# Quantum Measurement as Pragmatic Information Transfer: Observer Effects on (S)Objective Reality Formation[1]

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**Abstract:** ***Objective:*** In this study, quantum measurement is conceptualized as pragmatic information transfer when an intentional observer perceives motive-relevant quantum-based outcomes. Owing to the nature of pragmatic information as described in Lucadou's Model of Pragmatic Information, this information transfer causes an observer-dependent intentional co-formation of reality and can only be scientifically documented under reduced objectivity conditions. The effects thus reflect a "sobjective" reality that occupies the space between subjectivity and objectivity. The present study was designed to find evidence for the existence of this sobjective reality. ***Method:*** A pre-registered micro-psychokinesis task involving a quantum random number generator assessed the impact of intentional observation on quantum-based stochastic outcomes under experimental variations of the applied measures' objectivity. ***Results:*** As predicted, an intentionally congruent bias in quantum-based outcomes was observed using subjective memory data from the observations when additional objective computer-stored data were not inspected and finally erased (i.e., objectivity was reduced). Quantum randomness was confirmed in a maximum objective data collection context for both stored and memory data. ***Conclusion:*** The results indicate that pragmatic information was transferred during trial observation when scientific objectivity was reduced. The evidence for intentionally based reality formation or quantum-based random reality emergence was shown to be a function of the measurements' objectivity levels. The data suggest the existence of a sobjective reality and that a physicalist/materialist or an intentional creation worldview depends on the presence of an intentional agent and the definition of the measurement process.

*Keywords:* Pragmatic information, quantum observation, duality, micro-PK, quantum random number generator, intentional creation

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## Highlights

- Based on the model of pragmatic information (MPI) observer-dependent biases (micro-PK effects) were assumed to constitute a form of intentional agency on reality construction as opposed to passive reality registration.
- Experimental manipulations of the amount of objectivity involved in testing micro-PK effects were established and robust micro-PK effects were predicted for reduced objective conditions only.
- There were intentional observer effects on quantum-random outcomes (micro-PK) depending on different degrees of the applied measures' scientific objectivity.
- The data suggest that Descartes' duality approach (subjective vs. objective reality) should be supplemented by a third so-called sobjective reality lying in between the two, which solely provides the basis for intentional agency.

The theme of human agency is central to the life sciences. It considers how an individual's conscious or unconscious intentions, motivational goals, needs, desires, or volitional processes—such as conscious acts of free will—are translated into concurrent changes in the individual's physical environment. Many psychological theories of action control (e.g., Heckhausen & Gollwitzer, 1987; Ryan & Deci, 2017) describe how an individual's mind shapes its environment. Thus, these theories essentially concern the immaterial impact of an individual's subjective reality on the objective world. The underlying implicit assumption within most theoretical frameworks in psychology and cognitive neurosciences is that the brain functions as an interface between mind—subjective reality—and matter—objective reality. However, the idea that the brain functions as an interface between both forms of reality is highly problematic. Since the brain is part of the material world and thus an inherent component of objective reality, a gap remains between the subjective and objective worlds. Philosophers of mind address this gap as the "hard problem of consciousness" (Chalmers, 1995; see also Levine, 1983; Nagel, 1974) and argue that subjective states, such as consciousness, cannot be derived from a physical entity such as the brain. Moreover, the hard "problem of free will" (Shariff et al., 2008) emphasizes the fact that mental processes cannot interact with the brain's physical properties since they are mutually exclusive. How can a non-material concept such as the mind causally affect a material reality, particularly under the premise of causal closure in the physical domain?

Based on findings regarding intentional observer effects on quantum-based stochastic outcomes, Jahn and Dunne (1997) argued that the mind itself creates reality. Thus, an intentionally acting individual does not influence objective reality by producing certain actions, rather, through acts of intentional observation, individuals influence the emergence of an objective reality that features characteristics that align with their goals. This process may be considered a type of "goal-oriented creation of reality." Jahn and Dunne's interpretation has been supported by their own and others' use of micro-psychokinesis (micro-PK) tests that assess the effect of intentional observation on quantum-based stochastic outcomes, usually produced by a quantum random number generator (qRNG; for an overview, see Varvoglis & Bancel, 2015).

Micro-PK research using qRNGs has a long-established tradition (Schmidt, 1970, 1974), with numerous studies applying different variations in observers' intentions and various outcome measures. A qRNG uses a quantum process to establish a superposition of two potential states, such as the decay or non-decay of an atom (Schmidt, 1974) or a photon taking one of two potential paths. The possible quantum trial outcomes are then associated with a consciously experienced event—for example, the illumination of a lamp to the left or to the right in a circular display (Schmidt, 1970); the upward and downward movements of a random walk graphically displayed on a computer screen (Jahn et al., 1997); or the presentation of a positive or negative image on a computer screen (Maier et al., 2018). The volunteer's explicit or implicit task is then to mentally influence the experienced event and therefore the outcome of the quantum system.

Numerous studies have been conducted with different variations in observers' intentions and outcome measures and have yielded an impressive amount of data. Several meta-analyses of these studies observed an overall significant effect that supports observer-dependent variations in quantum randomness (Bösch et al., 2006; Duggan & Tressoldi, 2021; May et al., 1995; Radin & Nelson, 1989; for an overview see Varvoglis & Bancel, 2015), although a certain decline in the effect across studies has also been reported (Bierman, 2001; Lucadou, 2015) along with difficulties in replicating original findings (e.g., Dechamps et al., 2021; Jahn et al, 2000; Maier & Dechamps, 2018). These micro-PK effects may represent the influence of subjectivity and intentionality on objective reality, which suggests a transformation of subjective information—encoded in the individuals' conscious and unconscious goals, intentions, motives, and desires—into objective facts manifested in qRNG outcomes (Bierman, 2001; Jahn & Dunne, 1997). Micro-PK phenomena may thus transcend the duality of the subjective and objective worlds that Descartes (1641) initially proposed.

Jahn and Dunne (1997) recognized that such effects cannot be studied in a purely objective manner—which is necessary for the science of objective facts—and proposed as an alternative the unification of these dual aspects into a new "science of the subjective," adding to the "physics of observation" a new domain concerning the "physics of experience" (p. 213). The latter addresses the study of intentions, needs, and desires and their interaction with the surrounding environment's physical properties. A deterministic or quasi-deterministic worldview would thus be complemented by a teleological approach, which would function as a "keystone of the proposed science of the subjective" (Jahn & Dunne, 1997, p. 219). Similarly, Bierman (2001) argued that when consciousness interacts with matter, as is the case in micro-PK, an underlying reality arises between the purely subjective and objective realities that serves as an interface between both.

Another well-documented phenomenon in micro-PK research is the elusive nature of these effects, indicated by a decline in effect sizes across several decades of micro-PK research (Bierman, 2001), the non-replicability of original results despite the original existence of strong evidence for an effect (e.g., Dechamps et al., 2021; Jahn et al., 2000; Maier & Dechamps, 2018) and by the varying robustness of micro-PK effects within studies (e.g., Jakob et al., 2020; Lucadou, 2015; Maier et al., 2021). This elusive dimension may be an artifact and simply be the consequence of psi's inexistence (Wiseman, 2010). Nevertheless, the particularities of this elusive aspect have been observed in experimental conditions with sufficient consistency as to lend credibility to the hypothesis that elusivity may be a specific property of micro-PK phenomena. In this regard, Bierman (2001) proposed that any attempt to push a goal-oriented "impulse" from subjective into objective reality would ultimately destroy the objective status of these phenomena. That is, the impact of a unifying reality—a third reality beyond the objective and subjective worlds cannot be scientifically studied in a wholly objective manner that includes scientific standards, such as purely objective measurements, replicability, and robustness.

Von Lucadou formalized this conjecture more precisely with the Model of Pragmatic Information (MPI; Lucadou 1984, 1987, 1995, 1998, 2001, 2015; Lucadou et al., 2007). It considers micro-PK effects to be macroscopic entanglement correlations (ECs). ECs, which are described in quantum physics, follow quantum mechanical rules, and cannot be treated as causal signals (= 1st law; Lucadou, 2015) (Entanglement correlations are non-local correlations between quantum states that belong to one system observed after measurement, Schrödinger, 1935). Robust and replicable evidence for macroscopic/generalized ECs would allow the experimenter to use these results for non-local signal transfer. Since this would violate the ECs' nature, any signal-type evidence should decline after an effect has originally been documented (= 2nd law, Lucadou, 2015; also called the non-transmission [NT]-axiom; Lucadou et al., 2007). From a system-approach perspective, ECs are only present in closed subsystems and are not meant to communicate outside the system. They are thus recognizable only within a local (i.e., not fully objective) reality and tend to disappear when they are shared outside the system (i.e., when made objective).

In sum, any goal-oriented individual attempt to shape the physical environment implies a transfer of information from the subjective to the objective realm. Since the two are mutually exclusive, a third form of reality that may facilitate this transfer is proposed, echoing the proposals of Pauli and Jung (Atmanspacher & Fuchs, 2017; Pauli et al., 2000) and Bohm (Bohm & Fowler, 1978). This reality's key characteristic is that it is neither subjective nor objective but a mixture of both, rendering scientific documentation in purely objective terms impossible (Bierman, 2001; Jahn & Dunne, 1997; Lucadou et al., 2007). In what follows, we will investigate how this reality might nevertheless be explored scientifically.

## Pragmatic Information and Sobjective Reality

The theoretical framework detailed here is an elaboration and formalization of the ideas concerning the reality underlying micro-PK effects articulated by Jahn and Dunne (1997), Bierman (2001), and Lucadou et al. (2007). The subjective-objective distinction and the third reality introduced by Bierman (2001) will be described in information theoretical terms using the concept of pragmatic information proposed by von Weizsäcker (1974) and later applied to psi research by Lucadou.





The concept of pragmatic information was developed to characterize intentional and goal-oriented effects through information transfer from a sender to a receiver (von Weizsäcker, 1974). More precisely, pragmatic information ($I_p$) is defined as information through which the sender intends to elicit a certain reaction from the receiver. $I_p$ consists of two complementary and multiplicatively related aspects. First, the sender's goal-oriented impulse is encoded in a message called "novelty" (N), which concerns the autonomous, individual aspect of the message that is new and unpredictable to the receiver. It is the content of the sender's message, expressed to induce goal-related changes (cognitive or behavioral) in the receiver. This aspect emerges from the individual sender and is only known and controlled by him/her beforehand. The second aspect is "confirmation" (C), which corresponds to what is already known between the sender and the receiver and allows them to communicate. It includes all informational features that both sender and receiver already share beforehand and serve as carriers of the message. Pragmatic information can then be translated into the following formula: $I_p = N * C$. If either N or C is zero, no $I_p$ is produced. Moreover, since N and C are complementarily related to one another and $I_p$ is necessarily limited within a system, an increase in N causes a reduction in C and vice versa (see Lucadou, 2015). For example, if the sender's message is coded in a foreign language that is unknown to the receiver, C = 0, $I_p$ would be zero, and the message will not have the intended effect despite the high level of N. Similarly, if no N is provided—that is, if no new goal is encoded in the message (N = 0) —$I_p$ would be also zero. In this case, the receiver will passively register the information obtained from the sender without undergoing any transformation. By contrast, $I_p$ will reach a maximum when a message contains N and C in equal amounts. Consequently, the goal-oriented impulses needed for the creation of realities—as assumed in micro-PK experiments (Jahn & Dunne, 1997)—require an $I_p$ greater than zero, which means that (1) neither N nor C are at their minimum and (2) neither N nor C are at their maximum, since otherwise the complementary factor would become zero.

In the MPI, Lucadou applied the $I_p$ concept to the scientific measurement process (e.g., Lucadou, 2015), and we now apply the concept to the objectivity and subjectivity duality. The particle physicist Bernard d'Espagnat (2006) provided a definition of objectivity that strongly referred to the process of measurement in science. D'Espagnat (2006, pp. 93-94) defined objectivity in terms of statements based on measurements that inform us of some attributes of the things under study in an unbiased, observer-independent way. Objectivity in science is –according to this view– reached when the measurement instrument (MI) and measurement object (MO) are completely separate (MI ≠ MO). Such scenarios of unbiasing measurement will henceforth be called “non-invasive measurement” and constitute an ideal conjecture for attaining perfect objectivity. MIs are supposed to passively register an objective and independent reality. According to the $I_p$ concept, an MI can be considered a channel and has no individual impact (N = 0) on the measured object. Objective reality is thus defined as a realm wherein confirmation (C) is maximized to attain perfectly objective descriptions of its constituents. The consequence of this scientific success is that all forms of N are excluded from this objective world, and $I_p$ is zero (owing to the equation: $I_p = N * C$ and the complementary relation between N and C). Accordingly, no goal-oriented process, including psi, can emerge in this framework, in which everything is merely a product of objective and deterministic natural laws. Observers are thus reduced to “channels” that register events in the objective world but do not intentionally impact it. Jahn and Dunne (1997) called this the “physics of observation,” and it corresponds to a physicalist worldview.

Subjective reality does not contain $I_p$ either. Subjectivity is a pure experience composed of qualia that cannot be communicated to others. It remains within the individual and cannot be accessed from a third-person perspective (Levine, 1983; Nagel, 1974). This subjective reality is characterized by high amounts of autonomy, individuality, and intentionality, since all experiences are related to the self and are constructed from its motives and individual goals. From a measurement perspective, subjective experiences are defined by reality construction through introspection—that is, the MI and MO are merged (MI = MO). A maximally biased measurement, henceforth invasive measurement, is the result, leading to a maximization of N, reflecting the goal-oriented representation of experiences in an idiosyncratic manner. Subjective experiences cannot be communicated directly to others; consequently, C is zero, which matches the fact that N is at its maximum. Consequently, the $I_p$ within subjective reality must be zero.

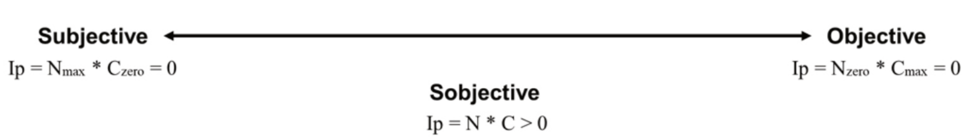
As described in the previous paragraphs the theoretical concepts C and N both underwent a transition from its original meaning in communication science to its meaning in measurement-related theories such as the MPI and our approach. In von Weizsäcker’s (1974) original pragmatic information theory C was defined as the informational aspect shared between two interacting individuals and thus confirmed by both during an information transfer from a sender to a receiver to enable communication. In the MPI the information transfer is translated into an interaction between observer and observandum during measurement processes. C in this context means stable, robust, and replicable results when the same observandum is observed multiple times. In our theory, C is closely related to the conceptualizations of Lucadou et al. (2007) and d’Espagnat (2006) and highlights the precondition leading to robust and replicable findings: C reflects the degree to which measurements are just passive registrations of measurement-independent facts that exist prior to observations as opposed to reality constructions. C is dominant when no biasing effects of individual observers on the observanda during measurements occur. Multiple passive-registrations of the same observandum leading to the same results, as is the case with robustness and replicability in science, allow an observandum to be defined as objectively real. Thus, $C_{max}$ naturally leads to the definition of an objective reality in terms of measurement-independent facts. N in von Weizsäcker’s (1974) theory was defined as the meaningful content of the message encoded autonomously by the sender and reflects his or her intention to change a knowledge state within a receiver. Within the MPI’s measurement framework, N defines the active, causal impact through which observers affect the measurement outcomes transforming them into signals. Similarly, in our approach N reflects the degree to which measurements are active reality constructions. These constructions are based on the observers’ goals, motives, and desires to form a subjective percept. Thus, under $N_{max}$ a fully individually constructed subjective reality created by the intentional agency of a perceiver is reached.

The logical correspondence of specific variations of $I_p$ to subjective ($I_p = N_{max} * C_{zero} = 0$) and objective realities ($I_p = N_{zero} * C_{max} = 0$) explains why $I_p > 0$ cannot be located in either of the two realities alone. To conceptualize intentional and goal-oriented agency, central to micro-PK (but also to motivation, volition, free will, etc.), a third form of reality in which $I_p > 0$ may be necessary. Based on psi research and decline effects, Bierman (2001) inferred the existence of a reality that is neither subjective nor fully objective, overcoming the Cartesian duality, and proposed that this third form of reality be called the “tribal reality”; we propose that it be renamed “sobjective” reality, given its function as an interface between the subjective and objective worlds. The specific feature of this reality, with respect to measurement and objectivity, is that a fully objective confirmation of phenomena arising from it cannot be reached since C cannot be maximum (since N > 0). The scientific criterion of objective evidence cannot be met when studying micro-PK. The MPI’s second law, which states that psi effects vanish when their existence is confirmed objectively formalizes this fact. This approach implies a transition from a “physics of observation” to a “physics of experience” as postulated by Jahn and Dunne (1997).

One might wonder whether this approaches a self-immunization strategy by arguing that micro-PK or other psi effects cannot be studied on objective scientific grounds and can only be experienced subjectively. However, this extrapolation is based on Cartesian duality's conviction that reality is either subjective or objective. By contrast, we suppose that both constitute the end points of a continuum that encompasses varying degrees of sobjectivity (see Fig. 1). Sobjective phenomena might then be studied scientifically under circumstances in which measurement objectivity is reduced (i.e., C < 100%) but not completely zero (i.e., C > 0). In this regard, Lucadou and Zahradnik (2004) offered theoretical propositions that recurrent spontaneous psychokinesis (RSPK) phenomena's effect sizes should be a function of the quality of the phenomenon's documentation (i.e., confirmation [C]). A reduction in the quality of documentation should favor the occurrence of these effects. The present research applies this proposition to experimental conditions and aims to investigate micro-PK effects under variations of C—that is, with different degrees of objectification of the effect. Since micro-PK involves intentional observer effects on quantum-based stochastic outcomes, a short digression concerning quantum mechanics, an explanation of the measurement process and its relationship to $I_p$ is warranted here.

**Figure 1**

*The Pseudo-Duality of Objective vs. Subjective Reality Described as a Continuum of Degrees of Sobjective Reality as a Function of Novelty (N) and Confirmation (C) Within Pragmatic Information (Ip)*




## Quantum Randomness and Pragmatic Information

In this section, we examine the most basic assumptions quantum mechanics made about the measurement process and underlying reality (for overviews see Becker, 2018; d'Espagnat, 2006). According to a mainstream interpretation of the findings of quantum physics—the "Copenhagen interpretation"—we cannot define the world before quantum measurement (Becker, 2018; Bell, 1964). Some physicists, such as d'Espagnat (2006), believe that the measurement of quantum systems will in fact create reality. In this case, measurement is thus highly invasive, which means that the MI fully overlaps with the MO (MI = MO). Nevertheless, the outcome of a quantum measurement is stochastic in nature owing to the indeterminacy principle (Bell, 1964; Kochen & Specker, 1967; for an overview see Becker, 2018). Thus, the MI has no impact (N = 0) on the specific result a measurement might produce and therefore does not achieve the full criterion of subjectivity in terms of goal-oriented experiences of reality. In other words, quantum randomness during measurement "saves" objectivity in physics but only in a weak objective sense (d'Espagnat, 2006). Data obtained from fully invasive (MI = MO) quantum measurements follow probability rules that are apparently inherent in objective reality (Born, 1926). Quantum mechanical research produces results that are highly predictable through probability functions and can be confirmed through trial repetition with an unsurpassed high degree of accuracy. The indeterminacy principle is considered an ontic feature of this reality and leads to a $C_{max}$ that is distinctive for science. Within it, there is no room for observers' intentions, given that $C_{max}$ implies N = 0 in this configuration. The quantum indeterminacy principle thus guarantees objectivity in this area of physics in which measurement creates reality and is devoid of any intentional agency.

The "physics of experience" (Jahn & Dunne, 1997) and its operationalization through micro-PK challenges the ontic nature of quantum randomness and by doing so challenges the $C_{max}$ criterion. Any observer-dependent biasing of quantum randomness would finally reveal a reality in which intentional agency can take place (N > 0), and C would no longer be maximum, but $I_p$ would be greater than zero. A strategy that investigates observer-dependent biases in quantum randomness using $C_{max}$ scientific standards would ultimately confirm quantum randomness. It is thus of paramount importance in micro-PK research to choose scientific methods that work with reduced Cs and possibly compare them to conditions in which C is maximized (Lucadou & Zahradnik, 2004). This would indicate that quantum randomness is merely a function of optimizing C, and reliable evidence for intentional biases in quantum randomness can occur under reduced objectivity (C < $C_{max}$) conditions—that is, with sobjective methods.

## The Present Study: Can We Study the Impact of Objectivity?

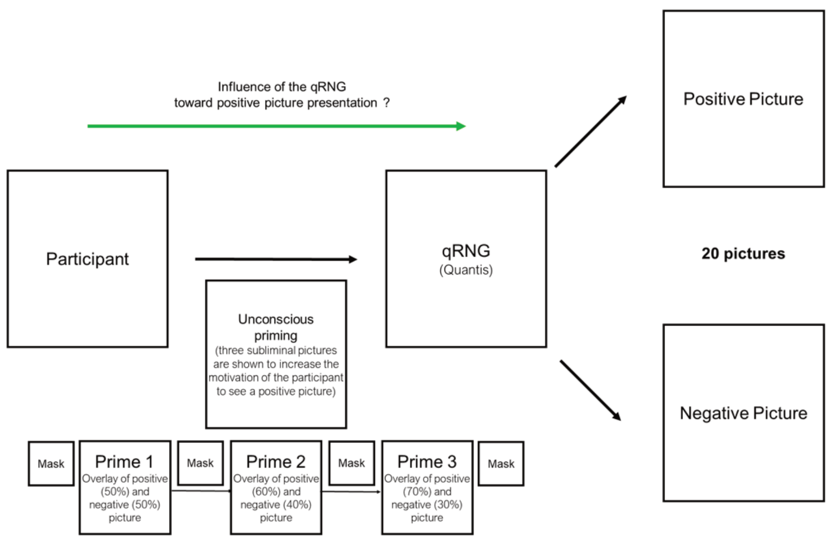
The present study's goal was to find evidence for the existence of a sobjective reality that fills the gap between the duality of the subjective and objective worlds. More precisely, sobjectivity was considered a realm in which $I_p > 0$, which implied that we could study the impact of reduced confirmation (C) on the emergence of psi effects.

Study participants performed a micro-PK task that replicated one condition in a series of studies recently conducted by Dechamps et al. (2021). A quantum-based random number generator (qRNG) was used in each trial to determine whether the participant would observe a positive or negative image. The participant's intention to see positive images was evoked by the nature of the task and was further primed subliminally to enhance its motivational impact (see Fig. 2). Research demonstrated an effect (strong Bayesian evidence) on positive image presentations in a first study (the qRNG had "chosen" the positive image more frequently), and a subsequent decline in this effect with null findings confirming quantum randomness was reported in two subsequent studies using the same protocol (Dechamps et al., 2021). Thus, on the objective level of evidence, null effects currently occur in this design. The main reasons for applying this design in our research reported here was that: a) it provided a promising task to find strong evidence for micro-PK as demonstrated by Dechamps et al. (2021, Study 1) and might thus allow those effects to re-appear on reduced objective/more subjective data and that b) the further trend with regard to the objective micro-PK data subsequently indicated strong evidence for a null effect (Dechamps et al., 2021, Studies 2 and 3) proposing that $C_{max}$ has been already reached by this design and in further replication attempts null effects will be obtained when objective data are analyzed.

The present study varied the objectivity (C) of micro-PK measures. Two micro-PK dependent variables were used in this design: the number of positive images selected by the qRNG and stored (or deleted; see below) in a data file (objective number), and the recall performance of this number derived from participants' memory stored in a data file (subjective number). Two within-subjects conditions were established. In the control condition, the objective number of positive images together with the subjective recall of this number were assessed ($C_{max}$ condition). In the experimental condition, the objective data were automatically deleted before inspection by the experiment designers, and only subjective memory data were available ($C_{reduced}$ condition). Thus, the measures applied within each condition involved a variation in the degree of objectivity (= variation of C) (see Fig. 3). We predicted that a micro-PK effect would be found in the experimental condition with quantitative data representing participants' subjective experiences ($C_{reduced}$). No micro-PK effect and evidence for a random distribution of positive images was predicted for the control condition's subjective as well as objective data ($C_{max}$). The study and its predictions were pre-registered at OSF (https://osf.io/cr42j).

**Figure 2**

*Overview of the Design (Experimental Condition with 20 Trials) of Dechamps et al.'s (2021) Studies 1 to 3*



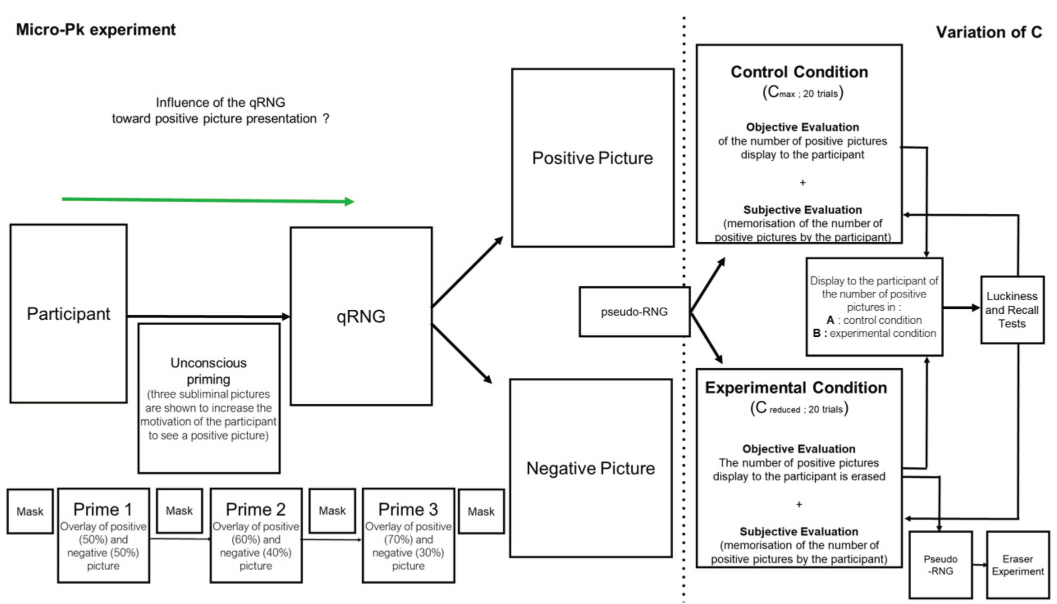

## Methods

### Participants

The study's sample comprised German participants (≥ 18 years of age) distributed throughout the country (see below the age and gender characteristics). Participant recruitment and data collection were organized by Kantar, who distributed invitations to participate in the study to a random selection of their participant pool daily via email, aiming for a completion rate of about 100 per day. Participants consented to participate in the study electronically by pressing an accept button prior to the experiment. They were informed in general terms about the study, advised that participation was voluntary, and given a brief written explanation of the study's purpose after its completion (informed consent procedure). All saved data were coded, stored, and analyzed anonymously. The ethical board of the Department of Psychology at LMU Munich and Kantar—a data collection company specializing in online surveys that conducted the data collection—approved this procedure.

**Figure 3**

*Overview of the Present Study's Design (40 trials)*




## Data Collection

The data collection took place during October 2020. We used a Bayesian approach in this study. Bayesian inference statistics allow for data accumulation (i.e., the addition of individuals' data until a specific stopping criterion has been met). The micro-PK effects for the experimental ($C_{reduced}$) and control ($C_{max}$) conditions were assessed using Bayesian one-sample *t*-tests testing whether the mean scores of positive images would exceed chance expectations in the experimental and control conditions (for objective and subjective data). The following procedural details were specified in the pre-registration: a Bayesian factor (BF) = 10 indicating strong evidence for either $H_0$ or $H_1$ in the experimental condition was defined as the stopping rule. The uninformed prior for the one-sample Bayesian t-tests, with a one-tailed approach to the analyses performed, followed a Cauchy distribution centered around 0.05 with an *r* = .05 (i.e., δ ~ Cauchy [0.05, 0.05]). This prior was based on an estimated effect size of $d_{cohen}$ = .1 and was the same as in Dechamps et al. (2021, Studies 2–3). These Bayesian analyses were performed on an irregular basis (more-or-less weekly) with the respective actualized sample's mean scores. We used the statistical software R's Bayes Factor packages for Bayesian analyses.

The stopping criterion of $BF_{10}$ = 10 was surpassed in the data from the experimental condition at sample size *n* = 856. At the point of data analysis, data from an additional 42 participants had already been collected, resulting in a total sample size of *N* = 898: 54.5% male, 45.2% female, 0.2% diverse; $M_{age}$ = 54.41, $SD_{age}$ = 16.82.

## Materials

### *Experimental Program*

This study partially replicated Dechamps et al.'s (2021) Study 1. The original study had two experimental conditions: a positive and a neutral subliminal image priming condition. As in the original studies, the present study was run as an online experiment. All participants could take part from any location using their private computers and internet access. The experiment was executed using a dedicated web server displayed on the participants' web browsers. The program was implemented using jsPsych (v 5.0.3; de Leeuw, 2015), a JavaScript library designed to run online behavioral experiments.

### *Stimuli*

Positive and negative images were used as target stimuli, and a mixture of them were used as prime stimuli. The target stimulus sets consisted of photographs obtained from Shutterstock, a provider of royalty-free stock images. The positive target stimuli comprised 20 photographs depicting pets, peaceful landscapes, and groups of happy-looking people. Negative target stimuli were 20 photographs depicting dangerous or attacking animals and cataclysmal scenarios. The stimulus material was converted to black and white to balance out a general inequality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with respect to the coloring of the positive and negative images. Both target sets were matched; that is, each positive target picture had a negative counterpart that was similar with respect to content. These pairs of target images represented specific subjects (e.g., a dog) with either positive (e.g., a friendly dog) or negative (e.g., an aggressive dog) valence.

One class of priming stimuli for later subliminal presentation was created for all trials. Each single priming stimulus comprised two matched, overlaid target images. Three different versions of picture overlay were designed and used in each priming trial, resulting in a three-time prime presentation within a trial. The first prime presented within a trial was designed in such a way that the positive and negative stimuli were arranged with equal emphasis (50/50). Therefore, the first prime represented a homogenous mixture of both matched target images. In the second prime presentation, the positive share representing the positive target was displayed more distinctly than the negative share (60/40), and in the third prime presentation within that trial, this distinction was intensified (70/30). The positive image became increasingly dominant during the subliminal priming sequence and was expected to be more strongly activated in the perceiver's unconscious mind. This should mimic the evolution of a desire for a positive image out of an originally equal superposition of positive and negative pairs within participants' unconscious minds. The positive priming procedure applied was intended to support the participants' intentions to perceive positive target images at the end of each trial. This priming technique was successfully used by Dechamps et al. (2021, Study 1).

Since 20 matched target pairs existed, the resulting number of corresponding priming stimuli was 20. To ensure subliminality, primes were accompanied by forward and backward masks comprising scrambled and indefinable versions of each prime. These masks preceding and following the primes were generated by dividing the 50/50 priming image into a 20 × 16 block grid and randomly shuffling these blocks in both the horizontal and vertical positions. For the resulting scrambled versions of the priming images, the local image information remained the same, but the images' meaningful content was distorted. Using such scrambled versions of the original stimuli as masks optimizes the masking process and is a standard procedure in subliminal priming (Huang et al., 2019). Each priming stimulus version (50/50; 60/40; 70/30) was presented along with its masks during a given trial before the target display. The target was then randomly selected by a quantum-based RNG (qRNG) from the pair of targets from which the corresponding prime stimuli were created.

*Generation of Quantum Randomness*

During each trial, after the priming sequence, a qRNG was used to determine whether the positive or negative image from the trial set was presented. To achieve this, a Quantis qRNG by ID Quantique was connected to the web server. This device generates two equally likely superposed quantum states by sending photons through a semi-conductive mirror-like prism. Upon measurement, only one of the two states can be observed and translated into either a 0 or a 1 bit. Owing to the random nature of quantum state reduction, a truly unpredictable result is generated. The Quantis qRNG passed all major validation tests of randomness (Turiel, 2007). The device was connected directly to the server via a USB and generated a random bit for each trial upon completion of the priming sequence and immediately before the target stimulus display, thereby working without a buffer. Care was also taken to ensure that each participant received an individual bit.

## Procedure

The polling company Kantar (www.kantar.com) issued the invitation to participate in the study via email to their pool of professional clients. The exclusion criterion for this study was that participants had not participated in a previous experiment using this paradigm. Participants were advised to ensure an undisturbed environment before starting the survey. They were asked for basic demographic information and after activating their browser's full-screen mode, they were given written instructions for the task. They were advised that over the course of the experiment they would see repeated flickering visual stimuli as well as positive and negative images and that these stimuli should be watched passively. They were reminded that they could stop the experiment at any time. Prime and image presentations commenced after the participants had acknowledged the instructions and consented to participation.

Each participant viewed a total of 40 trials and every target pair was selected twice and shuffled into a unique order. Subsequently, a software randomizer (pseudoRNG) randomly selected 20 out of all 40 trials to be randomly assigned to the experimental ($C_{reduced}$) and control ($C_{max}$) conditions, respectively.

During each trial, a fixation cross was first presented in the center of the screen (1200 ms) to direct the participants' attention toward this location. Next, in the priming sequence, various combinations of the two images that corresponded to the respective target pair of a given trial were used as prime stimuli. The 50/50 mixture prime stimulus was displayed for 55 ms and was accompanied by a corresponding forward mask (110 ms) and a backward mask (110 ms) to ensure subliminal presentation. The second prime presentation (55ms) was a 60/40 mixture in which the positive target image was more visible, and the third prime presentation (55ms) within this sequence was a 70/30 mixture of this kind, both also accompanied by forward and backward masks. A 1000 ms-long gap showing a black screen was displayed after each prime presentation. In each trial, after the priming procedure was displayed, the qRNG was activated to provide an individual random bit that determined whether the positive or negative target stimulus from a given matched pair would be presented. Depending on the trial's condition, this random bit was stored to memory ($C_{max}$) or added to a temporary counter ($C_{reduced}$). The selected target picture was presented for 1000 ms, followed by a black inter-trial interval for another 1200 ms until the next trial began. After 24 trials, participants were asked to click a button labeled continue to indicate their presence and alertness toward the experiment. Data were excluded if participants did not click the button within 10 seconds. After all 40 trials were completed, the actual number of positive images chosen by the qRNG in each condition was displayed to the participant. A heading above these numbers said, "You will see two numbers after A and B. Please watch these numbers carefully." Below this instruction, a text field with two lines, one below the other was presented. The number of positive images that the individual saw in the control condition ($C_{max}$) was presented after "A" in the first line and the number of positive images that the individual saw in the experimental condition ($C_{reduced}$) was presented after "B" in the second line. For example:

A: 9

B: 12



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These numbers reflect the objective micro-PK data in the respective conditions. The numbers were presented until the participant pressed a next button, displayed below the numbers. No explicit instruction to recall the numbers later was issued; that is, an incidental learning task was used here. After this, participants were asked to rate six different statements concerning perceived luckiness, which took around 30–90 seconds, depending on the individual's response speed. The perceived luckiness scale served simply as a filler task and will not be analyzed further here. Next, a recall task was presented, introduced by the statement: "Which numbers did you previously see after A and B? Please type in the numbers even if you are not sure whether they are correct!

A: _______

B: _______

The recalled number after "A" was the subjective number of positive images for the control condition ($C_{max}$) and that after "B" was the subjective number of positive images for the experimental condition ($C_{reduced}$), and were based on the participants' subjective memory performance. After the memory responses were given, participants were thanked for their participation. Since the temporary counter was not saved to the results file, for Creduced, only subjective memory data for the number of positive images were available ($C_{reduced}$-subjective), whereas for $C_{max}$, both data types—subjective memory ($C_{max}$-subjective) and objective, computer-stored data ($C_{max}$-objective)—were available, resulting in three dependent variables for final analyses.

### Design

The study employed a within-subjects design with two conditions: an experimental condition ($C_{reduced}$), in which the objective data (i.e., the computer-based count of positive target images) used to assess the micro-PK effect were not recorded to a result file, and only subjective recall data of the number of positive target images were available as dependent variable; and a control condition ($C_{max}$), in which both objective and subjective data of the micro-PK effect were available.

## Results

In the following analyses the recalled mean number of positive pictures (subjective scores) in both conditions and the computer-stored (objective score) mean number of positive pictures in the $C_{max}$ condition were

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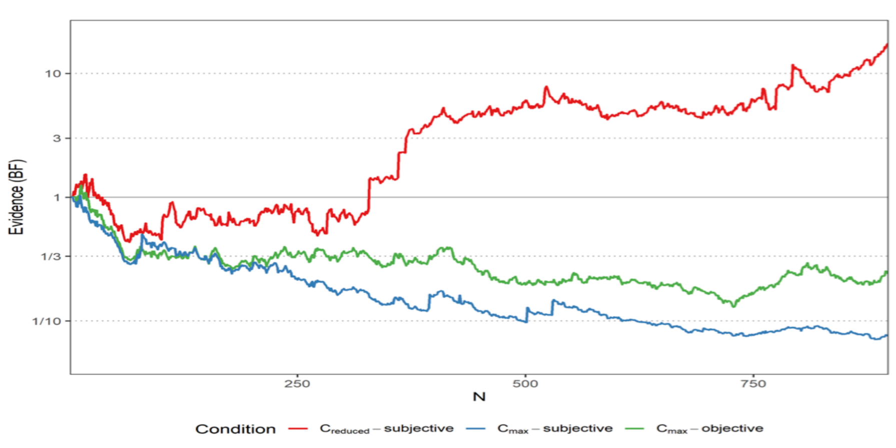
tested separately against chance occurrence. As specified in the pre-registration, three separate Bayesian one-sample *t*-tests (one-tailed) were performed: (a) to test whether the recalled mean number of positive images ($C_{reduced}$-subjective) was higher than expected by chance in the $C_{reduced}$ condition and (b) to test whether the recalled ($C_{max}$-subjective) and objective ($C_{max}$-objective) mean numbers of positive images were higher than expected by chance in the $C_{max}$ condition. We had predicted strong evidence for micro-PK in the $C_{reduced}$-subjective variable and null effects in both $C_{max}$-variables. The mean score expected to occur by chance was 10 positive images (out of 20 possible) on average for each dependent variable. Out of all 898 participants, 886 indicated a recalled number within the $C_{max}$ condition and 884 did so for the $C_{reduced}$ condition.

For the $C_{reduced}$-subjective variable, the Bayesian *t*-test (one-tailed, $N = 884$) revealed a final $BF_{10} = 17.14$, indicating strong evidence in support of $H_1$. The mean score of positive images recalled in this condition was M = 10.58 (SD = 6.37). For the $C_{max}$-subjective variable, the Bayesian *t*-test (one-tailed, $N = 886$) yielded a final $BF_{01} = 13.14$, indicating strong evidence for $H_0$ (M = 9.80, SD = 2.89). For the $C_{max}$-objective variable, the Bayesian *t*-test (one-tailed, $N = 898$) yielded a final $BF_{01} = 4.18$, indicating moderate evidence for $H_0$ ($M = 9.99$, SD = 2.17). Figure 4 shows the sequential Bayesian analyses for the three t-tests separately for each dependent variable. While the BF of the $C_{reduced}$-subjective variable hit the pre-specified stopping rule of $BF_{10} > 10$, the BFs of the $C_{max}$ dependent variables showed linear trends for null effects, since the accumulated evidence increasingly supported the null hypothesis, yielding moderate and strong evidence, respectively.

**Figure 4**

*Sequential Bayes Factors*



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The correlation between $C_{max}$-subjective and $C_{max}$-objective was calculated to assess the recall performance's validity. The Bravais-Pearson correlation revealed an $r(884) = .69$ indicating that recall performance was sufficiently but—as expected—not completely accurate. The difference between the subjective ($M = 9.80$) and objective ($M = 9.99$) values in the $C_{max}$ condition is significant, $t(885) = 2.77$, $p = .006$, suggesting that participants recalled lower scores than those actually presented.

Additionally, we analyzed the micro-PK data for gender differences (e.g., Jahn et al., 1997; Mossbridge & Radin, 2021). In these exploratory analyses, no significant effects were found with Bayesian independent-sample *t*-tests (two-tailed; uninformed prior $r = 0.1$, i.e., $\delta \sim$ Cauchy [0, .1]) in any of the three dependent variables: all $BFs_{10}$ found were between .48 and.64, indicating anecdotal evidence for $H_0$. Frequentist independent-sample *t*-tests revealed no significant gender effects, all *t*s < 1.13 ($C_{reduced}$-subjective: males: $M = 10.47$, SD = 6.00; females: $M = 10.74$, SD = 6.80; $C_{max}$-subjective: males: $M = 9.70$, SD = 3.01; females: $M = 9.92$, SD = 2.74; and $C_{max}$-objective: males: $M = 9.91$, SD = 2.23; females: $M = 10.08$, SD = 2.11).

### Analysis of the Results and Eraser Approach

At first glance, the results match our predictions. In the $C_{reduced}$ condition, strong evidence for a recall effect of more positive images than expected by chance was found. Moreover, in line with our expectations, no substantial positive deviation from chance was observed in the $C_{max}$ condition on either the subjective or objective data level. This data pattern supports our proposition according to which the micro-PK effect may be a consequence of intentional observer effects based on a sobjective reality whose influence can be revealed when scientific objectivity—and thus the parameter confirmation (C) in the Ip = N * C equation—is reduced. This fits with Lucadou and Zahradnik's (2004) proposition that reducing the quality of documenting a psi effect might favor the occurrence of such effects. Subjective data about micro-PK outcomes are of lower scientific quality than objective data (computer-stored micro-PK data), allowing effect documentation with $C_{reduced}$-subjective data only. When C is maximized, quantum randomness, as predicted by standard quantum mechanics, was found.

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However, this interpretation is not fully persuasive, since a confound was detected in the design after data collection and analysis. $C_{max}$-subjective was continuously presented and recalled after “A:___” and $C_{reduced}$-subjective after “B:___” in the experiment. Thus, the presentation and recall order was fixed. The micro-PK effect found with the $C_{reduced}$-subjective variable could be alternatively explained by an order effect. Such an order effect can have different causes. Participants who must recall two numbers could on average recall a higher number when another number has been presented/recalled immediately before (so they would tend to recall a higher number associated with B than A). Such a scenario would not be unlikely if some kind of re-ordering effect had taken place during the recall phase: The participants had to keep in mind two numbers potentially in their auditory memory system, since the visual system was active during the filler task (item ratings). Upon the recall phase the individuals might have retrieved the two target numbers from their memory storage in ascending order which is a natural way of ordering numbers. In other words, they might have recalled the original numbers fairly correctly but confused the original order (A vs. B). This re-organized recall process would lead on average to lower scores being recalled after A and higher scores being recalled after B. A similar recall preference for lower compared to higher numbers was also reported by Milikowski and Elshout (1995). Such an effect could fully and alternatively explain the results reported above (we thank one reviewer for providing this alternative explanation). The fact that the mean score of the $C_{max}$-subjective variable was found to be significantly below the $C_{max}$-objective variable, as revealed in the exploratory analysis reported above, seems to strongly support this interpretation. In addition, one could simply argue that the letters A and/or B themselves bias recall performance in the direction found. This or similar recall order effects provide highly plausible alternative standard interpretations of the effect found. Since a standard interpretation may be preferable to a subjective reality interpretation, these data cannot be taken as evidence for our theoretical proposition. In sum, the design did not allow us to test our prediction convincingly at this point and the actual status of the experiment does not exceed the value of a pilot study.

Nevertheless, a couple of weeks later, the second author (MD) observed that although in the $C_{reduced}$ condition, the raw data of the number of positive images stored by the computer (i.e., the objective micro-PK data in this condition) were deleted, the target images’ labels that were finally presented to the participants after qRNG selection were still saved, although they had not been imported into the analysis. From the picture labels, the valence (positive or negative) of the target images presented could be re-assessed, which means that the objective data were not entirely erased but merely not inspected. Thus, we decided to use these data to rule out the confound described above. We set up another pre-registration at OSF (https://osf.io/tsz5p) in which we announced that within the $C_{reduced}$ condition for half of the participants (*n* = 449), these labels would be deleted before inspection and for the other half (n = 449) the labels would now be inspected and analyzed. A pseudo-RNG was used to determine which data were to be restored and which were permanently deleted. The data within the $C_{max}$ condition remained untouched and were not further analyzed. Our pre-registered prediction was that within the original $C_{reduced}$ condition a micro-PK effect on the subjective recall data should be found in the condition in which no objective data for micro-PK were available ($C_{fully\text{-}erased\text{-}reduced}$subjective) and no micro-PK should exist in the subjective recall data of the participants ($C_{restored\text{-}not_reduced}$subjective) for whom restored objective data ($C_{restored\text{-}not\ reduced}$objective) were also available. This procedure reflects a quantum-eraser strategy type (Kim et al., 2000).





In the following analyses the recalled mean number of positive pictures (subjective scores) in both conditions (fully-erased-reduced and restored-not reduced) and the computer-restored (objective score) mean number of positive pictures in the $C_{restored\text{-}not\ reduced}$ condition were tested separately against chance occurrence. As specified in the pre-registration, three separate Bayesian one-sample *t*-tests (one-tailed) were performed: (a) to test whether the recalled mean number of positive images was higher than expected by chance in the $C_{fully\text{-}erased\text{-}reduced}$subjective condition and (b) to test whether the recalled (subjective) and objective mean numbers of positive images were higher than expected by chance in the $C_{restored\text{-}not\ reduced}$ condition. We predicted strong evidence for micro-PK in the $C_{fully\text{-}erased\text{-}reduced}$-subjective variable and null effects in both $C_{restored\text{-}not\ reduced}$-variables. The mean score expected to occur by chance was 10 positive images (out of 20 possible) on average for each dependent variable. For the $C_{fully\text{-}erased\text{-}reduced}$subjective variable, the Bayesian *t*-test (one-tailed, N = 441) revealed a final $BF_{10}$ = 15.47, indicating strong evidence in support of $H_1$. The mean score of the positive images recalled in this condition was *M* = 11.08, SD = 8.31. For the $C_{restored\ \text{-}not_reduced}$subjective variable, the Bayesian *t*-test (one-tailed, *N* = 443) yielded a final $BF_{01}$ = 1.62, indicating anecdotal evidence for $H_0$. For the $C_{restored\text{-}not_reduced}$objective variable, the Bayesian $t$-test (one-tailed, $N = 449$) yielded a final $BF_{01} = 2.67$, indicating anecdotal evidence for $H_0$ (see Table 1 for an overview). Figure 5 shows the sequential Bayesian analyses for the three $t$-tests separately for each dependent variable. While the BF of the $C_{fully\text{-}erased\text{-}reduced}$subjective variable hit the predicted $BF_{10} > 10$, the BFs of the $C_{restored\text{-}not\_reduced}$ dependent variables showed linear trends for null effects, although only anecdotal evidence was found.

**Figure 5**

*Sequential Bayes Factors*


In addition, the correlation between $C_{restored\text{-}not_reduced}$subjective and $C_{restored\text{-}not_reduced}$objective was calculated to assess the validity of the recall performance. The Bravais-Pearson correlation revealed an $r(441) = .64$ indicating that recall performance was sufficiently but—as expected—not completely accurate. No significant mean scores difference between subjective and objective data for the $C_{restored\text{-}not\_reduced}$ condition was found, $t < -0.87$.

In repeating the exploratory gender analyses reported above, we did not find any gender differences for the $C_{fully\text{-}erased\text{-}reduced}$ condition ($BF_{10} = .52$ male: $M = 11.16$, SD = 7.81; female: $M = 10.98$, SD = 8.92) but a significant difference for the $C_{restored\text{-}not\text{-}reduced}$ subjective condition (males: $M = 9.75$, SD = 3.07; females: $M = 10.51$, SD = 3.73; $t(389.4) = 2.30$, $p = .02$; $BF_{10} = 2.7$) and a marginally significant difference for the $C_{restored\text{-}not\text{-}reduced}$ objective condition (males: $M = 9.85$, SD = 2.12; females: $M = 10.12$, SD = 2.17; $t(444) = 1.74$, $p = .08$; $BF_{10} = 1.32$). Overall, no or only anecdotal evidence for gender differences in micro-PK were found in our data. Similar but stronger gender effects in micro-PK have been reported by Jahn et al. (1997) and by Mossbridge and Radin (2021).





Finally, owing to the open answer format of the recalled numbers, some memory recalls were unrealistically high (i.e., greater than 20). These extreme scores may have driven the effect found in the $C_{fully\text{-}erased\text{-}reduced\text{-}}$subjective variable. Thus, a re-analysis of the recalled numbers was performed in which all answers greater than 20 were set to 20 (which is the highest possible number of positive images). $C_{fully\text{-}erased\text{-}reduced}$subjective yielded a $BF_{10} = 26.94$ (M = 10.40; SD = 2.83). $C_{restored\text{-}not_reduced}$subjective yielded a $BF_{01} = 3.18$ (M = 9.96; SD = 2.74). This analysis with outlier control was not specified in the pre-registration but served as a robustness check and revealed the same results as when the outliers were included in the data.

A re-analysis of the $C_{reduced}$ condition when the sample was randomly split into participants for whom only subjective micro-PK data were available and individuals for whom finally, in addition to their subjective recall data, now inspected and analyzed objective, computer-stored data were available showed the predicted results. Only in the subjective data of the sub-sample for which no objective data were retrievable was evidence for a micro-PK effect found. Trends toward null effects were obtained when C was recovered and maximized. This shows that an experimental manipulation of C allowed for the appearance and disappearance of the micro-PK effect on subjective data. The subjective data of the whole sample originally showed strong evidence for micro-PK in the $C_{reduced}$ condition. However, the effect seems to have been driven only by participants in the sub-sample for which later all objective data were entirely erased. The psi effect was absent in the sub-sample for whom the objective data were finally recovered. This finding is not a post-hoc analysis given that the sub-sample manipulation was pre-registered and performed by a pseudo-random process and thus constitutes an a priori experimental manipulation of C. Thanks to this finding, the confounding factor could also be ruled out since all subjective data analyzed here were obtained from the recall performance after “B”, and thus, the presentation and recall order has been kept constant here. There are no changes in the $C_{restored\text{-}not\_reduced}$-objective condition when applying a limit to 20. All raw data and analysis scripts for the main and re-analysis can be accessed via the project’s OSF repository at https://osf.io/nveaq/files

**Table 1**

*Mean Values and t-Test Results of All Subsamples*

| Subsample | *N* | *M* (SD) | $BF_{10}$ ($BF_{01}$) |
|---|---|---|---|
| Original analysis | | | |
| $C_{reduced}$-subjective | 884 | 10.58 (6.37) | 17.14 (0.06) |
| $C_{max}$-subjective | 886 | 9.80 (2.89) | 0.08 (13.14) |
| $C_{max}$-objective | 898 | 9.99 (2.17) | 0.24 (4.18) |
| Eraser analysis | | | |
| $C_{fully\text{-}erased\text{-}reduced}$-subjective | 441 | 11.08 (8.31) | 15.47 (0.06) |
| $C_{restored\ \text{-}not\_reduced}$-subjective | 443 | 10.08 (3.42) | 0.62 (1.62) |
| $C_{restored\text{-}not\_reduced}$-objective | 449 | 10.00 (2.15) | 0.37 (2.67) |
| Eraser analysis: outlier limit set to 20 | | | |
| $C_{fully\text{-}erased\text{-}reduced}$-subjective | 441 | 10.40 (2.83) | 26.94 (0.04) |
| $C_{restored\ \text{-}not\_reduced}$-subjective | 443 | 9.96 (2.74) | 0.31 (3.18) |

*Note.* Since the Bayes Factor represents a symmetrical ratio of evidence for the concurring hypotheses, $BF_{01}$ is always $1/BF_{10}$.

## Discussion

This study aimed to test the existence of a sobjective reality from which micro-PK effects arise. Sobjective reality, in contrast to subjective and objective realities, is a realm in which pragmatic information ($I_p > 0$) and where intentional agency (N > 0)—for example, in the form of psi effects—might be found. Maximizing objectivity in science ($C_{max}$) is believed to override any micro-PK effects, and thus a strategy of reducing C was implemented in an experimental scenario to facilitate the observation of micro-PK outcomes following principles proposed by Lucadou and Zahradnik (2004).

Strong evidence for micro-PK was found on subjective data when objective data were erased. On average, participants recalled numbers associated with more positive images than expected by chance in the $C_{reduced}$ condition when the corresponding objective data were not inspected. The recalled numbers correspond to what would be expected by chance when objective data were additionally analyzed in the $C_{max}$ condition. Although this finding was initially questioned by a confound concerning presentation/recall order, an additional pre-registered a priori manipulation of C confirmed this main finding. In circumstances in which previously uninspected objective data concerning the number of positive target images presented to the individuals were permanently erased from the result files, micro-PK effects were again obtained with subjective memory data. Thus, an experimental reduction in the data's scientific objectivity led to positive micro-PK results. The subjective data are just an indirect indicator of the real picture presentations, and their measurement quality is limited owing to memory biases (this aspect served the purpose of reducing C). However, subjective data correlate substantially with objective data sets, which demonstrates that they are a reliable approximation of the objective rate of positive images. Additionally, any analysis of the objective data confirmed a null effect, with varying degrees of Bayesian evidence supporting the predictions made by standard quantum mechanics (Born, 1926) in a $C_{max}$ measurement context.





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In the past, the frequently reported decline effects across studies in the micro-PK research field have been attributed to an increase in confirmation when original findings were replicated (e.g., Bierman, 2001; Lucadou, 2015) and to the reduced N (i.e., diluted intentional impact) at work in later performed replication studies. This interpretation is nevertheless vulnerable to alternative interpretations. For example, the decline effect could also indicate false positives within the original data, or later studies' quality might be higher than those performed earlier, even if some of these objections have been ruled out (Bierman, 2001). The study presented here tested the MPI's conjectures by experimentally manipulating C. In this way, any alternative explanations for null effects may be ruled out. The results of our data suggest that micro-PK effects depend directly on C, supporting the explanation for the elusiveness of micro-PK effects offered by von Lucadou and colleagues.

Although an emphasis on manipulating C was made in the study presented here, the manipulation of N was kind of neglected, which might be considered a downside of this study. The intentional goal for reality construction used here was the participants' preference for positive pictures supported by subliminal priming. Another, maybe better option would have been to explicitly instruct the participants to approach positive picture presentations during trial observations. Such an implementation of a more active intentional goal might have been a better manipulation of *N* instead of the more passively present positivity preference applied here. Past micro-PK research successfully used such active intention inductions (e.g., Jahn et al., 1997) and a recent high-power micro-PK study using an active goal induction reported by Mossbridge and Radin (2021) found evidence for micro-PK in a first data set that could be replicated in a pre-registered analysis of micro-PK data in a second dataset. This finding might indicate that a strengthening of participants' intentions in terms of more actively induced goals could produce replicable effects in micro-PK and overcome the detrimental effects of C. Future research in micro-PK should further explore this stabilizing effect by emphasizing intention (N) possibly in addition to variations of C. As outlined above, our reason to stay with Dechamps et al. (2021, Study 1) original design was to ensure $C_{max}$ from the beginning of our new data collection, but admittedly this study carried the disadvantage of only imperfectly manipulating N. However, the manipulation of N, albeit potentially suboptimal in our study, successfully served its purpose to induce a goal-dependent creation of positive picture realities as documented by the results obtained from the $C_{fully\text{-}erased\text{-}reduced}$ subjective recall data. The exploratory analyses revealed some anecdotal evidence for gender differences in some of our dependent variables in the eraser experiment. Although this tentatively confirmed similar findings in micro-PK research reported by Jahn et al. (1997; see also e.g., Mossbridge & Radin, 2021), the analyses performed here were only exploratory in nature and did not reach a convincing level of empirical evidence. A theoretical interpretation about the role of gender within our data is thus premature and needs to be replicated in future research. Nevertheless, our results partially confirmed Mossbridge and Radin's (2021) argument that gender effects might play a relevant role in micro-PK research.





The study presented here tested the impact of intentional observation on quantum-based stochastic outcomes under experimental variations of the applied measures' objectivity. As predicted, an intentionally congruent bias in quantum-based outcomes was observed using subjective recall data when simultaneously objective data were not inspected and finally erased (i.e., confirmation was reduced). Quantum randomness was confirmed in a maximum objective data collection context for both stored and recalled data. These results indicate that $I_p$ was transferred during trial observation. Since neither the objective quantum and classical physical world nor the world of subjective experience contain $I_p > 0$, the results can only be explained by a third form of reality that serves as an interface between the two.

The approach developed in this research when replicated in a future study might at some point suggest the existence of a subjective reality that may be located between the subjective-objective distinction. This implies that it can only be tested with a reduced-objective design but still in a quantitative manner and is thus not merely a matter of subjective beliefs. In this regard, the natural laws obtained from scientific research in classical and quantum physics—which exclude intentional agency (Schrödinger, 1958)—may be considered a special case that implies certain restrictions to the measurement process, with the MI defined as a channel that passively registers the measurement outcome. We may speculate that the idea that our objective world, at its deepest level, might be caused by random events is merely a consequence of maximizing the confirmation procedures in science (e.g., direct replication, separation of MI and MO, etc.). Thus, it seems that our world might be guided only by randomness when viewed through the lens of objective science. In this case, the big bang, evolution, and everything that exists are primarily based on initially random processes that are subsequently shaped by the laws of nature. The potential influence of intentional agency is excluded from this world owing to a narrow definition of measurement considered to be passive observation (Jahn & Dunne, 1997). The existence of a sobjective reality, as tentatively documented here, renders the influence of intentional agency in the creation, or emergence, of reality a plausible alternative possibility. A worldview based on either deterministic laws or intentional creation is thus a matter of how measurement is conceptualized. Moreover, even in pure physics experiments, the data are finally observed by human beings, and thus a $C_{max}$ approach might be merely an idealistic assumption. Future research should endeavor to replicate the findings reported herein and explore other designs to study the influence of a reduction of C on objective and subjective data. The confirmation of such an effect might then have implications for our worldview that transcend the limited domain of psi research. In addition, the operationalization of N and C in the present study is just a first attempt towards an understanding of these concepts and their effects on micro-PK. Future research should explore additional factors that contribute to N and C to allow a more precise definition of these concepts that goes beyond the rather superficial definitions originally provided by von Weizsäcker (1974). Our research should be considered as just a first step in this direction. Finally, we would like to emphasize that our explanatory framework is not the only plausible explanation for micro-PK effects and their decline (e.g., May et al., 1995) and our study was not planned as a decisive experiment to rule out alternative explanations. It rather provides evidence for the role of confirmation (C) in micro-PK and should be considered as one among many other theories explaining micro-PK.

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