Shariff et al., 2008). This research project is an empirical contribution to the puzzle these big questions still pose to nowadays' science, and it will hopefully inspire more research to pursue this promising path.

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7. Deutsche Zusammenfassung

Die Psychologie ist definiert als Wissenschaft vom menschlichen Erleben und Verhalten. Der Begriff stammt aus dem Altgriechischen und bedeutet wörtlich „Lehre des Geistes“. Gegenstand psychologischer Forschung ist demnach die Psyche, die geistige Entität. Dabei unterscheidet der in dieser wissenschaftlichen Disziplin verbreitete cartesianische Dualismus (siehe Brüntrup, 2018) zwischen zwei unabhängig voneinander existierenden Substanzklassen: Materie („res extensa“) und Geist („res cogitans“). „Res extensa“ ist ausschließlich durch die Ausdehnung im Raum gekennzeichnet und kann durch die kausalen Beziehungen ihrer Elemente mathematisch vollständig beschrieben werden (Brüntrup, 2018). Im Gegensatz dazu bezeichnet der Begriff „res cogitans“ die denkende, zweifelnde, verstehende, bestätigende, widersprechende, wollende, ablehnende, phantasierende und wahrnehmende Entität. Descartes (1641) formulierte den berühmten Satz „Cogito ergo sum“ („Ich denke, also bin ich“). Auch wenn die Objektivität von Sinneseindrücken und die Gültigkeit bestimmter Gedanken angezweifelt werden können, beweist allein die Tatsache, dass der Mensch sich seiner selbst bewusst ist und somit die Fähigkeit besitzt, die Realität zu hinterfragen, unweigerlich seine Existenz.

Da mentale Prozesse also per Definition Gegenstand der Psychologie sind, muss im Gegensatz zu anderen Naturwissenschaften auch die subjektive Komponente des menschlichen Erlebens mitbedacht werden. Gleichzeitig versteht sich die Psychologie heute als empirische Wissenschaft, die nach objektivierbaren, reproduzierbaren Befunden strebt. In den letzten Jahren scheint sie allerdings an ihre Grenzen zu stoßen, da publizierte, signifikante Effekte in vielen Fällen nicht reproduziert werden konnten. Die Psychologie befindet sich also (neben anderen wissenschaftlichen Disziplinen) in einer Replikationskrise. Einer der Auslöser dieser Debatte war die Studie von Bem (2011), die Evidenz für Präkognition berichtete (siehe Rabeyron, 2020). Seitdem wurde eine Vielzahl von Artikeln zur Reproduzierbarkeit

empirischer Ergebnisse sowie zu skeptischen Betrachtungen der in der (psychologischen) Forschung angewandten Methoden veröffentlicht. Eine mögliche Ursache für das Ausbleiben der erwarteten Objektivierbarkeit von psychologischen Befunden könnte das Leib-Seele-Problem darstellen: In der Psychologie werden zumeist Wechselwirkungen zwischen Geist und Materie untersucht. Ausgehend vom cartesischen Dualismus stellt sich jedoch die Frage, wie zwei grundsätzlich verschiedene Substanzklassen miteinander interagieren können (siehe Brüntrup, 2018). Zusammengefasst gibt es dabei zwei Hauptprobleme: Das „harte Problem des freien Willens“, das sich damit beschäftigt, ob und wie mentale Zustände in physische Korrelate umgesetzt werden können (Shariff et al., 2008), und das „harte Problem des Bewusstseins“, warum und wie ein mit der äußeren, materiellen Realität übereinstimmendes Bewusstsein entstehen kann (Chalmers, 1995).

Eines der gängigen, dualistischen Modelle stellt die radikale Emergenz dar, die bidirektionale kausale Wechselwirkungen zwischen Geist und Materie annimmt. Sie geht davon aus, dass das Bewusstsein auf unerklärliche und unvorhersehbare Weise aus dem Zusammenspiel verschiedener materieller Elemente eines komplexen Systems wie den neuronalen Verschaltungen im menschlichen Gehirn hervorgeht. Das Konzept der radikalen Emergenz widerspricht jedoch dem „genetischen Argument“, das besagt, dass Elemente einer bestimmten Substanzklasse keine andere Entität mit essenziell verschiedenen Eigenschaften erzeugen können (Brüntrup, 2018). Die psychologische Forschung nimmt diese logische Schwäche häufig hin oder klammert die „harten Probleme“ der Geist-Materie-Interaktion gänzlich aus. Ein weiterer verbreiteter empirischer Ansatz ist der Physikalismus, der auf eine Unterscheidung zwischen Geist und Materie im Sinne des Dualismus verzichtet oder den epistemischen Fokus auf die „materiellen“ Dimensionen der Psychologie beschränkt (siehe Brüntrup, 2018). Ein traditionelles Beispiel ist der Behaviorismus (Watson, 1913), der dafür plädierte, menschliches Verhalten ausschließlich in Form von Reiz-Reaktions-Mustern zu erforschen und auf die introspektive Untersuchung mentaler Prozesse innerhalb des

Organismus (die so genannte „Black Box“) zu verzichten. Eine moderne Variante des Physikalismus stellt das neurowissenschaftliche Paradigma dar, das sämtliche mentale Prozesse auf Gehirnaktivitäten reduziert. Der Vorteil dieser Betrachtungsweise besteht darin, dass sie eine Objektivierung psychologischer Befunde gemäß naturwissenschaftlichem Standard ermöglicht. Im Gegenzug werden allerdings alle Aspekte der subjektiven Erfahrung von der empirischen Forschung ausgeschlossen, was Descartes' erkenntnistheoretischem Grundsatz „Cogito ergo sum“ nicht gerecht wird. Zudem ermöglicht dieser Ansatz nur einen begrenzten Erkenntnisgewinn, da selbst die vollständige Kenntnis aller neuronalen Funktionen die Frage nach der Entstehung des Bewusstseins nicht beantworten könnte (siehe Brüntrup, 2018).

In der modernen Psychologie sind trotz einer Vielzahl von Studien und theoretischen Konzepten die Mechanismen hinter vielen empirischen Befunden nach wie vor unbekannt. Selbst in der Psychotherapie, deren Wirksamkeit als hinreichend empirisch bestätigt gilt, sind die spezifische Wirksamkeit von Interventionen und die genauen Prozessvariablen bisher größtenteils unklar. Kiesler (1966) bezeichnete die fehlende Kenntnis darüber, wie genau psychische Entwicklungen in der Psychotherapie angestoßen werden, als das fehlende Bindeglied (engl. „the missing link“). Darüber hinaus werden in der Forschung immer wieder spontan auftretende Grenzphänomene beobachtet, wie z. B. Psi-Effekte, als bedeutungsvoll erlebte Zufälle oder außerkörperliche Erfahrungen, die durch rein reduktionistische Modelle der Psyche nicht erklärt werden können (Atmanspacher, 2020). Folglich kann der Physikalismus der Komplexität der menschlichen Psyche und damit der Psychologie als Wissenschaft vom menschlichen Erleben und Verhalten nicht vollständig gerecht werden.

Im Laufe der Zeit haben sich über unterschiedliche Disziplinen hinweg zahlreiche Vorstellungen über die Interaktionsweise von Geist und Materie entwickelt, die jeweils gewisse logische Stärken und Schwächen aufweisen. Darunter befinden sich u. a. Theorien des sogenannten Zwei-Aspekte-Monismus (engl. dual-aspect monism), die Geist und Materie als zwei verschiedene Aspekte eines gemeinsamen Ursprungs betrachten (siehe z. B.

Atmanspacher, 2014). Somit stehen die zwei essenziell verschiedenen Substanzklassen nicht in direkter Wechselwirkung zueinander, sondern sind indirekt über eine tieferliegende, gemeinsame Ebene miteinander verbunden. Eine Variante dieses Ansatzes, der psychophysische Substanzdualismus, nimmt an, dass Geist und Materie einem gemeinsamen, der Realität zugrundliegenden Potentialraum entstammen, in dem sie zunächst jeweils als Vorformen (vorbewusst und vormateriell) existieren, und sich erst durch Messprozesse als zwei getrennte Entitäten manifestieren. Die Vorstellung von einer solchen „Prä-Realität“ mag auf den ersten Blick gewagt erscheinen, ist allerdings ein etabliertes Konzept der Quantenmechanik. Dementsprechend geht die Quantenphysik davon aus, dass potenzielle Eigenschaften eines Quantenteilchens, wie z. B. dessen genaue Position im Raum, zunächst in einer Überlagerung aller potentiellen Zustände (Superposition) existieren. Erst durch den Akt der Messung wird eines der möglichen Ereignisse makroskopisch beobachtbar (siehe z. B. Greenstein & Zajonc, 2006). Daher bildet die Quantenmechanik den theoretischen Rahmen für moderne Versionen des psychophysischen Substanzdualismus wie das „Unus Mundus Modell“ (UMM; siehe Atmanspacher et al., 2013; Atmanspacher, 2020) und die „Generalisierte Quanten-Theorie“ (GQT; Atmanspacher et al., 2002; Filk & Römer, 2011).

Das so genannte Doppelspaltexperiment veranschaulicht die zentrale Rolle des Messvorgangs in der Quantenmechanik (siehe Greenstein und Zajonc, 2006): Bei diesem Versuchsaufbau werden Teilchen wie z. B. Photonen durch ein spezielles Gitter mit zwei Schlitzen auf einen fluoreszierenden Schirm geschossen. Nach den Gesetzen der klassischen Physik wäre zu erwarten, dass makroskopische Objekte mit gleicher Wahrscheinlichkeit einen der beiden Spalte passieren. Solange aufgezeichnet wird, welches Teilchen welchen Schlitz passiert, verhalten sich mikroskopische Teilchen wie makroskopische. Erfolgt allerdings keine Registrierung am Doppelspalt, erscheint auf dem Leuchtschirm ein wellenförmiges Interferenzmuster aus abwechselnden Minima und Maxima. Das bedeutet, dass mikroskopische Teilchen vor der Messung in allen potenziellen Zuständen gleichzeitig existieren. Dabei

beschreibt Schrödingers Wellenfunktion die Gesamtheit aller möglichen Quantenzustände über die Zeit (Schrödinger, 1935). Durch die Wechselwirkung mit einem anderen System, z. B. einem Beobachter[1], wird eine der möglichen Positionen des Photons gemessen. Es bleibt jedoch unklar, was genau zum Übergang des Interferenzmusters der Superpositionszustände zu einem konkreten Messergebnis führt (z. B. der reine Messapparat vs. das Bewusstsein des Beobachters), und was im Anschluss an die Messung mit den nicht beobachteten Überlagerungszuständen geschieht (Kollaps vs. Nicht-Kollaps der Wellenfunktion). Das so genannte „Messproblem“ in der Quantenmechanik geht also über rein physikalische Fragestellungen hinaus und reicht damit bis in die Disziplinen der Philosophie und Psychologie hinein.

Jedenfalls kann selbst unter konstanten Versuchsbedingungen keine genaue Vorhersage über das Endergebnis der Messung determiniert werden. Mithilfe der Bornschen Regel (Born, 1926) kann jedem Superpositionszustand eine Messwahrscheinlichkeit zugewiesen werden (quadrierte Amplitude der Wellenfunktion für den jeweiligen Quantenzustand). Die orthodoxe Quantenphysik geht davon aus, dass die Bornsche Regel dem Zufall folgt, so dass jedes mögliche Ergebnis mit gleicher Wahrscheinlichkeit gemessen wird und somit bei einer großen Anzahl von Versuchsdurchläufen gleich häufig auftritt (Bell, 1964; Greenstein & Zajonc, 2006). Innerhalb des physikalischen Fachbereichs erscheint diese Annahme plausibel, da Experimente in der Regel von neutralen Beobachtern durchgeführt werden. Für den Versuchsleiter hat der Ausgang einer Messung keinerlei persönliche Bedeutung. Im Feld könnte jede Person als motivierter Beobachter von Quantenmessprozessen verstanden werden, da reale Ereignisse unmittelbare Konsequenzen für das Individuum haben. Folglich wäre eine

[1] Aus Gründen der besseren Lesbarkeit wird im Text das generische Maskulinum verwendet. Sämtliche Bezeichnungen gelten jedoch im Sinne der Gleichbehandlung grundsätzlich für alle Geschlechter.

Erweiterung der Quantenmechanik erforderlich, um den Einfluss der subjektiven Bedeutsamkeit und ihre Auswirkungen auf die makroskopische Realität einzubeziehen.

Einige Autoren (z. B. Mensky, 2014; Penrose & Hameroff, 2011; Stapp, 2007) halten es in der Tat für möglich, dass ein bewusster Beobachter Einfluss auf die Quantenwahrscheinlichkeiten nehmen kann, wodurch ein Messausgang wahrscheinlicher wird als von der Bornschen Regel vorhersagt. So bieten beispielsweise die UMM (siehe Atmanspacher et al., 2013; Atmanspacher, 2014) und ihre mathematische Formalisierung durch die GQT (z. B. Filk & Römer, 2011; Atmanspacher et al., 2002) eine elegante Erklärung für psychophysische Interaktionen bei Quantenmessungen. Wie bereits erläutert nehmen diese Modelle eine gemeinsame, superpositionsartige Vorrealität von Geist und Materie an. Erst durch den Akt der Messung bzw. den Übergang von unbewusster Information zu bewussten Wissensinhalten erfolgt die Aufspaltung („epistemische Spaltung“; Atmanspacher, 2020) in die separaten Substanzklassen bewusste Erfahrung und klassische Materie. Von diesem Zeitpunkt an können Geist und Materie nicht mehr direkt miteinander interagieren, da sie sich als zwei essenziell verschiedene Substanzen manifestiert haben. Dennoch bleiben sie aufgrund ihres gemeinsamen Ursprungs miteinander verschränkt. Es werden zwei verschiedene Arten von Interaktionen zwischen Geist und Materie unterschieden:

Strukturelle Korrelationen (engl. Structural Correlations, SCs) umfassen Phänomene, bei denen klassische physikalische Ereignisse bewusst wahrgenommen werden. Sie sind unidirektional, da sich ein bestimmter Aspekt der Unus Mundus sowohl auf materieller als auch auf bewusster Ebene parallel abbildet. Dazu gehören z. B. klassische psychosomatische Phänomene wie erhöhter Blutdruck bei psychischem Stress (Atmanspacher, 2020). Der Geist agiert also reaktiv in einer passiven Beobachterrolle, die kein intentionales Zutun des Individuums erfordert (Maier et al., 2022). Daher folgen SCs beim Übergang von der gemeinsamen Vorrealität in die dualistische makroskopische Realität der Bornschen Regel und gelten als stabil und reproduzierbar.

Induzierte Korrelationen (engl. Induced Correlations, ICs) hingegen, beziehen sich auf bidirektionale Interaktionen von Geist und Materie. Sobald einem physisch beobachtbaren Ereignis durch das Individuum eine persönliche Bedeutung beigemessen wird, führt dies zu einer Veränderung im Bewusstsein des Individuums und wirkt sich damit gemäß dem UMM automatisch auf die gemeinsame Vorrealität aus, über die Geist und Materie weiterhin miteinander verschränkt sind. Diese Wechselwirkung des Bewusstseins mit der Unus Mundus beeinflusst wiederum die materielle Realität auf makroskopischer Ebene. Dies bedeutet, dass autonome Individuen über die Unus Mundus mentalen Einfluss auf die Realitätswerdung der Superpositionszustände ausüben können (siehe auch Maier et al., 2022). Somit führen ICs zu einer temporären Verzerrung der Bornschen Regel gemäß den motivationalen Tendenzen menschlicher Beobachter z. B. in Form von Grenzphänomenen der Geist-Materie-Interaktion wie bedeutungsvoll erlebte Zufälle. Pauli und Jung (siehe auch Atmanspacher et al., 2013) bezeichneten solche außergewöhnlichen Beziehungen zwischen Bedeutung und Zeit als „synchronistische Ereignisse“ und betonten damit die diffuse Natur dieser Effekte, die nicht den klassischen Prinzipien von Kausalität und Lokalität folgen. Im Gegensatz zu SCs werden ICs daher als nicht reproduzierbar angesehen.

Diese Annahme greifen von Lucadou et al. (2007) im „Model of Pragmatic Information“ (MPI) auf, nach dem die Neuartigkeit einer Beobachtung, die auf non-lokalen Verschränkungskorrelationen beruht, in einem komplementären Zusammenhang zu ihrer Bestätigungswahrscheinlichkeit steht (siehe auch von Lucadou, 2006; 2015). Die Autoren argumentieren, dass eine Verletzung der Bornschen Regel in der Quantenmechanik dem No-Signal-Theorem widerspricht, das besagt, dass pragmatische Information nicht schneller als Lichtgeschwindigkeit übertragen werden kann. Wäre es möglich, reproduzierbare und stabile Verschränkungskorrelationen zu erzeugen, könnten mit dieser Methode Nachrichten über weite Entfernungen schneller als Lichtgeschwindigkeit übertragen werden. Dieser Signalcharakter ist durch physikalische Gesetzmäßigkeiten untersagt, so dass solche Effekte bei kumulierender

Evidenz z. B. in Form von systematischen Replikationsstudien eines Experiments, zurückgehen müssen (Atmanspacher et al., 2002). Maier et al. (2018) führten diese Idee weiter aus, indem sie Parallelen zum zweiten Hauptsatz der Thermodynamik zogen, laut dem sich Entropie in geschlossenen Systemen ausbreiten muss, um sicherzustellen, dass keine Ordnung aus Chaos (bzw. Information aus Zufall) entsteht. Daher nehmen die Autoren einen systematischen Gegenmechanismus an, der die ursprüngliche IC eliminiert, solange ein Signalcharakter erkennbar ist, was im zeitlichen Verlauf der Datenerhebung zu einem oszillierenden Muster des Auftretens und Verschwindens eines Effekts über Studien und Teilnehmer hinweg führt. Diese Interaktion aus Effekt und Gegeneffekt bildet sich in einem spezifischen Verlauf der Evidenz über die Zeit ab, der systematisch erfasst werden kann.

Ein traditioneller experimenteller Ansatz zur Untersuchung des Einflusses intentionaler Beobachtung auf probabilistische Prozesse wie Würfeln, Münzwurf oder die Erzeugung einer Zufallssequenz mithilfe von Hardware-basierten Zufallszahlengeneratoren (engl. Random Number Generators, RNGs) wird als Mikro-Psychokinese (Mikro-PK) bezeichnet (siehe z. B. Jahn et al., 1987; Jahn & Dunne, 1997; Stanford, 1976; Stanford et al., 1975; Schmidt, 1974). Dabei werden üblicherweise Abweichungen vom Zufall mittels statistischer Methoden analysiert (Varvoglis & Bancel, 2015). Durch die Verwendung von quantenbasierten Zufallsgeneratoren (engl. Quantum Random Number Generators, QRNGs) ist es möglich, in jedem Versuchsdurchgang einen Superpositionszustand für binäre Quantenereignisse herzustellen (Maier et al., 2022). Jeder Quantenzustand führt potenziell zur Präsentation eines bestimmten Stimulus z. B. der Lichtkegel einer Lampe, der sich nach links oder rechts dreht (Schmidt, 1970), die Auf- und Abwärtsbewegungen eines Random-Walk-Graphen (Jahn et al., 1997) oder das Einblenden eines positiven oder negativen Bildes (Maier et al., 2018). Darüber hinaus unterscheiden sich Studiendesgins dahingehend, ob eine explizite oder implizite Instruktion zur mentalen Beeinflussung der Zufallsverteilung des jeweiligen Systems erfolgt.

Meta-Analysen kamen mehrfach zum Schluss, dass Probanden in zahlreichen Studien durch den bloßen Akt der Beobachtung der Ergebnisse des Zufallsprozesses Einfluss auf die produzierten Verteilungen des QRNG gemäß ihren bewussten oder unbewussten Intentionen nahmen (Bösch et al., 2006; Radin & Nelson, 1989). Darüber hinaus zeigten Varvoglis und Bancel (2015), dass der Publikationsbias eine unwahrscheinliche alternative Erklärung für Mikro-PK-Effekte darstellt, indem sie berechneten, dass dazu eine unrealistisch große Anzahl an unpublizierten, nicht-signifikanten Studien existieren müsste (siehe auch Radin et al., 2006). Allerdings fehlt es an erfolgreichen direkten Replikationen von Mikro-PK Experimenten (z. B. Dechamps et al., 2021; Jahn et al., 2000; Dechamps & Maier, 2019). Skeptiker argumentieren daher, dass es sich bei den initial beobachteten Effekten um falsch-positive Befunde oder um das Ergebnis fragwürdiger Forschungspraktiken (engl. Questionable Research Practices, QRPs; z. B. Wagenmakers et al., 2011; Alcock, 2003) handle.

Eine alternative Erklärung für initial beobachtbare Effekte und nachfolgende, gescheiterte Replikationsversuche kann aus dem MPI (von Lucadou et al., 2007) abgeleitet werden: Aufgrund physikalischer Gesetzmäßigkeiten muss es bei zunehmender Beweiskraft für ICs durch Replikationen zur Abnahme des Effekts kommen. An dieser Stelle besteht ein Konflikt zwischen der diffusen Natur von ICs und der empirischen Forderung nach Objektivierung von wissenschaftlichen Beobachtungen. Als Lösungsversuch bezüglich dieser Kontroverse schlug Rabeyron (2020) vor, die Daten bei der experimentellen Untersuchung von Grenzphänomenen u. a. in Hinblick auf ungewöhnliche Muster zu analysieren, um dadurch ein besseres Verständnis der wahren Natur von ICs zu erreichen (siehe auch Atmanspacher et al., 2002; von Lucadou et al., 2007; von Lucadou, 2015). So könnten Datensequenzen neben den üblicherweise erfassten durchschnittlichen Abweichungen von der Zufallsverteilung beispielsweise auf das von Maier et al. (2018) vermutete systematisch oszillierende Muster der Evidenz für den Effekt im Zeitverlauf mittels geeigneter statistischer Methoden untersucht werden.

Eine gängige Interpretation der in Mikro-PK Studien gezeigten Abweichungen vom Quantenzufall ist, dass Probanden alleine durch die Beobachtung von Messprozessen die Entstehung einer Realität begünstigen, die ihren Zielorientierungen entspricht (z. B. Maier et al., 2022). Basierend auf Modellen des psychophysikalischen Substanzdualismus argumentieren Maier et al. (2018), dass es sich dabei nicht um eine direkte Interaktion zwischen Geist und Materie handeln kann, sondern dass die Wechselwirkung gemäß dem UMM auf einer tieferliegenden, gemeinsamen Realitätsebene (vor-bewusst und vor-materiell) stattfinden muss. Sie gehen davon aus, dass ein bestimmter vorbewusster mentaler Zustand die Bornsche Regel dahingehend beeinflussen kann, dass die Wahrscheinlichkeit eines entsprechenden physikalischen Ereignisses nach der Messung erhöht wird, sodass für die Probanden bedeutsame Ergebnisse häufiger oder seltener beobachtet werden als per Zufall zu erwarten. Studien konnten zeigen, dass Mikro-PK Effekte auch bei Teilnehmern auftraten, die keine expliziten Instruktionen erhielten, willentlichen Einfluss auf die Zufallsverteilung zu nehmen (Stanford, 1976; Stanford et al., 1975). Daher ist anzunehmen, dass nicht die bewussten Absichten einer Person an sich, sondern in erster Linie deren implizite Motive ausschlaggebend für Mikro-PK Effekte sind (siehe Dechamps & Maier, 2019; Maier & Dechamps, 2018).

Die Richtung des Effekts intentionaler Beobachtung auf die Wahrscheinlichkeitsverteilung von Zufallssystemen kann mithilfe des Modells der Emotionalen Transgression (Emotional Transgression Model, ETM) hergeleitet werden. Das ETM erweitert die in diesem Forschungszweig etablierten Konzepte der Nicht-Intentionalität (Stanford, 1990) sowie der Zielorientierung (Schmidt, 1974) um die Annahme, dass die emotionale Konnotation von Zielsetzungen die Richtung des Effekts bestimmt. Die emotionale Interpretation hängt wiederum von den Erwartungen des Individuums hinsichtlich der Zielerreichung ab. Die Einschätzungen der Erfolgschance bzw. des Misserfolgsrisikos sowie die damit verbundenen Emotionen basieren auf impliziten Grundannahmen, die wiederum zu (automatischen) Bewertungsprozessen führen, die einem Ereignis eine persönliche Bedeutung

beimessen. Grundsätzlich lassen sich motivationale Tendenzen in Annäherungs- und Vermeidungsorientierung einteilen. Die entsprechenden Emotionen sind Hoffnung (Annäherung) auf positive Ergebnisse und Angst (Vermeidung) vor negativen Konsequenzen (siehe z. B. Elliot, 2008). Die Kernaussage des ETMs besteht darin, dass nur die emotional kodierte Information einer Zielorientierung (Angst oder Hoffnung) vom Bewusstsein in den Bereich der Prä-Realität vordringen und somit zu einer Wechselwirkung zwischen Geist und Materie führen kann. Wie eine selbsterfüllende Prophezeiung beeinflussen Individuen folglich ihre physische Realität entsprechend ihrer Erwartungen, die dadurch wiederum bestätigt und aufrechterhalten werden. Somit kann die Persönlichkeit eines Individuums, die die Grundüberzeugungen über sich selbst und andere sowie alle motivationalen Tendenzen umfasst, als eine Prädisposition der individuellen Superpositionszustände innerhalb der Prä-Realität betrachtet werden. Daher wurden in diesem Forschungsprojekt Zusammenhänge zwischen etablierten, messbaren Persönlichkeitsmerkmalen und durch das ETM vorhergesagten Abweichungen vom Quantenzufall während der intentionalen Beobachtung von Messprozessen untersucht.

Ziel dieser Dissertation war es, einen empirischen Beitrag zum Leib-Seele-Problem zu leisten. Dazu wurden drei präregistrierte, quantitative Mikro-PK-Studien an umfangreichen Stichproben durchgeführt, bei denen Probanden verschiedene von einem QRNG ausgewählte Stimuli auf einem Bildschirm präsentiert wurden. Die dargebotenen Stimuli wurden von den Teilnehmern entweder als neutral oder als emotional bedeutungsvoll in Hinblick auf ihre jeweiligen motivationalen Tendenzen erlebt. Zur Datenanalyse wurde ein Bayesianischer Ansatz gewählt, der es ermöglicht, die Plausibilität von Studienergebnissen zu bewerten und sequenzielle Evidenzverläufe abzubilden.

In Studie 1 repräsentierten positive und negative Stimuli (Annäherungs- vs. Vermeidungsorientierung) in Form von Wörtern oder Bildern die von den Teilnehmern wahrgenommene Inkongruenz bezüglich ihrer psychischen Grundbedürfnisse (Grawe, 1998).

Es wurde jeweils eine Mikro-PK Aufgabe für die Bedürfnisse Bindung, Selbstwertschutz und Kontrolle operationalisiert. Anhand der Werte im Inkongruenzfragebogen (Grosse Holtforth et al., 2004) wurden die Probanden in zwei Gruppen eingeteilt: Hohe Inkongruenz (engl. High Incongruence, HI) und niedrige Inkongruenz (engl. Low Incongruence, LI).

In Studie 2 und 3 wurde die Ausprägung der Persönlichkeitsstile des Clusters C—dependent, ängstlich-vermeidend und zwanghaft—mit dem VDS-30 Fragebogen (Sulz, 2000) erfasst. Als bedeutungsvolle Stimuli wurden entsprechend Sätze gewählt, die die für die jeweiligen Persönlichkeitsstile typischen Ängste (siehe Sachse, 2001) widerspiegeln. Für jeden der drei Stile wurden die Teilnehmer in eine Gruppe mit hohen (engl. Personality Trait-high, PT-high) und eine Gruppe mit niedrigen Werten (engl. Personality Trait-low, PT-low) eingeteilt. In Studie 2 wurde jedem der drei Stile eine Mikro-PK Aufgabe zugeordnet. Da die drei Persönlichkeitsstile aufgrund ihrer ähnlichen Merkmale in der klinischen Forschung zu einem Cluster zusammengefasst werden (APA, 2013) und sich in den Daten hohe Interkorrelationen zeigten, führten wir in Studie 3 eine zusätzliche Post-hoc-Re-Analyse mit einem kombinierten Index der drei Persönlichkeitsstile als unabhängige Variable an einer Teilstichprobe der Daten aus Studie 2 durch. Im Anschluss erfolgte ein präregistrierter Replikationsversuch der Ergebnisse der Post-hoc-Re-Analyse auf konfirmatorischer Ebene.

Basierend auf den angeführten quantenbasierten Modellen des psychophysischen Substanzdualismus, erwarteten wir in allen drei Studien, dass die emotional besetzten Grundüberzeugungen der Teilnehmer während der Beobachtung der Ergebnisse des Messprozesses Verschränkungen mit der Verteilung der vom QRNG ausgewählten Stimuluskategorien (bedeutungsvoll vs. neutral) bilden. Somit sagten wir für Probanden, deren unbewusste Motive durch die in der jeweiligen Mikro-PK Aufgabe verwendeten Stimuli angesprochen wurden (HI- bzw. PT-high-Gruppen), gemäß dem ETM gerichtete Abweichungen vom Erwartungswert der Zufallsverteilung des QRNGs voraus (Signifikanzkriterium: $BF_{10} \geq 10$; starke Evidenz). Im Gegensatz dazu wurden für Probanden

ohne entsprechende Eigenschaften (LI- bzw. PT-low-Gruppen) keine signifikanten Abweichungen vom Quantenzufall erwartet. In Hinblick auf das skizzierte Problem bezüglich direkter Replikationsversuche von ICs, wurde in Studie 3 eine indirekte Replikation mithilfe übergeordneter Analysestrategien (engl. Higher Level Analytical Strategies, HLASs) angestrebt: Anstatt ein signifikantes Endergebnis zu reproduzieren, lautete die Hypothese, dass sich das zuvor in der Post-hoc-Re-Analyse beobachtete charakteristische sequenzielle Muster in den empirischen Replikationsdaten wiederholt und sich signifikant von einem simulierten Datensatz unterscheiden lässt (siehe Dechamps & Maier, 2019). Dazu wurden in Zusammenarbeit mit Prof. Günter Schiepek (Institut für Synergetik- und Psychotherapieforschung) Change-of-Evidence (CoE)-Analysen entwickelt, mit denen der sequentielle Bayes-Faktor (BF) der empirischen Datensätze mit zufällig generierten Simulationen verglichen werden kann.

In Studie 1 wurde unser Signifikanzkriterium ($BF_{10} \geq 10$; starke Evidenz) für H_1 in der HI-Gruppe bei der Mikro-PK Aufgabe des Bedürfnisses Selbstwertschutz erreicht. Probanden, die im Inkongruenzfragebogen angaben, nicht in der Lage zu sein, selbstwertmindernde Alltagserfahrungen adäquat zu vermeiden, bekamen während des Experiments mehr durch den QRNG ausgewählte abwertende Begriffe präsentiert als unter Zufall zu erwarten. Für die Mikro-PK Aufgaben der Bedürfnisse Bindung und Kontrolle ergab sich in der HI-Gruppe entgegen unseren Annahmen anekdotische Evidenz für H_0. Wie vorhergesagt, wurden keine Abweichungen vom Zufall in einer der LI-Gruppen festgestellt. Wir interpretierten diese Ergebnisse als Hinweis dafür, dass die impliziten motivationalen Tendenzen eines Beobachters Quantenzufallsprozesse gemäß den Vorhersagen des ETMs temporär beeinflussen können, sofern sie durch eine Mikro-PK Aufgabe präzise angesprochen werden.

In Studie 2 wurde unsere Vorhersage für eine der drei PT-high-Gruppen bestätigt ($BF_{10} \geq 10$, starke Evidenz). In der PT-high Gruppe mit ausgeprägten dependenten Persönlichkeitszügen wurden vom QRNG mehr für diese Personengruppe bedeutungsvolle als

neutralen Stimuli ausgewählt als unter Zufall zu erwarten. Diese Ergebnisse untermauern ebenfalls die Annahme des ETMs, dass die angstbesetzen Erwartungen von Personen mit dependenten Eigenschaften, Sicherheit und Unterstützung in Beziehungen zu verlieren, die Wahrscheinlichkeit für das Eintreten entsprechender Ereignisse erhöhen. In den beiden anderen PT-high-Gruppen mit ängstlich-vermeidenden und zwanghaften Zügen zeigte sich allerdings anekdotische Evidenz für H_0. Erwartungsgemäß wurden in keiner der PT-low-Gruppen signifikante Abweichungen von der Zufallsverteilung festgestellt.

In der in Studie 3 berichteten Post-hoc-Re-Analyse einer Teilstichprobe des Datensatzes aus Studie 2 zeigte sich starke Evidenz für H_1 ($BF_{10} > 10$) innerhalb der PT-high-Gruppe, die im zeitlichen Verlauf über die Probanden auf ein moderates Evidenzniveau für H_1 ($BF_{10} = 3.18$) abnahm. Die durchgeführten CoE-Analysen unterschieden sich in der PT-high Gruppe signifikant von einem simulierten Datensatz. Diese Ergebnisse deuten darauf hin, dass die empirischen Daten trotz der rückläufigen sequenziellen Evidenz mit hoher Wahrscheinlichkeit nicht auf Zufallsschwankungen zurückzuführen sind. Innerhalb der PT-low Gruppe wurden keine Unterschiede zu den simulierten Daten beobachtet. Der anschließende Replikationsversuch mittels HLAS ergab lediglich anekdotische Evidenz für H_1 in der PT-high-Gruppe, womit der Effekt der Re-Analyse nicht reproduziert werden konnte. Wie vorhergesagt, traten keine signifikanten Abweichungen vom Zufall in der PT-low Gruppe auf. Entsprechend zeigten sich für beide Gruppen keine bedeutsamen Unterschiede zwischen dem empirischen Datensatz und den generierten Simulationen in den CoE-Analysen.

Zusammenfassend ergaben sich über alle drei Studien hinweg temporäre, signifikante Abweichungen vom Quantenzufall bei der motivierten Beobachtung der Messergebnisse durch Probanden mit den untersuchten Persönlichkeitseigenschaften. Die durch den QRNG erzeugte Verteilung wurden also durch unbewusste motivationale Zustände der Beobachter in die jeweils vorhergesagte Richtung beeinflusst, sodass bedeutungsvolle Stimuli im Vergleich zu neutralen häufiger ausgewählt wurden, als durch die Bornschen Regel vorhersagt. Somit untermauern die

Ergebnisse Interpretationen der Quantenmechanik, die Einflüsse von menschlichem Bewusstsein auf Quantenprozesse während der Beobachtung des Messvorgangs für möglich halten (z. B. Mensky, 2014; Penrose & Hameroff, 2011; Stapp, 2007). Zudem stützen die Befunde quantenbasierte Theorien des psychophysischen Substanzdualismus wie das UMM (siehe Atmanspacher et al., 2013; Atmanspacher, 2014) und dessen mathematische Formalisierung durch die GQT (z. B. Filk & Römer, 2011; Atmanspacher et al., 2002), die Wechselwirkungen zwischen Geist und Materie in einer gemeinsamen superpositionsartigen Vorrealität verorten. Wie durch das ETM vorhergesagt, erhöhten die auf impliziten Grundüberzeugen beruhenden, emotional besetzen Erwartungen der Probanden die Wahrscheinlichkeit, dass damit übereinstimmende Ereignisse (Stimuli) auf makroskopischer Ebene eintraten. Folglich deuten die Befunde in Übereinstimmung mit anderen Mikro-PK Studien wie Maier und Dechamps (2018), Stanford (1976) und Stanford et al. (1975) auf einen möglichen Einfluss mentaler Zustände bei der Realitätswerdung im Rahmen von Quantenmessvorgängen hin—sofern sie in Zukunft repliziert werden können.

Der in Studie 3 angestrebte Replikationsversuch mittels CoE-Analysen scheiterte vergleichbar mit zahlreichen vorherigen Studien (z. B. Dechamps et al., 2021; Dechamps & Maier, 2019; Jahn et al., 2000). Folglich ermöglicht weder dieser Ansatz noch die durch von Lucadou (2006) vorgeschlagene Matrix Methode (siehe Walach et al., 2019; 2021) eine Reproduzierbarkeit von Mikro-PK Effekten auf höherer Analyseebene. Daher liegt die Schlussfolgerung nahe, dass jeder Versuch einer Objektivierung von Mikro-PK Phänomenen auf lange Sicht zu abnehmender Evidenz führen muss, da Replikationsstudien die konfirmatorische Beweiskraft erhöhen und damit das No-Signal-Theorem verletzen würden. Das naturwissenschaftliche Konzept der direkten Replikation bezieht sich auf die Untersuchung stabiler, klassisch kausaler Effekte wie z. B. SCs. Nach dem MPI (von Lucadou et al., 2007) folgt Micro-PK zwar einer Systematik, ist allerdings per Definition non-lokal und akausal. Diese in den Naturgesetzen verankerten Prinzipien können also auch mittels HLASs nicht

umgangen werden. Damit können Mikro-PK Studien dem in der modernen Naturwissenschaft geforderten Anspruch direkter Replikationen empirischer Befunde nicht vollständig gerecht werden. Dennoch ist es für die Psychologie als Wissenschaft des menschlichen Erlebens und Verhaltens essenziell, Wechselwirkungen zwischen Geist und Materie zu erforschen, die auch das subjektiv Bedeutsame beinhalten. Ein alternativer Lösungsansatz, um die empirische Untersuchung von ICs trotz dieser Problematik mit neuen Strategien fortzusetzen, wurde beispielsweise von Maier et al. (2022) vorgeschlagen. Schlussfolgernd sollten die im Rahmen dieses Forschungsprojekts dargestellten empirischen Ansätze zur Untersuchung von Geist-Materie-Interaktionen, die im weiteren, interdisziplinären Sinne das Messproblem der Quantenphysik und die damit in enger Verbindung stehenden „harten Probleme“ der Philosophie des Geistes adressieren, in künftigen Studien verfolgt und weiterentwickelt werden.

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