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Collecting evidence for the permanent coexistence of parallel realities: An interdisciplinary approach

by

Prof. Dr. Christian D. Schade

Email: cds@wiwi.hu-berlin.de

Collecting evidence for the permanent coexistence of parallel realities:

An interdisciplinary approach

Abstract: This paper assembles an interdisciplinary 'presumptive evidence proof' for the existence of parallel worlds, hence supports physics in solving the interpretation problem of quantum mechanics by making use of theory and experimental findings from psychology, philosophy, and the neurosciences. It will demonstrate that two questions are closely intertwined: the question of whether an *actual free will* exists and the *interpretation of quantum mechanics* chosen. Specifically, the paper will argue that whereas there is no room for an actual free will if the *Copenhagen interpretation* of quantum mechanics (postulating the 'disappearance' of Schroedinger's wave function and the appearance of a singular state under measurement) is adopted (the same is true with other interpretations involving a collapse of the wave packet), an actual free will is possible if specific versions of the *multi-verse interpretation* are chosen. This point cannot be made directly. In fact, it can *only* be produced within the proposed, interdisciplinary 'presumptive evidence proof' for the co-existence of parallel realities. Finally, the paper tentatively suggests an 'interpretation' of the many-worlds interpretation that circumvents some of the 'strange' ontological implications that this perspective exhibits according to some of its previous interpretations and develops a view on how free choices might actually be made.

Keywords: parallel realities, consciousness, freedom of choice, 'many-worlds' inter-pretation(s) of quantum mechanics, Copenhagen interpretation of quantum mechanics, time, decision-making

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Interpretation of quantum mechanics as an interdisciplinary effort

Numerous interpretations of quantum mechanics (QM) have been proposed, and the theoretically most coherent – but also most thought provoking – of them, the many-worlds interpretation by Everett-DeWitt (Everett 1957; DeWitt 1970, 1971) – or any other, more recent version of the multiverse view –, would have huge consequences for our worldview also outside physics. Building conclusive evidence for any of the multiverse interpretations within theoretical and experimental physics alone is rather hard or perhaps even impossible at this point. Therefore it is important to take into account theory and experiments also from other scientific domains that are of fundamental relevance in this regard.

Consequently, the paper is assembling a 'presumptive evidence proof' to go as far as possible with making the permanent coexistence of parallel realities plausible. Specifically, the paper crafts an interdisciplinary approach, predominately based on physics, psychology, neuroscience, and philosophy. In the center of the argument are considerations on *free will*. According to any version of the multiverse view, *different realities* permanently coexist. Whereas this view uncomfortably suggests that our everyday experiences are based on a somewhat limited (or at least incomplete) picture of the actual world, other interpretations of quantum mechanics also come at a price.

As the paper is going to argue, other interpretations of quantum mechanics such as the popular Copenhagen interpretation – postulating a 'wave function collapse' resulting in a singular reality – are inconsistent with the existence of an *actual* freedom of choice – whose proposed absence is intuitively rejected by most people outside science (Nichols, 2011). Interestingly then, the line of arguments Hameroff (2012) quite recently presented in favor of an existence of free will in light of quantum brain biology will turn out to be partially

related to the respective argument presented in this paper on the one hand. However, on the other hand, whereas Hameroff (2012) argues that the objective reduction modification of quantum mechanics (Penrose 1994; Hameroff and Penrose 1995) – a singular-universe approach – would also be able to 'rescue' freedom of choice, this paper will argue that the latter is only possible in the multiverse. More precisely, this paper will show that quantum mechanics *is* free-will friendly, but only if we (a) allow for the permanent coexistence of parallel realities and (b) if specific 'interpretations' of the many-worlds interpretation are chosen. As our analysis is going to demonstrate, one of the existing multiverse interpretations (the EEC by Mensky 2005, 2007a,b, 2010) is indeed free-will friendly. It will turn out, however, that this approach has strange consequences, ontologically, as any other of the existing multiverse interpretations to be analyzed in this contribution. Hence the paper will tentatively propose a new interpretation of the multiverse whose consequences might be seen as ontologically less irritating. The paper will finally address the question how free choices might be made, what it actually means to freely choose between alternatives in the multiverse.

The contribution is building up primarily on the seminal works by David Deutsch (Department of Atomic and Laser Physics, Centre for Quantum Computation, Clarendon Laboratory, Oxford) and Michael Mensky (Lebedev Physical Institute, Russian Academy of Sciences, Moscow), both very outspoken about their preference for a multiverse interpretation of quantum mechanics, and both publishing their thoughts in scholarly journals as well as popular science monographs (for the latter see, e.g., Deutsch 1997; Mensky 2010).

Regarding the contributions by Deutsch, the paper is sharing many of his thoughts on the nature of time (see the proof section of the paper, step 3). Other basic premises of the

contribution are related to the work by Mensky, he himself mainly building up on the work by Squires (1988). According to Mensky (2010, p. 54), essential arguments against von Neumann's (1996) [1932] reduction postulate, explicating the Copenhagen interpretation, "will be connected with the phenomenon of consciousness". Hence, the idea that only an *interdisciplinary treatment* may suffice in generating a convincing case for the many-worlds view can be traced back to the works by Mensky (e.g., 2005, 2007a,b, 2010).[1]

The 'presumptive evidence proof' for many worlds is presented in a stepwise manner, as *pieces of a puzzle* that will finally form a coherent picture. The pieces of the puzzle are taken from different domains, mainly quantum mechanics (measurement/interpretation problem etc.), role of consciousness (in quantum measurement as well as in light of neuroscience findings), findings on/explanations of predictive physiological anticipation, and considerations on the possibility of free will (being at the core of the contribution). Interestingly, *within each* of these *domains* (i.e., quantum mechanics, free-will problem in philosophy, etc.) there are *alternatives* to treat or interpret the respective phenomena or theories, but the flexibility is gone when trying to form a joint perspective out of all those domains. Indeed, within each of those disciplines there is always just one approach that qualifies as piece of a puzzle appropriate to complete the picture. This idea is depicted in Figure 1.

The remainder of the contribution is structured as follows. In the next, main chapter, the paper will craft, in a stepwise manner, a 'presumptive evidence proof' for parallel existing realities. It ends with a long subchapter on freedom of choice and on interpreting the many-

[1] However, whereas Mensky's work is firmly rooted in the measurement theory of quantum mechanics, his psychological arguments are rather presented in the form of 'anecdotal evidence'. Instead, the goal of this paper is to push as much as possible towards a 'proof', given the interdisciplinary knowledge we have. This requires being as specific, as rigorous with arguments from psychology, philosophy, and the social sciences as with those from quantum mechanics. Furthermore, this paper is going to reverse some of Mensky's arguments. What he sometimes postulates for the sphere outside physics, this contribution shall employ together with (additional) empirical or theoretical evidence in favor of the respective phenomena, to substantiate the parallel and permanent coexistence of multiple parallel realities.

worlds interpretation in a form that is free-will friendly and makes sense, ontologically. This chapter is followed by a chapter addressing the question how free choices are made in the multiverse. The final chapter summarizes the results of the presented analysis and briefly outlines some consequences of accepting a many-worlds view for future research in different scientific areas and speculates on what consequences the adoption of a multiple realities perspective might have on how we see our lives.

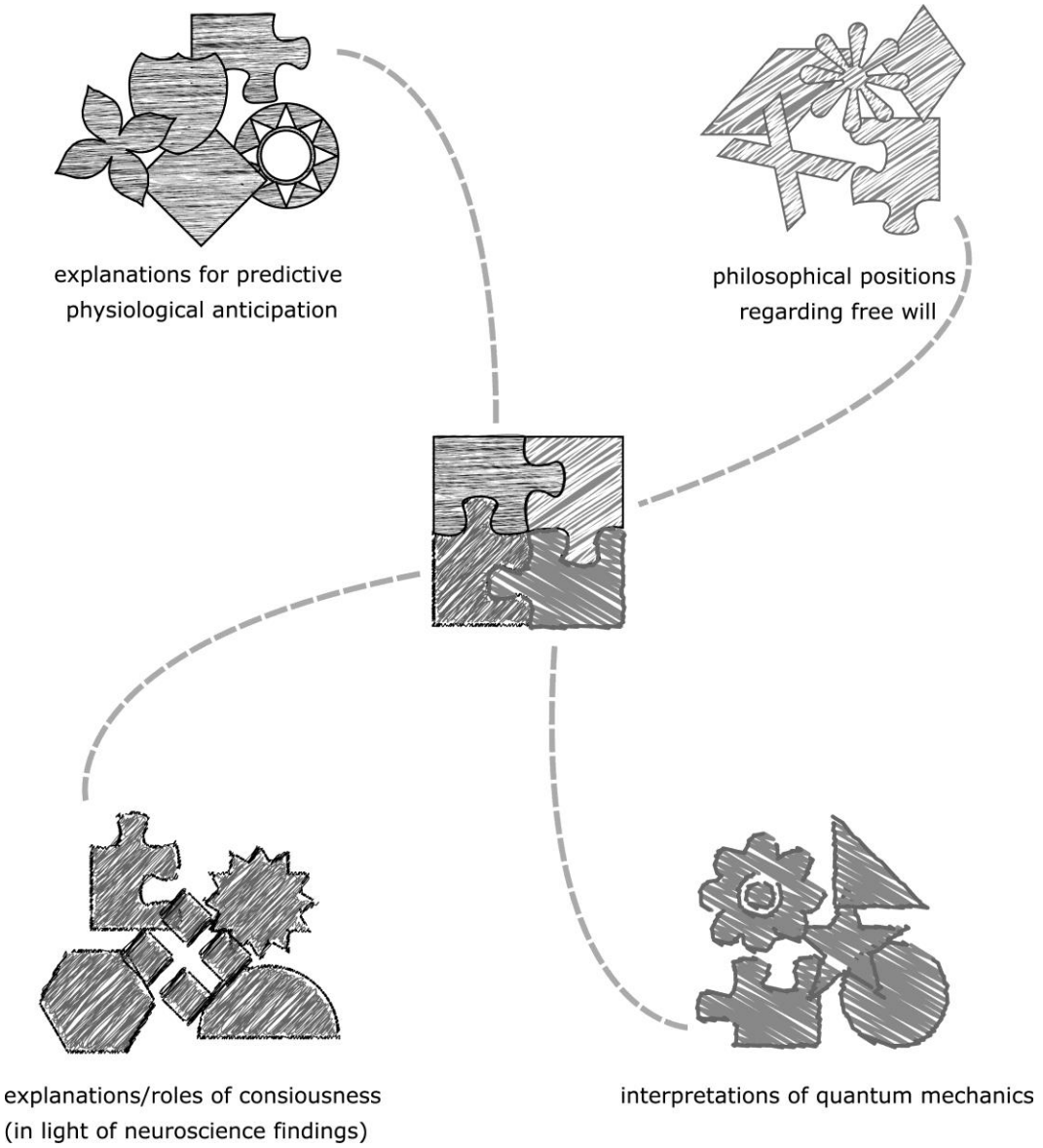

Figure 1: Structure of the interdisciplinary 'proof' of the multiverse

A 'presumptive evidence proof' for the coexistence of parallel worlds

Step 1: Many worlds as a convincing interpretation of quantum mechanics

Of the many possible interpretations of quantum mechanics (see, e.g., Auletta 2001), all being trials to address the so-called measurement problem[2], the most well-accepted so far have been the Copenhagen interpretation[3] (together with von Neumann's reduction postulate (von Neumann 1996 [1932])[4]) as well as the many-worlds interpretation, initially based on Hugh Everett (1957) and its further interpretation by Bruce DeWitt (1970, 1971).[5] In this article, I shall mainly concentrate on those two; although the objective reduction formalism[6] (Penrose 1994; Hameroff and Penrose 1995) will briefly be touched, and, as already mentioned, the many-worlds interpretation will again turn out to be interpretable.[7] Dealing with other interpretations is beyond the scope of this article.[8]

[2] An important aspect of the measurement problem is the fact that measurement results achieved on some quantum system are uninterpretable without taking into account the consciousness of the observer. This turns out to always be the end of a logical chain of reasoning defining a measuring device, then defining the brain as evaluating the result shown on the measurement device, etc.

[3] The Copenhagen interpretation of quantum mechanics is the one most representative of something that might be called a 'quasi-Newtonian' worldview; it is that interpretation of quantum mechanics that challenges the validity of our everyday experience in the least radical way.

[4] For simplicity, whenever the paper mentions the Copenhagen interpretation, this (most prominent) version of it is meant.

[5] Within the academic community in physics, other well-known current or past proponents of the many-worlds interpretation are, e.g., David Deutsch, Murray Gell-Mann, Richard Feynman, Stephen Hawking, Michael Mensky, and Euan Squires.

[6] Since objective reduction changes the formalism of quantum mechanics, it is actually more than an interpretation.

[7] Examples for interpretations of the many-worlds interpretation are found in Albert and Loewer (1988), Mensky (2005, 2007a), Squires (1988, 1991), (Zeh 1970), Barrett (1999), and in various contributions to the Oxford University Press Volume on "Many Worlds" (ed. by Saunders et al. 2012). The two main issues dealt with in those interpretations are the notion of probability and/or the distribution of consciousness between the parallel worlds.

[8] I am also not dealing with the description of the measurement problem via decoherence, since decoherence does not attempt to *explain* the measurement problem – and hence does not suggest an independent interpretation of quantum mechanics.

It appears to be hard to generate clear-cut experimental evidence within physics that can be interpreted in favor of either the Copenhagen interpretation or the 'many-worlds' view.[9] Bohr's complementarity principle, however, closely related to the Copenhagen interpretation and implying that physical entities may either behave as a particle or a wave but never both ways at the same time, got more and more undermined by experimental findings at the double slit.[10] By using very clever experimental designs, some research groups (see, e.g., Mittelstaedt et al. 1987; Scully et el. 1991; Menzel et al. 2012) have demonstrated that it is possible to partially or fully keep the interference pattern (wave-like behavior) whilst nevertheless measuring the path the respective particle was taking. Whereas those findings are unfavorable for the Copenhagen interpretation, they are leaving the many-worlds interpretation untouched.[11] Indeed, in his 1997 popular science book 'The fabric of reality', David Deutsch seems to indirectly base his argument pro many worlds already on those novel findings. When discussing the interesting change of the interference patterns of a singular photon sent through four versus two slits even though the way of the photon through one of the slits can clearly be identified (Deutsch 1997, chapter 2), he leaves the possibility unmentioned which has been demonstrated in an overwhelming number of older experiments: that measuring the path of the photon would often *destroy* (or largely diminish) the interference pattern; and that only very clever experiments lead to the new type of results.

[9] The situation is unclear enough that David Deutsch and Michael Mensky, two vivid proponents of the many-worlds view on the physics side, disagree on the evidence presented within physics. Deutsch believes that the experimental evidence generated within physics is already in favor of the many-worlds view (Deutsch 1997, chapters 2 and 3). He even *identifies* quantum mechanics with, how he calls if, the *Everett theory* (Deutsch, 2012). However, Mensky (2005, 2007a,b, 2010) argues that the evidence generated within physics cannot unambiguously be interpreted in favor of the multiverse view.

[10] The original double-slit experiment demonstrating the wave-like nature of light has been carried out first by Young in 1803, already; the first experiment of this type using electrons has been designed and carried out by Jönsson (1961). When carrying out those experiments and measuring the path of the electron (or of other particles) through any of the slits, the interference pattern normally gets destroyed.

[11] For another (hypothetical) way of potentially discriminating between different interpretations of quantum mechanics, see Deutsch (1985).

Sure enough, those novel findings at the double slit have not necessarily been interpreted in favor of the many-worlds view by other physicists. Just one, perhaps quite unspectacular example is a poster by Boscá Díaz-Pintado (2007) who discusses, in light of those novel findings, the necessity to change the formalism of quantum mechanics, to formulate further assumptions, to modify the complementarity principle etc. Nothing more 'radical' is mentioned.

There are more reasons, however, for taking the many-worlds view seriously (and seeing the Copenhagen interpretation quite critically): Taking the linear Schrödinger equation literally, as a description of the actual world[12], there is no need or even possibility to think of anything 'artificial' like a state reduction or collapse of the wave function to a singular universe. The Copenhagen interpretation, as convenient as it might be as a workhorse in applied physics, is just not parsimonious. The implied collapse of the wave function is 'alien' to quantum mechanics (Mensky 2005, 2007a, 2010, chapters 1 and 2).[13]

So it looks like if some evidence for the permanent coexistence of parallel worlds already evolves within physics, but skepticism regarding its potential to actually encourage a shift of paradigm towards a many-worlds view (both within and outside physics) is advisable. After all, shifts of paradigms require time and effort (Kuhn 1996 [1962]). This is the reason why this article is proposing an interdisciplinary search for evidence for the many-worlds view.

[12] A more precise view on the Schroedinger equation, accepting human epistemological limits, would be saying that it accurately describes our *room of perceptual possibilities* (see also FN 36).

[13] Neither Deutsch nor Mensky consider it a problem applying the many-worlds perspective to macro phenomena, i.e., our life, whereas the experiments underlying the measurement problem as well as quantum mechanics itself have originally been conducted or developed, respectively, for the world of micro particles. I am sharing this perspective with Deutsch and Mensky. A stream of research that does *not* help with better understanding the micro-macro link, is the experimental work showing that quantum effects (i.e., systems being in superposition states) already occur with somewhat 'larger' objects, with atoms or even molecules (see Venugopalan 2010), or even visible objects under very low temperature (O'Connell et al. 2010). (To keep things clear, only the object, a micromechanical resonator, is visible with the eye, not the quantum effects themselves).

Step 2: Role of consciousness in quantum mechanics –

not only important for the multiverse view

Many current theories of consciousness, e.g., many of the approaches proposed in psychology, are characterized by a reductionist approach where the work of consciousness is 'degraded' to some *specific cognitive operations*. Such type of theorizing (as well as the underlying empirical studies) would be categorized as belonging to the 'easy problems' regarding consciousness by David Chalmers (1995, 1996); whereas the 'hard problem' of consciousness could be described by questions such as "why are some organisms *subjects* of experience?" or "why do *qualia* exist?"[14]

From the perspective of quantum mechanics, consciousness – in the second, 'hard' interpretation as sort of a *pure subjectivity* – plays a central role in the solution of the measurement problem (e.g., Squires 1988; Mensky 2005, 2007a; Stapp 2009). Quantum systems – including the measurement device etc.[15] – are in a *superposition state* before any conscious observation is conducted; or in other words, a *unique result* or outcome of the measurement is – finally – determined whenever consciousness of the observer comes into play. Thus, paradoxes can be constructed such as Schrödinger's cat or Wigner's friend.[16]

The measurement problem is a fairly complex issue, but even trickier is the question as to how to make use of the effects of conscious observation in a multiverse 'proof'. The reason

[14] The term qualia describes the individual's conscious experience and is at the core of the mind-body problem. The term has first been defined in its modern usage by Lewis (1956 [1929]).

[15] The view that measurement per se (by whatever device) is at the core of the measurement problem will not be supported, here. There is no logical line that can be drawn between either the to be measured physical system and the physical measurement device, between the latter and the perceptual apparatus, between the perceptual apparatus and the brain etc.

[16] Wigner's friend is a thought experiment, an extension of the well-known Schrödinger's cat consideration. Here, a friend of the principal investigator conducts a measurement at some quantum system for him, e.g., measures the outcome of Schrödinger's cat experiment, whilst the principal investigator is absent from the laboratory. The question is when the outcome of the measurement is actually determined, only after the return of the principal investigator, or at a previous moment, e.g., when the friend has looked at the device but the principal investigator is not informed about the outcome, yet?

is that the role that the observer's consciousness plays in the solution of the measurement problem can be interpreted differently, in turn favoring different interpretations of quantum mechanics or being related to changes in its formalism (examples):

1. Consciousness can be seen as the 'force' causing the *collapse of the wave function* hence favoring the Copenhagen interpretation (Stapp 2009).
2. Consciousness might be interpreted as the entity responsible for *separating between infinite 'alternatives'* or 'alternative realities' (Everett 1957; DeWitt 1970, 1971).
3. Consciousness might also be *identified* with the *selection* of *one* subjective alternative (Squires 1988; Mensky 2005, 2007a,b, 2010).
4. And, based on the *objective reduction formulation* of quantum mechanics, there are approaches that link the action of consciousness to *processes in the brain* (e.g., Hameroff and Penrose 1995; Hameroff 2012).

Since nothing can be concluded at this point from the relation between consciousness and the measurement problem for the 'presumptive evidence proof', the paper will look at the action of consciousness from a different angle, later, when the issue of free will is dealt with. The four exemplary perspectives just presented, however, share the view of consciousness being at the center of a process of 'creation' of subjective reality.

Step 3: Individuals' bodies anticipate the future – and this makes only sense in the multiverse

This subchapter will report on evidence that people are able to anticipate the future. This *fact* is quite important for the multiverse 'proof' to be crafted in this paper because it makes a case against a linear flow of time with important consequences as demonstrated at the

end of this subsection; to make this point, it is not important that the most conclusive evidence for this ability actually pertains to *body reactions*. However, since free will is associated with conscious activity, we will nevertheless have to come back to this point later. The presented evidence has a close relationship with the findings by Libet and coauthors (e.g., Libet et al. 1982, 1983) as well as Soon and coauthors (Soon et al. 2008) that will play an important role in the next subsection.

In a large-scale meta-study on *anticipatory physiological responses*[17], Mossbridge et al. (2012) analyze a total of 26 reports published between 1978 and 2010. The authors find strong evidence for individuals' abilities to physiologically anticipate unpredictable events (randomly ordered arousing vs. non-arousing stimuli or guessing tasks with correct/incorrect feedback), no matter what type of physiological measure was used: "electrodermal activity, heart rate, blood volume, pupil dilation, electroencephalographic activity, blood oxygenation level dependent (BOLD) activity" (p. 1). In a fixed effects model, the overall statistical significance for predictive physiological anticipation turned out to be $p < 2.7 \times 10^{-12}$. The evidence is so clear, that (conservatively calculated) 87 unpublished contrary reports would have been necessary to reduce this evidence to chance ($p > 0.05$). Hence it is quite safe to conclude that individuals' bodies are able to anticipate future developments.[18]

What does this imply in terms of physical theory? Is there any way of explaining such effects of the future on the present? And why is this evidence supposed to help with the 'existence proof' of parallel realities? The question one wants to ask here is "are there ways to think of time as something that does not just flow in the direction we would normally suppose, from

[17] An example for this type of research is the study by Bierman and Radin (1997) where individuals' electrodermal response significantly differed between emotional and calm pictures already before their presentation.

[18] Interestingly, such 'time-backwards' effects have also been proposed as an explanation for some 'strange' behavior of particles (see, e.g., the experimental evidence reported by Herzog et al. 1995).

past over present to future"?[19] There are exactly two ways that physics has taken to deal with that question:

(1) Scholars have intensively thought about how physical laws could be applied the 'other way around', i.e., backwards.[20] There is one physical law, however, that seems to contradict such approaches because it appears not to be reversible: the second law of thermodynamics, i.e., the increase of entropy over time. If entropy increases over time, how could we possibly 'go back'? Time-reversing physical laws in a singular world, however, also runs into *logical paradoxes*, described in a graphic way in the form of the 'grandfather paradox'[21] in the literature on time travel. Although time travel seems to be a different pair of shoes than physiological anticipation, *any effects* of anticipating the future potentially leading to changes in an individual's present behavior so that the respective future will *not be reached*, anymore, leads to the same type of paradox.

(2) A second, more radical way is to question the idea of a flow of time altogether. Actually, this second approach should be judged as the theoretically convincing way, because it does not run into 'grandfather' type paradoxes. David Deutsch (1991) was the one who introduced a mathematical solution to this problem in his treatment of time travel (see also Deutsch and Lockwood 1994). Time travel does not lead to any logical inconsistencies *if* there are parallel universes. Specifically, the logical inconsistency of traveling to and changing one's own past is solved by switching

[19] For a systematic analysis of different physical theories regarding our subjectively perceived, asymmetric flow of time see Zeh (1999).

[20] A good impression of this type of research can be gained by looking at the numerous theoretical and empirical contributions to 'Frontiers of time: retrocausation – experiment and theory' (ed. by D. P. Sheehan 2006).

[21] In the grandfather problem, the time traveler goes back and kills his grandfather at young ages, actually before his father was conceived, so that the time traveler himself should not exist.

universes. After traveling to the 'past' and 'returning' to 'presence', the time traveler resides in a new, parallel reality. As already argued above, this consideration of the potential effect of time travel is relevant for our case of anticipatory responses of the human body since changes in the body's reaction that prevent the foreseen future involve the same type of paradox. In his popular science publication 'The fabric of reality', Deutsch (1997, chapter 11) develops different times as special cases of other universes.

Hence, a logically consistent theoretical account for the possibility of predictive physiological anticipation by individuals is only possible on the basis of a permanent coexistence of parallel realities. A graphic way of looking at both anticipatory reactions as well as our regular perception of a flow of time might be sort of 'lateral movements' between universes or realities or just 'locations'. Note that this is not to suppose that there is any novel, underlying physics needed for this. The underlying physics is the multiverse. The fact that we are normally moving from one reality to another reality, where the second reality is perceived as a 'later' point in time might be seen as a 'convention of conscious experience' or 'perceptual convention', perhaps rooted in culture. A different perspective on the same phenomenon would be Kant's view of time (Kant 1996 [1781], A30-2/B46-9 and A35-6/B52). According to Kant, "Time is not an empirical concept that is somehow drawn from experience. For simultaneity or succession would not themselves come into perception if the representation of time did not ground them a priori. Only under its presuppositions can one represent that several things exist at one and the same time (simultaneously) or in different times (successively)" (A30/B46).

This view has an important consequence for the one remaining problem that has been put forward against the potential existence of time-backwards effects: The second law of thermodynamics would not be a problem for 'time-backwards' effects, anymore. In the case of parallel universes, i.e., if 'different times' coexist, different states of physical entities with respect to their entropy would also coexist. And if conscious beings were able to 'laterally move' with their conscious 'emphasis' between those versions of themselves, i.e., across different realities/parallel times, this would imply that they were also able to 'move' between different states of entropy, say, of different versions of their body. That in turn implies that consciousness would be able to also 'move' in the direction of lower entropy[22], appearing as if the time arrow would have been reversed.

Summarizing this view, our perception of time could be described as taking 'snapshots' of different realities where some 'perceptual convention' or a priori category in the sense of Kant normally organizes them in the form of a unidirectional flow of time (for inspiring empirical findings on this matter varying the duration between 'snapshots' of various courses of action see, e.g., Gruber and Block 2012).[23] Since in principle other points in time are always present, however, this opens the door for time-backwards effects.

Step 4: Freedom of choice can only exist in the multiverse

1. Structure of the argument

As already mentioned in the introduction, empirical results across different cultures clearly demonstrate that most people intuitively believe to have a freedom of choice (Nichols

[22] A similar line of reasoning is presented by Mensky (2010) to better understand the survival of living beings. He relates this to the 'anthropic principle'.
[23] Hameroff (2012) gives an overview of different approaches and results underlining this idea.

2011). Also, philosophy has a hard time justifying *responsibility* of individuals for their actions without it; neuroscience however, seems to prove freedom of choice to be just an *illusion*, a position that has been widely discussed in the last couple of years.[24]

Besides the older, more general problem of incompatibility of free will with either a deterministic or an indeterministic worldview (Nichols 2009; see also Walter 2001), the quite emotional debate originated in the well-known Libet-experiments (Libet et al. 1982, 1983; Libet 1985) suggesting that the measured readiness potential for a motor action was running ahead of the reported conscious decision. Whereas there has been a critical debate about how to interpret those findings, e.g., by John Eccles (1985)[25], most interpreted them as evidence for (a) free will being *impossible* and (b) subjective perception of possessing free will being an *illusion*.[26]

The debate regained its vigor quite recently with technically more advanced neuroscience studies (Soon et al. 2008) where consciousness not only has been demonstrated to run *several seconds* after specific activities in the brain. But allowing subjects to actually *choose between two alternatives* (i.e., pressing a left or a right key), the authors were able to *predict* the respondents' choice for one of the alternatives based on *specific brain areas* that were activated before the conscious decision was reported. Or in other words, when a certain brain area would be activated, consciousness would make a choice for, say, left, a few seconds later, and after that the person would press the left key. The same would hold for the decision to press the right key, but with a *different brain area* activated ahead of time.

[24] For an overview and discussion of different philosophical perspectives on this problem and an interesting, compatibilist way of justifying different degrees of responsibility under a regime of determinism, see Walter (2001).

[25] The question *how* consciousness might influence (material) brain activities is further analyzed by Beck and Eccles (1992).

[26] Since the observed order of events in the experiments is: (1) readiness potential, (2) conscious decision, (3) action, Libet (1999) argued that consciousness might still be able to veto behavior. However, this argument has also been criticized. See, e.g., Velmans (2003) and Kühn and Brass (2009).

So the fact that people think they are consciously deciding in favor of pressing a left or a right key simply *must* be an illusion, no? So how *realistic* is our perception of free voluntary acts?

In the following it will be argued that Libet's findings can actually be used to *justify* the permanent coexistence of parallel realities. A couple of introductory thoughts are necessary at this point:

- The paper is going to employ a *teleological* argument[27]. It will be argued that having free will gives our consciously experienced life a *purpose* or meaning. And despite a large and important body of compatibilist (e.g., Dennett, 2003) and 'random-libertarian' (e.g., Kane, 2003) perspectives,[28] it might nevertheless be argued that such a 'meaning of qualia', a 'meaning' of our conscious life experience, is more difficult to identify if everything is either fully determined or the outcome of a random process. This is perhaps the main reason why most people intuitively reject the notion of an absence of an actual freedom of choice (Nichols, 2011). The paper will then elaborate on why experiments of the Libet type and modern followers (e.g., Libet et al. 1982, 1983; Libet 1985; Soon et al. 2008) do not necessarily rule out the possibility of an actual free will in the sense of being able to choose A instead of B under identical internal and external causes.
- Later in this subchapter, it will then be discussed what interpretation of the many-worlds view could make free will *possible* and what their respective ontological

[27] 'Questions about teleology have, broadly, to do with whether a thing has a purpose or is acting for the sake of purpose, and if so, what that purpose is' (Woodfield 2010 [1976], p. 1). Teleological or so-called design arguments have, e.g., been crafted in favor of the existence of God (e.g., Aristotle 1999 [350 B.C.], p. 5-6; Plato 2000 [360 B.C.], Timaeus 28a-34b; Aquinas 2006 [1265-1273], p. 19) or to disapprove philosophical positions such as the solipsism (Kant 1996 [1781], B 39 et passim).

[28] For a good overview of different positions on free will see Kane (2003) as well as Walter (2001).

consequences are. For this means, the paper will first briefly discuss how plausible the many-worlds interpretations are that have already been suggested by Everett-DeWitt, Albert and Loewer (1988), Squires (1988, 1991) as well as Mensky (2005, 2007a,b).[29] A novel interpretation that is free-will friendly and ontologically more appealing than the previously suggested ones will also be suggested.

- Still on the way of completing the argument, the chapter following this one will deal with the way *how* consciousness might freely choose between alternatives in the multiverse.

2. Freedom of choice might not be an illusion if different times are parallel

Regarding the existence of consciousness, a teleological perspective (see footnote 27) might lead to the following question: What could be the 'reason', the 'sense' of being conscious in the basic meaning of *qualia* (the 'hard-problem' aspect of consciousness; Chalmers 1995, 1996), if there is not any effect of this basic feature of consciousness on our decisions whatsoever? Note that asking this question is inspired by two (related) convictions: (a) Consciousness is not a byproduct of physiological (brain) activity, because qualia, i.e., our conscious experience of life, are something *qualitatively* different from physiological processes.[30] (b) Consciousness is neither supervenient on the physical nor does it influence any physical processes. This is a radical departure from many well-known approaches (e.g., Lewis, 1994), that, however, will become more transparent towards the end of this contribution.

[29] Recent realist perspectives (see Saunders et al., 2012) will not be discussed.
[30] A detailed discussion of this important and controversial matter as well as an overview of the relevant literature beyond the 'hard-problem' analysis by Chalmers (1996) is not possible in this paper.

Contemplating the question on the 'meaning' of consciousness, one is indeed tempted to conclude that consciousness might have the 'sense' of 'producing' something like a free will. Especially since the alternative perspective on *subjective experience*, watching of and acting in (with fixed roles) a technically advanced 3-D movie, with no possibility to change anything we see, is a view with hardly any teleological appeal.

But then, people might argue: "Nice thought, but how to rule out the argument put forward based on Libet's and followers' experiments? If consciousness is always running after the fact, freedom of choice simply *must* be an illusion, no?"[31]

Here is my argument: The discussion in step 3 of my 'proof' lead to the impression that parallel realities might grant us with the possibility of *laterally* moving between different times (because they coexist); this also being a theoretically consistent explanation for predictive physiological anticipation by individuals (or time-backwards phenomena in general). Assuming the appropriateness of this explanation, however, it is only a small step to also assume that consciousness is able to influence motor actions 'backwards' – or better laterally – in time. This in turn would allow for a very different perspective on the Libet type experiments: The fact that the experience of a conscious decision takes place *after* building the readiness potential for a motor action – or *after* observable activities in certain brain areas – would become meaningless for the freedom of choice debate.

In a recent publication, Hameroff (2012) also argues that consciousness might influence decisions backwards. And he states to have 'saved free will' despite Libet's and others' evidence. However, his argument is on the objective reduction formalism. This alternative explanation for an existence of free will be discussed at the end of this subchapter.

[31] For the theoretical foundation of this thought, see Dennett (1991); Dennet and Kinsbourne (1992).

3. Analyzing free-will friendliness and ontological consequences of different versions of the multiverse view

In this subchapter, some fundamental versions of the multiverse interpretation will be dealt with. They will all be analyzed regarding their free-will friendliness as well as their ontological consequences. A basic problem pertaining to all those multiverse versions is the question how to deal with the Born rule. Therefore the subchapter starts with this generic problem.

The problem with the Born rule: The Born (1926) rule, successfully used in practical applications of quantum mechanics for many decades and integral part of the Copenhagen interpretation predicts specific probabilities for measurement outcomes. For a multiverse perspective, this causes trouble in two regards: (1) How could one make any sense of probabilities in the multiverse, when in fact the Schroedinger equation is deterministic? How could the Born rule be derived within this framework?[32] (2) How could an actual freedom of choice possibly be established if probabilities of measurement appear to be governed by the Born rule?

(1) The problem starts with the fact that it is generally unclear (also outside the multiverse view; see, e.g., Landsman, 2008) what exactly justifies the Born rule theoretically (empirically, its support is excellent). After decades of different approaches, a few scholars have quite recently pursued ways to derive the Born rule from *subjective* principles, either decisions (Everettian view: Deutsch 1999; Wallace 2012) or

[32] See also the discussion in Squires (1991).

generalized probability theory (quantum bayesianism: e.g., Fuchs 2010). Both approaches assume the application of certain normative principles or axioms.

(2) Since an individual may not necessarily be *obliged* to obey to either the rationality axioms proposed by Deutsch (1999) and Wallace (2012) or the generalized probability theory proposed within quantum bayesianism[33], those approaches do principally open the space for freedom of choice; if, as assumed above, consciousness is not supervenient on the physical. But, given the excellent empirical support for the Born rule, is there actually any *room* for free will? The problem we seem to be facing here arises from a conflict between subjective and intersubjective perception.[34] Measurements carried out in physics as well as psychology laboratories are *reported* and communicated (that's the main point of carrying out those scientific exercises in the first place); their results become intersubjective facts. The Born rule is such an intersubjective fact. If individuals' consciousness would *measurably* and *intersubjectively communicable* influence the observation probability of quantum outcomes in a straightforward and replicable way, this intersubjective fact would be violated. Instead, an individual's influence on developments might rather be expected regarding non-measurable, non-reported, fuzzy, and complex developments; or, in other words: with respect to the individual, personal or better *subjective experience of life*. E.g., meeting the perfect person to marry, as improbable that might objectively be, may (a) nevertheless happen and (b) never violate the Born rule because it can simply not be analyzed within its framework. Admitted, this poses some problems for a direct 'proof' of the existence of freedom of choice. This is not saying that it pre-

[33] Outside quantum mechanics, e.g., in economics and psychology, there are large research fields devoted to the understanding of deviations of people from rational decision principles (e.g., Kahneman and Tversky, 1979) or the Bayes rule.

[34] For a related perspective see Mensky (e.g., 2005, 2007a; 2010).

cludes clever experiments on this matter to be carried out in the future. But it helps understanding why evidence does not exist so far and why the existence of any freedom of choice can only be suggested indirectly at this point, as is the case with the 'proof' of the multiverse (see again the introduction, especially Figure 1, for the underlying logics). The solution to the two problems is intertwined.

Opening the space for freedom of choice: EEC framework as a starting point: According to Mensky's (2005, 2007a) multiverse interpretation, the extended Everett concept (EEC), consciousness is indeed able to influence subjective probabilities so that preferred developments of the world are *perceived* with higher probability within the individual's subjective experience, but without changing anything in the *wavefunction*[35] (see also the quite similar thought presented in Squires (1988, p. 18)). This feature arises from the fact that in the EEC interpretation of the multiverse, consciousness is *associated* with the selection of alternatives, a different idea than 'consciousness separating between alternative realities' – the original Everett-DeWitt view. In EEC, consciousness, instead of passively residing with all possibilities given by the Schrödinger equation, gets an active role. According to Mensky, the question of free will can then be addressed as follows: "What is *free will*? … all alternative behavior scenarios are present as superposition components but the subject can compare them with each other and increase the observation probabilities for the alternatives that seem more attractive to her" (Mensky 2007a, p. 403).

[35] Menky (along with many others) would call the Schroedinger equation the 'objective wavefunction' associating the Schroedinger equation with the physical world (see also FN 12). An important question is, however, whether or not the wavefunction is really objective. The Schroedinger equation might alternatively be seen as describing accurately our room of perceptual possibilities; close to 'objective' reality, but not identical with it. Since it contains a time dimension and individuals organize reality along the time dimension, the setup of the Schroedinger equation might be manmade. Certainly, people in different areas of the planet will all get support for the Schroedinger equation. But given the epistemological limits of mankind, the Schroedinger equation might rather be called *intersubjective* than objective.

It is quite clear that the EEC interpretation of the multiverse is free-will friendly since the individual is supposed to have an influence on what world of the infinite number of worlds to experience: consciousness is not obliged to 'stay' with all parallel worlds. However, there are three issues with Mensky's concept of free choices that require clarification:

- One issue is that Mensky only 'allows' the unconscious to have access to parallel realities (see, e.g., Mensky 2007; 2010), a thought consistent with the fact that the best evidence for individuals getting knowledge of the future is physiological (hence unconscious) (Mossbridge et al., 2012; see also the above discussion); but how could consciousness then make any (free) choices if there is only one reality left to perceive? A potential solution would be that the number of parallel realities that consciousness considers is smaller than the number considered by the unconscious, but sometimes larger than one.[36] Conscious choices between alternatives could subjectively be experienced in the form of phantasies or case studies.[37]
- The other issue is that Mensky's concept somehow equates perception with choice, a problem that will be addressed in the next chapter because sorting this out it also relevant for the concept of densely and sparsely populated universes, i.e., the novel multiverse version that will be proposed, below.[38]
- Finally, a major problem of the EEC – not directly related to the freedom of choice problem – that will turn out, however, to be quite relevant for the development to

[36] 'Sometimes' is an appropriate description since in many cases choices are made by the unconscious leaving nothing left to decide for consciousness.
[37] More precise than the English 'case studies' would be the German term 'Probehandeln' that had already been used by Sigmund Freud.
[38] In psychology, perception and choices are traditionally treated as separate processes (see, e.g., the textbooks by Hayes 1994; Lefton 1994). To the best of my knowledge, Mensky's position regarding the relationship between perception and choices is not clearer, unfortunately, in any of his publications so far.

be pursued here pertains to the *solipsism*[39] that Mensky's approach necessarily generates. This implies that EEC is ontologically problematic as will be demonstrated in the following.

Towards a free-will friendly *and* ontologically convincing multiverse interpretation: Different authors (Everett 1957; DeWitt 1970, 1971; Albert and Loewer 1988; Squires 1988, 1991; Mensky 2005, 2007a,b; Zeh 1970) have proposed different basic interpretations of the multiverse.[40] Each of those interpretations offers a different idea about how consciousness is *distributed* between parallel realities. Whereas the EEC concept is accommodating to free will, other existing interpretations are not.[41] The analyzed concepts are somewhat 'strange', ontologically. Hence, a new multiverse interpretation will tentatively be sketched.

Everett-DeWitt interpretation: The original account by Everett-DeWitt simply postulates that consciousness is *separating* between different realities; those realities being the result of infinite branchings of the universe. This first theory of the multiverse has been criticized by Albert and Loewer (1988). They argue that this approach is incompatible with the conservation of mass problem.[42] Even more critical for the line of arguments presented here, this approach appears to open no room for free choices since branchings are assumed to be 'automatic', and consciousness is assumed to follow all of them on equal footing.

EEC interpretation: We have seen that the *EEC interpretation is free-will friendly* (Mensky 2005, 2007a,b). But EEC has a huge disadvantage, ontologically. To illustrate this, I am going to provide a simple choice example. For the sake of simplicity, I will not pay any attention to

[39] According to the philosophical position of solipsism, a person can only be sure of her own existence. A nice overview is given by Fumerton (2011).
[40] Further interesting interpretations of the multiverse that are, however, not useful in the course of my argument, can be found in Saunders et al. (2012).
[41] This also applies to recent 'realist' interpretations of the multiverse that, from my point of view, do not allow for the existence of an actual free will (for an overview of such approaches see Saunders et al., 2012).
[42] It is beyond the scope of this article to evaluate this criticism.

the blurred boundary between choice and perception (see above), at this point; this problem will be addressed in the next chapter. A couple, Tim and Louise, jointly decides whether to buy a Volkswagen or a Toyota as the sole family car. Louise wants a Volkswagen; however Tim wishes to buy a Toyota. Let me further suppose that *both* are *fully* successful in perceiving those realities they would like to see (Mensky 2005, 2007a,b, 2010, chapters 1 and 2). So Tim's consciousness realizes a Toyota, Louise's realizes a Volkswagen. This implies having to deal with *two parallel worlds* where in one of them, Louise is happy with Tim and the Volkswagen, whereas in the other, Tim enjoys his marriage with Louise and their Toyota. The problem with this 'wonderful world', however, can be derived from Table 1 where the two individuals are listed in the rows, the two different realities in the columns.

		Alternative realities	
		Reality 1: VW	*Reality 2: Toyota*
Alternative individuals	*Louise*	Consciousness present	Consciousness absent
	Tim	Consciousness absent	Consciousness present

Table 1: EEC and the 'zombie' problem

The consequence is that there is no alternative reality where *both* individuals are present with their consciousness. From now on, each of the two partners lives with a 'zombie', since consciousness is turned away crosswise from the respective realities of the spouses. In this example, freedom of choice would be rather unlimited, but would have an extremely high price, too: to basically live *alone*. This potential problem of some multiverse interpretations has already been detected by others. Barrett (2003, pp. 186-192) calls it the 'mindless-hulk'

problem, and although not crafted for the criticism of EEC (because Barrett's monograph preceded EEC) it fully applies to it.

I would like to again argue here in a teleological sense, by stating that living in a world of 'zombies' would intuitively not make much sense to me and would at least be perceived as quite unappealing or just 'strange' also by many other people. Although there are well-known proponents of (moderate) *solipsism* such as Schopenhauer, stating that 'THE world is my representation' (Schopenhauer 2010 [1818], p. 23), Kant, e.g., has argued against such a position, actually in form of sort of a teleology: "It still remains a scandal to philosophy and to the general human reason to be obliged to assume, as an article of mere belief, the existence of things external to ourselves … and not to be able to oppose a satisfactory proof to anyone who may call it in question" (Kant 1996 [1781], B 39).[43]

Universal consciousness interpretation: Squires (1988), when suggesting the same kind of 'selection' of one reality by the individual as Mensky (2005, 2007a,b), realized the solipsism problem and also argues in a teleological way: "… how do we ensure that different observers see the same result? … I suppose I am here making the untestable(?) assumption that most people that I meet are conscious" (Squires 1988, p. 18). But then he makes a radical proposal that must be seen as an independent interpretation of the multiverse: "The only solution to this problem seems to be that "consciousness" has a *unity*, i.e., there is, in some sense, one consciousness which knows the result as soon as I … have made an observation. This *universal consciousness* must then guide the selection of any subsequent observer" (same page). Requiring 'one consciousness' coordinating all individuals' measurements on one

[43] The following humorous statement by Karl Popper shows how difficult this discussion actually is: 'I know that I have not created Bach's music or Mozart's […] I just do not have it in me' (Popper 1999 [1956], p. 83). Although this consideration nicely demonstrates that Popper simply cannot be *alone*, it does not necessarily lend support to other visible entities possessing consciousness.

consistent picture of the world (Squires 1988, 1991), however, is bringing back a singular reality 'through the backdoor'. Also, this view is *not* free-will friendly, since the 'one consciousness' would have to kind of 'dictate' the individuals' measurements/choices.

Many-minds interpretation: Albert and Loewer (1988) propose a 'many-minds view', related to the earlier one by Zeh (1970).[44] This perspective is closer to the original Everett-DeWitt formulation than the perspectives suggested by Mensky and Squires; other than Everett-DeWitt, however, it explicitly brings in a probabilistic element. Albert and Loewer (1988) propose an infinite number of minds whose proportions of perceiving one or the other outcome of a measurement are assumed to resemble the probabilities of the "experimentally verified probability rule of quantum theory" (i.e., the Born rule; see also Squires 1991, p. 283, in an article comparing his and Albert and Loewers' (1988) view). So if two outcomes of a measurement are, say, equally probable, half of the minds will see one of the two outcomes, and the other half will see the alternative outcome. The authors admit that "this talk of infinitely many minds sounds *crazy*" (Albert and Loewers 1988, p. 207)[45]; Squires (1991) adds that he is not sure '… that the idea of an infinite number of existing minds … makes ontological sense' (p. 285). Since the probabilities are assumed to be given, Albert and Loewer's interpretation is not free-will friendly, either.

Densely and sparsely populated universes: So we are left with two equally problematic alternatives; the free-will-friendly EEC by Mensky, leading to solipsism, and all other interpretations not being free-will friendly for different reasons. At the core of the problem is the question how consciousness is assumed to be *distributed* between alternative realities. All

[44] Differences between those authors' and Zeh's (1970) 'many minds view' will not be analyzed in this article.
[45] Sure enough, they developed this account for one purpose, only: to solve theoretical problems of the Everett-DeWitt formulation that they had earlier discussed in their article.

interpretations that have been proposed, so far, indeed served the extremes: Consciousness is seen as residing with just one or all realities.

But what is the alternative? One possibility would be having densely and sparsely populated universes in terms of the amount of consciousness allocated to them.[46] Let me introduce this concept by using the allegory of a torch light, whose cone of light is brightest in the middle, and where the light intensity fades with more and more distance from the center. Let me assume that each individual's consciousness is distributed in the same way as this cone of light. There is one reality where the center of consciousness resides, and there are neighboring realities where less consciousness resides. The 'distance' from the center is measured in terms of differing choices. Let us look at a situation where our individual in the middle of the cone of light (the one with the strongest consciousness) decides to take a left turn at some traffic light using her car. In the multiverse, there will always be a 'replica' (a term used by Deutsch in many of his publications) taking the right turn. Now, the 'replica' taking the right turn is slightly off the center, with slightly reduced consciousness. The more choices a certain 'replica' has made that differ from the choices of the 'center individual', i.e., the larger the distance from it, the less bright the light of the cone, and consequently, the lower the amount of consciousness allocated to this individual. In other words, there is a smooth removing of consciousness from realities that are close to the 'center individual', a strong removing of consciousness, however, from those that are located 'many decisions away'.[47]

[46] I am very grateful to Tanja Schade-Strohm for suggesting this solution to me in a discussion.

[47] Clearly, two questions are open to debate. First, it is unclear whether the 'center individual' will always be perfect in 'picking' the reality that is 'best' for her life or survival (and only the 'replicas' are characterized by less optimal choices). In fact, this might be very unlikely in case of, e.g., unresolved traumata or auto-destructive motives. Second, it is unclear whether only the 'center individual' has the power to make choices (and drags the others along), or whether each of the 'replicas' has some (perhaps small) influence on where the light cone moves (making the presented concept slightly more complicated).

Given this reasoning, we may either find ourselves in rather densely populated universes, defined, say, as a cluster of 'similar realities', where a lot of consciousness from many individuals resides (where many bright areas of the light cones meet); the condition being that many individuals have made decisions that get them into those 'similar reality clusters'. Or we are going to find ourselves in sparsely populated universes, where only few people have made choices leading them into our reality, and, consequently, where consciousness of others is involved to a smaller degree; and there might certainly be many cases where the situation is located somewhere in the middle between those two possibilities. However, since consciousness is only removed smoothly, there are no universes with actual "zombies". Or to stay within the allegory of the torch light, there is no darkness around the individual, even if only distant parts of the light cones of the other individuals/'replicas' reach that reality.

Although this novel interpretation clearly needs to be further elaborated in future contributions, I would like to argue that it is *free-will friendly* because people[48] have an influence on the reality to be experienced (with what degree of consciousness) and that it *makes more sense, ontologically*, than interpretations leading to either solipsism or to consciousness splitting according to the Born rule etc. Following this novel interpretation, consciousness is *partially* decoupled from the physical world by being able to choose how much emphasis to put on what types of realities.

[48] As already discussed in the last FN, the question whether only the 'center individual' possesses freedom of choice or whether part of this ability also pertains to other 'replicas' has to be left open, here.

4. Objective reduction and entanglement as an alternative to 'save free will'?

Quite recently, Hameroff (2012) also argued that Libet-type findings might be consistent with free will if consciousness where able to influence the actions of the brain/body as well as individual's choices 'backwards' – and, based on quantum brain biology, he is convinced that consciousness has this capability. However, there are two reasons why one might question that Hameroff's interpretation, based on the objective reduction modification of quantum mechanics, is able to 'save free will':

1. *Reappearance of all paradoxes connected to time-backwards effects*: Hameroff's argument that only 'acausal' information will be sent backwards (Hameroff 2012, p. 11) is hard to swallow. Either the respective information *changes something*, e.g., a choice, or it doesn't, where in the latter case it is irrelevant, no? Only the *multiverse* interpretation of quantum mechanics is able to account for changes in the 'past' that are inspired by the 'future' and in turn change the 'future' (see Deutsch 1991). I simply do not see how any single-universe interpretation or the objective reduction formalism – both involving some sort of collapse of the wave-function – would allow for this.
2. *The material world has to wait for all of us?* If one follows Hameroff's theory regarding the fact that microtubules in the brain are able to maintain quantum states for a substantial time period (recent evidence appears to be in favor of this part of his theory; Science Daily, January 16th, 2014), how would freedom of choice play out outside the respective individuals' brain in a singular universe? Does the outside world 'wait' for, say, one or two seconds for *each* individual's brain to decide what reality to

'select', and how would 'bargaining' between different brains take place if preferences are different?[49]

Those arguments show that Hameroff's (2012) way of demonstrating the possibility of freedom of choice in an objective reduction framework is implausible and hence no alternative to the respective claim based on the multiverse interpretation presented here.

What is a free choice in the multiverse?

It turned out that free choices appear to be in principle possible if certain versions of the multiverse interpretation are adopted (either EEC with the unappealing consequence of solipsism or the densely and sparsely populated universes interpretation). So it might be tempting to ask how that works. Consciousness is associated with *perceiving* a specific outcome of the measurement process (see above). In psychology, perception and choices are traditionally treated as separate processes (see, e.g., the textbooks by Hayes 1994; Lefton 1994). So *how* could consciousness actually produce *free choices*?

One possibility of interpreting the action of consciousness is indeed that an individual's choices are *automatic*, given the perception that she has, and that freedom of choice works *indirectly*, via the ability of consciousness to influence what will actually be perceived. This is a complex thought, and an example will be used to clarify. It starts with a classical (non-quantum), decision-theoretic analysis: Julia wants to buy either a Volkswagen or a Toyota. If she perceives the Volkswagen as more reliable than the Toyota, she will buy it (unlike in the above example with Louise and Tim, there is no conflict between partners here; we may

[49] Note that there is a similarity between this 'bargaining requirement' and the argument made by Squires (1988) in the framework of his multiverse interpretation: universal consciousness; that perspective has already been critically discussed above.

think of Julia being a single). If she perceives the Toyota as more reliable, she will buy that car. Thus, given her *preferences* (only reliability is relevant!) and her respective (automatic) *perception* of the reliability of the two cars her choice is fully determined.[50] This simple decision-scientific analysis is depicted in Figure 2. In this as well as the subsequent Figures 3 and 4, the smiley represents the point where people think they decide.

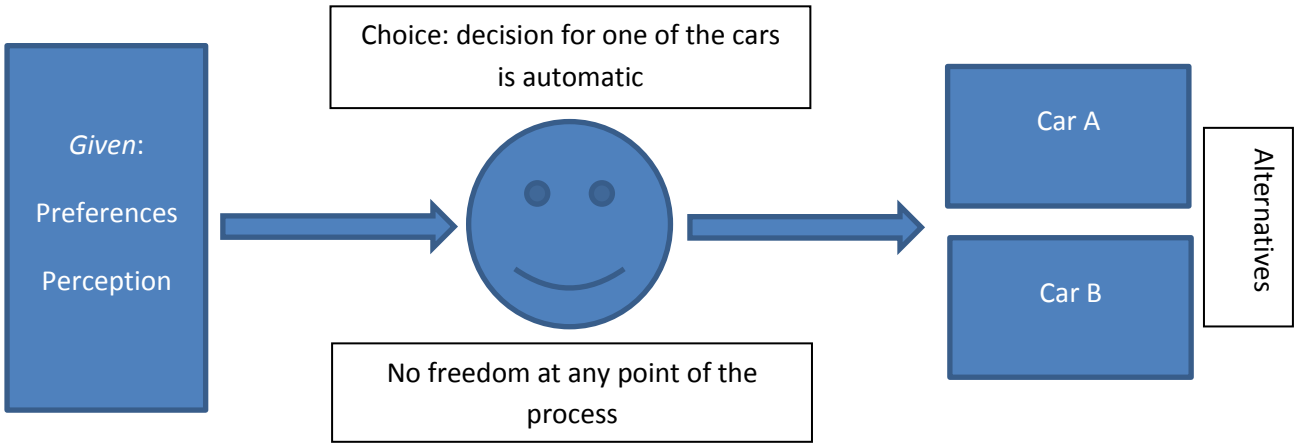

Figure 2: Freedom of choice in a decision-scientific framework

But let us now assume that her consciousness is able to *choose how she perceives* the reliability of those two cars simply by 'choosing' that alternative reality (more precisely, influencing the probability of subjective observation) in which one or the other car *is* more reliable. Then, freedom of choice could play out in the *choice of the reliability perception* or more precisely, in enlarging the probability to observe this specific reality; given this operation, the choice of the car is still automatic (see Figure 3).

[50] For the sake of simplicity, the analysis is abstracting here from many complexities of those decisions, i.e., using heuristics, falling prey to biases etc. This picture is hence closer to a normative rather than descriptive decision-theoretic account.

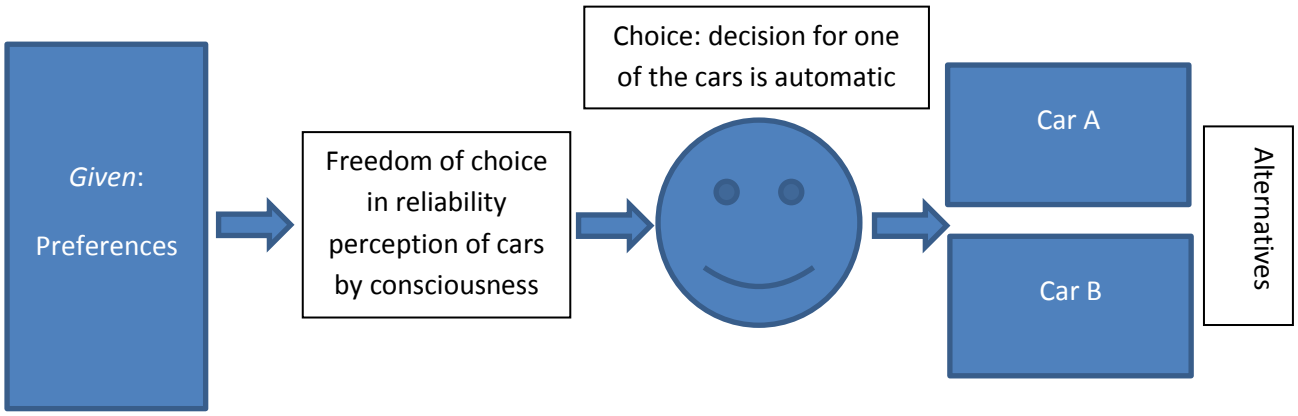

Figure 3: Freedom of choice when choosing how to perceive different realities

Another possibility of thinking about this problem is that not a certain characteristic of an object is perceived (here, the reliability of a car) – and a decision will automatically be made based on this perception – but instead the 'attractiveness' of different alternative realities already *including the choice* of a specific car (see Figure 4). Let us assume that parts of those possible realities are the different choices that Julia *has made*. So Julia can 'opt' between perceiving a reality in which she *has chosen* a Volkswagen and a reality where she *has chosen* a Toyota. If the reality with the Volkswagen turns out to be more attractive (still with the reliability of the car being the only component that differs), her consciousness may opt for perceiving this version as 'real'. So again, freedom of choice would be applied rather indirectly, by choosing to perceive a reality where a certain, favorable choice had been made. It is important to note how consistent this description appears to be with what was discussed above when the experiments by Libet and coauthors were compared with those on predictive physiological anticipation (Mossbridge 2012). Specifically, it was argued that both perception and conscious decisions appear to work backwards and that those processes might be related. This is exactly what the interpretation just sketched is about: Everything is about choices what reality to perceive!

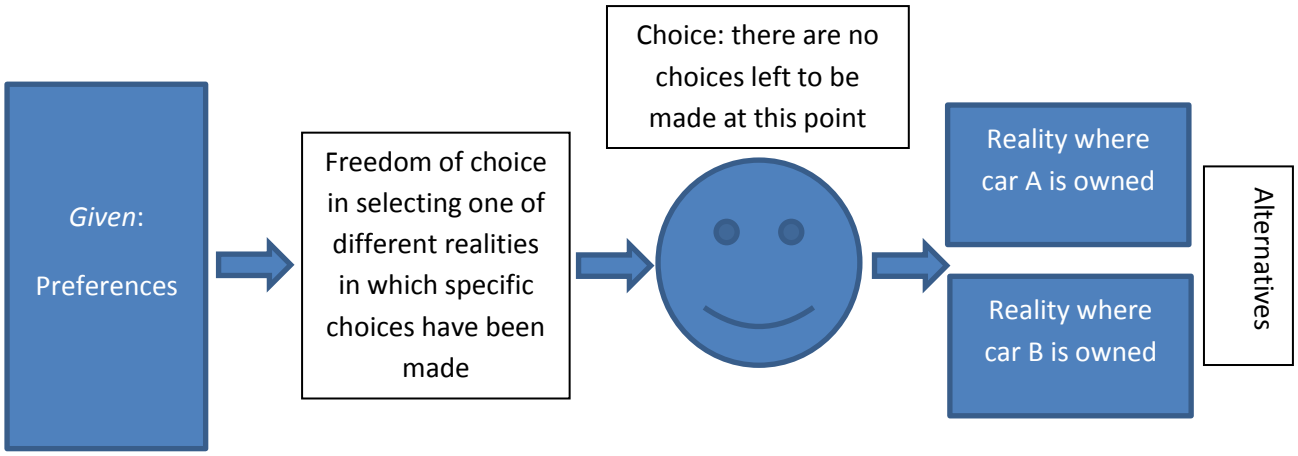

Figure 4: Freedom of choice when choosing in which reality to reside

Thus, the theoretical perspective depicted in Figure 4 appears to be the one that is most consistent with the reasoning presented in other parts of this paper. As a consequence, this would imply that the type of freedom of choice that the multiverse allows us to have is a *freedom of perception*. We have the perceptual freedom to opt for experiencing certain realities rather than others. Moreover, this means that although consciousness is not supervenient on the physical, at the same time is has no influence on the physical (such a claim was earlier made and it should have become more transparent at this point). But although consciousness has no influence on the physical, possibilities of perception are in principle infinite – even if the *degree* of flexibility in actually choosing between those 'films' is unclear at this point and might differ considerably between individuals and situations.

Summary and potential consequences for research and worldview

This contribution presented free-will friendly versions of the multiverse interpretation (one of them, a version sketched for the first time in this paper, might also be judged as ontologically acceptable). This required giving up the idea of a linear, unidirectional flow of time (for which empirical evidence has been reported and which is in principle consistent with the

multiverse view). In fact, the entire reasoning turned out to be exclusively possible in the multiverse. This partially was the case because the Libet-type evidence would otherwise prove the conscious experience of choosing between alternatives to be an illusion. Hence, the message of the paper is clear: Freedom of choice, actually in the form of a freedom of perceived choice, comes hand in hand with the multiverse. So if we insist on qualia having a purpose, and if we insist on freedom of choice being that purpose (both being teleological arguments), then we in turn have an indirect 'proof' of the multiverse.

What would be the consequences of accepting such a multiverse perspective? The remainder of this last chapter will first briefly look at research in different areas and then at how we might see our lives. Regarding research: Progress in the proposed direction in each of the below fields will potentially 'harden' the evidence pro many worlds, given the idea of a 'presumptive evidence proof' proposed in this paper and the concept of fitting pieces of a puzzle depicted in Figure 1.

Potential consequences for different fields of science (examples)

1. Quantum mechanics:

If the perspective developed in this paper would further encourage a change in perspective towards the multiverse view, research might be stimulated on how to empirically support the multiverse interpretation of quantum mechanics *within* physics or perhaps even in an interdisciplinary effort.

2. Free will in psychology, philosophy, and the neurosciences:

Given a change in perspective towards the possible existence of an actual free will, research will perhaps try to show the exact mechanism how consciousness produces free choices, perhaps in a joint effort of all those three disciplines.

3. Bridging eastern and western philosophy:

Part of the beauty of the multiverse view lies in the fact that it is deeply rooted in western science, hence closely related to western philosophy (or better: epistemology), whilst simultaneously lending itself to interpretations that are fully in tune with eastern philosophy with its dominance of the (subjective) operation of consciousness.

4. Developing a science of consciousness (as a separate, however interdisciplinary, field):

Another reasonable judgment appears to be that the acceptance of a multiverse view will lead to a *shift* in the science of consciousness: towards identifying and better understanding the function of consciousness, i.e., how the individual's consciousness *navigates* through the multiverse. Also, specific functions of consciousness (additionally to freedom of choice) could be identified.

5. Building a new basis for the decision sciences and game theory:

At the core of the decision sciences are the concepts of preferences, perceptions, probabilities, and choices. Closely related, game theory is dealing with strategic interaction between individuals where (potentially different) perceptions of the game situation and expectations about the counterparts' behavior come into play. Since identical aspects were

at the core of the analysis presented in this paper (but the treatment very different from current decision sciences and game theory), the effects of accepting a multiple realities perspective on those fields would be substantial.

Consequences for how we see (and live) our life

The most dramatic shift when moving towards a multiverse view might be the resulting understanding of the *plethora of possibilities* how to live our life since freedom of choice can be justified within this framework. Even though the exact flexibility we would have for perceiving different realities is unclear and most certainly dependent of the individual and her circumstances, this might, in turn, leave less space for people feeling as 'victims of circumstances' than in a deterministic or probabilistic, single-universe worldview. Rather, it should strengthen the *perception of responsibility*. And people who understand having an actual influence on what they experience in their lives might also act differently, less fearful, perhaps, and more optimistic.

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