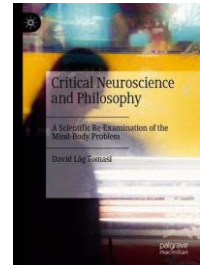


# Elements of Mathematical Logic for Consistency Analysis of Axiomatic Sets in the Mind-Body Problem

From *“Critical Neuroscience and Philosophy. A scientific re-examination of the mind-body problem”*

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*In this analysis, our neural activity will be actually mediating the impulses, stimuli and information coming from “the other substance and the*

*substance of the other” (once again, also in Levinasian sense). As an example, we could think of the limbic system, and more specifically of the*

*To briefly summarize the main positions related to what we have discussed so far, we could start from the fully reductionist-materialist*

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*perspective found in a monism fully focused on neural process, activities which are not underlying anything, they are not neural underpinnings of psychological processes, because there is no distinction, whether ontological or even theoretical between psychological process and neural activities. Neural equals to psychological in this view, which –depending on the epistemological weight posited– can be fully defined as neurologically-based monism (it is the case of Hebb and Pinel, for instance) or “neurophilosophical eliminative materialism” (the “Churchlands”). Mario Bunge proposed a “systemic psychoneural monism” which, from a certain perspective is the common view in many contemporary neuroscientists, especially cognitive and computational, but on the other side fails, in our opinion, to*

*a) add any major change to the classical positions on the mind-body problem, and*

*b) it is still very unclear on the combining-reacting-producing factors that link internal (even if*

*fully neurological-matter-based) and external (even if fully justified in evolutionary-biological terms) environment. In this sense we can certainly talk of an “explanatory gap” as in Levine (1983)*

*An “agnostic monistic view” is what is to be observed in neutral monism, where there isn’t (again) any distinction between mind and matter, but there is also no knowledge, actual or possible (and achievable) of this “neither matter-based nor mind-based entity”, a (form of) being which is perceived (by us and by our experimentation, thus appears) very material under the lenses of external-empirical, evidence-based science, and yet has some “ideal taste” as “felt from the inside of our minds, of ourselves.”*

*This view is, in practice, not very distant from the dualism found in Spinoza, where there are separate (thus independently existing) processes, mental (psychological) on one side, and cerebral (neural) on the other, but the function “in parallel.” “Pushing dualism to the*

*extreme” means to account for spiritual, mystical, mysteric, religious, transcendental, esoteric, (etc.) experiences, which by definition (again, a very rooted form of experiential definition) are not against the proposals and verified proofs obtained via the scientific method, but they also go far beyond what reductionist views in the science (again, not in science per sé e in sé) claim. A more agnostic “front” in this form of dualism (to some extent found also in Chomsky) views mind and matter as existent, yet unknowable, and in this sense it is also shared by certain mysteric perspectives with the aforementioned neutral monism, in some sense incorporating a “yin-yang” outlook on the whole of reality. A view that more strongly suggests not only the existence of separate entities, but also their interaction in reality is found in interactionist dualism (at the center of the traditional forms of psychology and psychoanalysis, starting with Freud, and in philosophy with the Cartesian offspring). Within interactionism we should also account for naturalism, defining both sides of the spectrum*

*as “fully natural” in the sense that there is no such thing as supernatural, although this view would be rejected not only by some exponents of psychological-psychoanalytic theories such as Jung, but also by followers of Popper. In naturalism therefore, the view is that (depending on “how strong” this naturalism is in the proponent):*

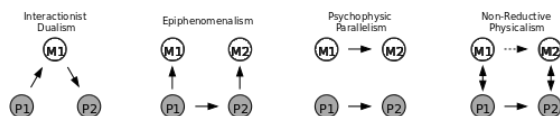
- a) Yes, there is a mind-type of substance, but it is fully controlled by neural (i.e. materialistically-intended natural) processes, or*
- b) –which creates an added layer of uncertainty and logical problem– if mind is understood as separate from matter, and matter is fully equivalent with nature in the senses that natural processes are one and the same as neural processes (even considering the theoretical separation between them and psychological or sociological*

processes), than claiming that this view is not fully (1) monistic, and (2) materialist/reductionist is somewhat of a misnomer.

Of course, the traditional, albeit not always common, way out of this impasse is represented by hylomorphism, either in the classical Aristotelian sense of connection between mind and form or in the developments of neoplatonic and scholastic views (especially Universal hylomorphism of Avicenna in the first case, Thomistic dualism of Aquinas in the second) as well as in the more recent developments such as the ones proposed by Jaworski (2016). As it follows, many of these positions present at least some contradictory aspects of comparison, whether on just one side, i.e. specific characters related to matter, or the other, e.g. defining elements of mind.

**Table 4.** Most common views in philosophy of mind, according to the model proposed by Baxter (2010), more specifically dualism, epiphenomenalism, psychophysical parallelism and non-reductive physicalism.

As we have seen, many of the challenges in examining the validity of each of these philosophical positions regarding the mind-body problem and the related hard problem of consciousness have to do with such conditioning definitions (Table 4). Many theoreticians, including Stanislas Dehaene, Shiro Ishikawa, Leopold Kronecker, Colin McGinn, John Taylor, Sybil Wolfram, and many others, both classical and contemporary, have dealt with the connections between mind-body problem, consciousness, language and semiotics, philosophical logic, and mathematics. It would be impossible to account for all the outcomes of each of the studies published in this context in this work, but we could try examining the most important elements of the philosophical discourse therein, by using very basic equation modeling as example.



*For instance, let us hypothetically assign the coefficient  $x$  and  $y$  to mind and matter (we will not make any distinction with body and or brain, yet), respectively. We could start by a reductionist equation such as the one evidenced in the Hypothesis a1:*

$$H_{a1}: x \equiv y$$

*In this case, we are simply stating that  $x$  and  $y$  are the same, i.e., for every character(istic) of  $x$  we would find an exactly equal character(istic) of  $y$ . We would obviously call this type of equation “reductionist” rather than “materialist” because of the very nature of the statement “it is equal to”, which does not allow for preeminence or prevalence of matter (for which we would use the term materialist) or mind (for which we could use the term mind-based or similar). In this view, mind and matter are simply identical. Of course, if there is absolutely no difference between  $x$  and  $y$ , than this equation would not make sense (i.e. it would not be needed) except from (abstract) philosophical or linguistic (especially semantical) considerations. These considerations are truly important as we will see, especially given some*

*very interesting theoretical parallels between philosophical and neuroscientific research on consciousness and aother areas of scientific investigation such as physics, in particular, quantum mechanics. In fact, using the term “materialistic” in this context, thus following perspectives compatible with the Copenhagen interpretation, would refer to essential (ontological?) elements of matter. “Matter” in this sense could be viewed –literally, given the observer’s perspective at the center of quantum mechanics– as related to:*

- a) An observable physical structure or process, thus empirically verifiable, and*
- b) The defining element needed for predictability purpose, as in the expected “probability wave” or “matter wave”*

*inherent to an observed particle.<sup>2</sup>*

*Of course, in the context of critical neuroscience, i.e. the application of quantum mechanics-based explanation of consciousness, we could say that, depending on the observer–observing instrument we would see behaviors we would expect from a particle as opposed to behaviors we would expect from a wave. In both cases, the crucial point is, in fact, this expectation which truly involves “looking out for”, “waiting”, “anticipating”, “deferring action”, and even “hoping (that or for)” and “believing (that or for)”. This is a fundamental point in that, claiming this identity between matter (in our case, the brain or the neurological processes) and mind (psychological process but also possible metaphysical or even spiritual, transcendental elements) truly depends on our perspective.*

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<sup>2</sup> This is an obvious reference to the “double slit” experiment, the Bohr’s model, and the Schrödinger’s equation.

*Thus, not only philosophical perspectives are not useless because “they do not reach any ultimate (absolute) solution to the mind-body problem,” but they are the determining factor for finding these solutions. We could even say that the solutions are to some extent created (in our view) by these perspectives, in that if we do not observe (for instance, in the case of quantum mechanics) an electron, it will behave like a “matter wave”, while if we look at it (i.e. we use experimental observation) it will behave like a particle. Of course, there are still doubts on the applicability of such theoretical assumptions from quantum mechanics to neuroscience, however, if assuming the complete equality between  $x$  and  $y$  in the equation above turns out to be wrong, we could incorporate such theories in morphing the equation into the Hypothesis  $b$  which simply states that the two variables are actually equal, not necessarily identical:*

$$H_b: x = y$$

*Of course, generally speaking this could be viewed as a simple equation without any intrinsic value, as it simply compares the equivalent element in  $x$  and  $y$ . However, this does not truly solve the problem, for the basic reason that a) "some equations are statements, some are meant to be solved, some are not," and b) if we claim equivalency between  $x$  and  $y$ , we should still use Hypothesis a1. A possible (incomplete solution) would be "adding more to the matter," i.e. relating the two variables in terms of material equivalence, as in Hypothesis a2:*

$$H_{a2}: x \leftrightarrow y / x \Leftrightarrow y$$

*This material equivalence however, presents two added aspects:*

*a) It posits a biconditional logical connective (in the second case of  $\Leftrightarrow$ ) between  $x$  and  $y$ , thus an "if and only if" carrying necessity and sufficiency, and*

*b) It involves (in propositional logic terms, or  $\leftrightarrow$ ) further investigation on the concepts of "valence" vs. "value".*

*For point a) there is of course a theoretical assumption of time vs. space to be considered, which presents a practical application of Heideggerian consideration on essential Being of matter vs. mind. In other words, this "if and only if" presupposes at least two moments, either temporal-chronological or spatial between:*

- 1. The observation of  $x$  and spatial between the observation of  $y$ , and*
- 2. Between the first/primary observation of  $x$  and  $y$  and the second/secondary observation of  $x$  and  $y$ .*

*Thus, observation is truly time-framed and space-framed. Therefore, trying to define this connection between mind and matter after (i.e.*

*following) observation is, from this perspective, a fallacy, possibly even meaningless. Of course, in the examples above there is an intrinsic problem in even considering mind and matter as variables, both on a purely logical level (i.e. the primary investigation at this level is their interdependency, not their essence as define by special-particular features, characters, or traits) as well as from the perspective of experimentability (i.e. we could possibly examine both of them only indirectly).*

*For point b) we have to further examine valence and value in relation to psychological and neurological processes, and relate those processes to what we already discussed in terms of ethical and moral decision making. In this sense, our decision of looking at something, including processes themselves, is preconditioned by our decision of:*

*a) Deciding to look in the first place (all meanings thereby included),*

*b) Looking for or towards something and not something else, and*

*c) Looking “in a certain way” or “from a certain perspective”.*

*Certainly, the same problems encountered on the free will debate apply to the mind-body problem as well, in that this decision is itself influenced and influencing –thus constrained– in these assumptions, not completely free from these parameters. In order to understand, at least from a purely logical point of view the levels of freedom of this decision, we have to go back to the level of freedom of the entity making this decision, i.e. whether decisions are fully the product of matter (for which we will have to move back many steps following evolution in biological terms) and vs. or the product of mind, which (again) requires investigation on warrant for existence of two separate, independent variables, our x and y. Given the discussions above, we could at least argue that, for the sake of observable processes, x and y appear to*



behave as if they both existed independently and (dependently or independently) worked on different levels, using or creating different processes, and possibly following different (albeit non necessarily non-contradictory) laws. A possible approximation might be defined by the set:

$$\mathbb{U}1: x \sim y, x \approx y$$

However, whether we chose a weak or strong approximation, the set would not make any sense at all, if (once more) this choice would not be justified in either temporal or spatial sense or given the context of possible applicability of the set in different circumstances. This would obviously represent a dualism in itself as we would (for instance) posit and apply a full identity-equality-equivalence of  $x$  and  $y$  when applying Newtonian physics to certain observations we make (it would be the case of neural correlates), and we would posit and apply a non-identity-equality-equivalence of  $x$  and  $y$  when applying Quantum mechanics to other observations. Following this dualism in and of

theories, the same set would need to be slightly modified:

$$\mathbb{U}2: (x \sim y) \cup (x \approx y);$$

$$\mathbb{U}3: (x \sim y) \cap (x \approx y);$$

$$\mathbb{U}4a: (x \sim y) \subseteq (x \approx y) \text{ vs. } \mathbb{U}4b: (x \sim y) \supseteq (x \approx y)$$

Let us analyse these sets for a moment. In  $\mathbb{U}2$  we can see that a weak equivalence between  $x$ -mind and  $y$ -matter is united to a strong equivalence between these two variables, while in  $\mathbb{U}3$  we observe an intersection of these two levels of strength. However, applying this significance in the context of consciousness would mean that the same order of magnitude found in the connection  $\sim$  would account for an approximation based on logarithmic calculation, while the isomorphism defined by  $\approx$  would mean that mind and matter are *structurally* identical. To be more specific, if we are to say that  $x \sim y$  that the approximate measure of the size of (in this case) the mind (or the computational value vs. number associated to it), would be equal to the base 10-logarithm rounded to a whole number,

and the same number would be what would quantify matter. Thus, we could see how mind and matter could be, at least mathematically, connected by a computational relation, or, in other word, via the analysis of computational valence providing the same number for both entities. Saying instead that mind and matter are structurally identical is actually going beyond their mathematical number, or that, in a hylomorphic sense, hyle and form present the same structure. It thus follows that in  $\mathbb{U}2$  computational value and structure for mind and matter are united, in the sense that the connecting elements of mind and matter are found either in  $(x \sim y)$  or  $(x \approx y)$  or in both. The set  $\mathbb{U}3$  instead clearly states that *all those connecting elements are shared by  $(x \sim y)$  and  $(x \approx y)$* . This is certainly no small difference given what we previously said about the quantum element of observation present in order to discern those connecting elements. Which set should we therefore accept as valid? If  $\mathbb{U}1$  only presents these two type of connection, and  $\mathbb{U}2$  “only” provides a general

(probabilistic?) function of presence of such elements,  $\mathbb{U}3$  might *appear* too “confident” in stating the existence of all connecting elements, whether on a computational or structural level in boths sets. A possible redefinition of the significance of the set is to be found in  $\mathbb{U}4a: (x \sim y) \subseteq (x \approx y)$  vs.  $\mathbb{U}4b: (x \sim y) \supseteq (x \approx y)$ , which simply states the comparison-contrast between the possibility that every element of  $(x \sim y)$  is also an element of  $(x \approx y)$  for  $\mathbb{U}4a$ , and the possibility that every element of  $(x \approx y)$  is also an element of  $(x \sim y)$ . Of course these are all hypothesis, but the fact that they might not be verifiable “objectively” might actually be connected to the “valence of decision and the decision of valence” in a philosophical sense, especially given a) the multiple significance of each mathematical symbol used in this context, and b) the needed warrant for the application of mathematical constructs on subsets of neural vs. psychological constructs. Now, the assumption here is that we can theoretically create a separation between *x and y to verify the existence of such separation, which truly appears*

to be a contradiction in terms. Furthermore, things are complicated by the fact that not only this separation might truly be an artificial one, but also that the artifice to obtain such result is created by the observer/decision-maker or observation/decision-making (cut-off) method. Thus, we would at least attempt to calculate the probability that each of these solutions might actually be “close to truth” in a statistical approximation sense. Thus, using the *p*-value to calculate the statistical probability for each of the hypotheses  $H_{a1}$ ,  $H_{a2}$ , and  $H_b$  we could start from verifying:

- a)  $\Pr(x)$ , thus limiting the investigation on whether ether is (enough)<sup>3</sup> warrant for (independent) existence of mind
- b)  $\Pr(y)$ , thus limiting the investigation on whether ether is

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<sup>3</sup> Of course, the underlying question here is whether we can still use computational elements to even calculate not only the degrees of freedom in statistical sense, but also the levels of possible

- (enough) warrant for (independent) existence of matter
- c)  $\Pr(H_{a1})$ , for identity (structural, computational, etc.)
- d)  $\Pr(H_{a2})$ , for material equivalence (biconditional logical connective in terms of necessity and sufficiency for existence)
- e)  $\Pr(H_b)$ , for equivalence (as opposed to equality)

Certainly we could do the same at each intersection thus applying the above to all the sets  $U1$ ,  $U2$ ,  $U3$ , and even  $U4a$  and  $U4b$ , although we think that, beside this being an interesting (read: entertaining) opportunity for logico-mathematical analysis, it would still yield results to a test which we have previously chosen, thus an *a priori* decision in the full sense. More specifically, since we are talking about a) a

increase vs. decrease in evidence to support such warrant.

possible comparison between computation and structure (hyle vs. form), and b) probability ( $p$ ) value, it might be appropriate to remove, or at least account for fixed significance thresholds as opposed to incremental values. This would mean interpreting our results as grades/degrees, steps, or stages of the “strength of evidence of existence” against the null hypothesis. We should at the same time be very careful in not “assigning value to the value”, given that our investigation is about the parameters which could help us define the existence of mind and matter as either completely separated entities, combined or interacting entities, or if we should only talk about one entity, in turn presenting with features appearing connected to a mind-based series of process or activities or a matter-based series of process or activities. Therefore, although starting from a test for probability value, is fundamental to understand that the  $p$ -value is not the probability that the null

hypothesis is true, or the probability that the alternative hypothesis is false, which is especially important in the context of quantum mechanics, given that it represents the *prior probability* of an observed effect given that the null hypothesis is true, and not the *posterior probability* that the null hypothesis is true given the observed effect<sup>4</sup>. Again, “no observation after observation.”

Going back to  $H_{a2}: x \leftrightarrow y / x \Leftrightarrow y$ , we should really follow our previous discussion and rewrite this hypothesis as a set of hypotheses:

$$\mathbb{U}[\mathbb{U}(H_{a2})5a \text{ vs. } \mathbb{U}(H_{a2})5b]: \mathbb{U}(H_{a2})5a: (x \leftrightarrow y) \subseteq (x \Leftrightarrow y) \text{ vs. } \mathbb{U}(H_{a2})5b: (x \leftrightarrow y) \supseteq (x \Leftrightarrow y)$$

To simplify, we would leave aside for now the differences between  $\mathbb{U}(H_{a2})5a$  and  $\mathbb{U}(H_{a2})5b$  in terms of subset vs. superset, and we would only focus on the connection in *propositional logic terms between  $x$  and  $y$ , i.e. between mind and matter. In any case, we are interested in*

statement on  $p$ -values: context, process, and purpose". *The American Statistician*. 70 (2): 129–133.

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<sup>4</sup> For further reference, see bibliography, especially Wasserstein R.L., and Lazar N. A. 2016. "The ASA's

seeing whether the assumption of possible ontological separation between these two variables and the following (in purely logical terms) connection-mutual influence between them can be theorized in a simpler form. Certainly, this is an oversimplification of the very complex logical analysis of the mind-body problem, but we would like to be especially “mindful and parsimonious” in regard to the application of Occam’s razor to critical neuroscience in the context of the hard problem of consciousness. Thus, let us go back to our original hypothesis by “splitting” the sets into smaller components:

$$\mathbb{U}[\mathbb{U}(Ha2)5a \text{ vs. } \mathbb{U}(Ha2)5b]$$

$$\mathbb{U}(Ha2)5a: (x \leftrightarrow y) \subseteq (x \Leftrightarrow y) \text{ vs.}$$

$$\mathbb{U}(Ha2)5b: (x \leftrightarrow y) \supseteq (x \Leftrightarrow y)$$

$$H_{a2}: x \leftrightarrow y / x \Leftrightarrow y$$

$$H_{c1}: x \leftrightarrow y$$

$$H_{c1}: x \rightarrow y \text{ vs. } H_{c2}: x \leftarrow y$$

In  $H_{c1}$  can be defined as “mind over matter” and  $H_{c2}$  as “matter over mind” in the sense that the

arrows represent an implication (“it implies”), a (logical, psychological, process-based, computational) direction, or function. In  $H_c$  these arrows are bidirectional, thus “implying mutual implication” between mind and matter. This view represents the core of dualism, although to better define which type of dualism we are talking about (for instance Substance dualism, Predicate dualism, Property dualism, but also Epiphenomenalism, Interactionism, Non-reductive physicalism, Occasionalism, Parallelism, Universalism, etc.) we suggest we operate a further split, from:

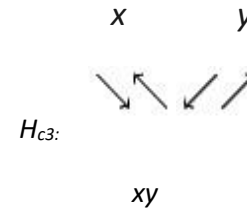
$$H_{c1}: x \leftrightarrow y$$

to:

$$H_{c2}: x \overset{\Leftrightarrow}{\leftarrow} \rightarrow y$$

With this hypothesis we actually suggest a third element to provide such explanation, in practice moving from different dualistic modalities to a position close to neutral monism, in the sense that:

- a) *The variables x and y exist independently on an ontological level and yet they are influencing one another. This contradiction between independency and dependency is solved by a<sup>1</sup>) the dependency between x and y is not direct but indirect (the arrows do not touch), and a<sup>2</sup>) the paradox is represented by the “third element” above (the arrows on top), and*
- b) *This connection-mutual influence happens on two different planes/levels, intended either as horizontally vs. vertically or parallel vs. perpendicular*



*With this hypothesis<sup>5</sup> another type of neutral monism is presented in strong connection with interactionist perspectives. Thus, whether we are talking about a monistic (single) entity with two (or more, as we will see) interacting aspects (faces) or dualistic (two) entities interacting with one another, this interaction happen indirectly, thus a) on a different/separate(d)/ulterior level or b) neutrally, with respect to mind vs. body. This perspective will obviously bring us back to other triads in the context of neuroscience, psychology, and sociology, most especially Social Cognitive Theory (SCT), as seen in Table 5:*

*Another way to represent this hypothesis could be this type of relation:*

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<sup>5</sup> A similar view and representation has been presented by Herald Atmanspacher, first in 2004 and then in 2015 in the Stanford Encyclopedia of Philosophy. For further reference, please see

Atmanspacher, H. 2015. *Quantum Approaches to Consciousness*. Stanford, CA: Stanford Encyclopedia of Philosophy.

*Although the application of SCT is on the learning process, in terms of education and knowledge acquisition via observation, and this observation is directed towards (the) other / (the) external, thus through experiences, media / environmental influences, and social interactions, the underlying idea of a “third element” can provide further basis for a movement beyond dualism, not in the sense of a separation between two variables (in our case  $x$  and  $y$  for mind and matter), but a separation between planes, even between dimensions; in this context between two dimensions and three dimensions. Of course, considering a tridimensional conceptualization of the mind-body problem would immediately make us think of Trinitarian theories, especially in the metaphysical or theological sense, but also in relation to the physical dimension of structural features, for instance the double helix of the DNA. In this regard, we would like to briefly mention the work by Francis Collins, who focused on a) human nature, b) the divine origin of evolution, genetic (sub)structure of creation*

*(including us humans), and c) moral law (as perceived by us humans) and altruism through a philosophical analysis at the basis of his research on the Human Genome Project. The most important aspect of this perspective is the presumed scientific requirements that science demands atheism from within (although it would be interesting to see, also in reference to the related studies by Pinker and beyond evolutionary perspectives, if it would be correct to talk about “faith” or “hope” in the case of an atheist saying “Come on! Please! Score!” while watching a football game). In other words, science uses itself to claim that it is more scientific to expose a position in which there is no warrant for (a) god than the other way round. Collins presents numerous fallacious assumptions of the concept of a deistic vs. theistic and personal god, religion, religiosity, and spirituality, including Mark Twain (“Faith is believing what you know ain’t so”), Sigmund Freud (“the belief in God is just wishful thinking”) and the one by Dawkins ([Faith is] “blind trust, in the absence of evidence, even in the teeth of*

evidence”) (Tomasí, 2016). Experiences in multiple areas of healing traditions, albeit possibly misguided under the aforementioned points of view, almost always involved a spiritual, mystical dimension based on Nonordinary states of consciousness, where the healer is the one who does indeed “attend and assist in the healing process” which is truly the origin and etymology of compounds of iatry. Modern science and modern medicine often forget these elements and splits the intervention on sides. More specifically, we have a biologically analyzed evidence-based data on one side, and a systematic, symbolic, introspective as well as transpersonal exploration of the human nature, starting from the psyche. However, since this side of the equation is not “truly” observable with the means of evidence-based science, this represents (and presents, shows) a limitation defining our “real”, physical (material) nature. Grof writes:

“According to the Newtonian-Cartesian paradigm of traditional Western science, these restrictions and limitations are absolutely mandatory and definitive, since they result from the material nature of the world and are determined by physiological laws of perception. However, modern consciousness research has clearly demonstrated that in transpersonal experiences these limitations do not apply and can be transcended. This represents a critical challenge not only for psychiatry and psychology, but for the entire philosophy of Western science.”<sup>6</sup>

In recent studies, these phenomena have been analyzed by many medical scientists, philosophers, and physicists; good examples are found in the research by Beauregard on alternate states of mind, Moore, Jansen, and van Lommel on Near-death experiences,<sup>7</sup>

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<sup>6</sup> Ibid., p. 47

<sup>7</sup> Jansen, K.L. R. 1998. *The Ketamine Model of the Near Death Experience: A Central Role for the NMDA*

*Receptor*. Journal Article, The Maudsley Hospital, Denmark Hill, London.



Penrose-Hameroff on Consciousness,<sup>8</sup> Stevenson on Reincarnation,<sup>9</sup> and many others. In fact, as we will see, the main problem in addressing these issues is first and foremost philosophical in nature. Of course, empirical observation through evidence-based experiments can provide fundamental elements to support the existence of neural underpinnings to the aforementioned processes and events, but the analysis of the matter-at-hand still requires philosophical explanation. In this context we would like to quote the viewpoint offered by Jaworski (2016) in regard to (the concept of) structure, from a hylomorphic point of view:

“Structure matters: it operates as an irreducible ontological principle, one that accounts at

least in part for what things essentially are.

Structure makes a difference: it operates as an irreducible explanatory principle, one that accounts at least in part for what things can do, the powers they have.

Structure counts: it explains the unity of composite things, including the persistence of one and the same living individual through the dynamic influx and efflux of matter and energy that characterize many of its interactions with the wider world.

Structure minds: it provides us with resources for understanding the place of mental phenomena within the natural world.”<sup>10</sup>

These observations are truly important, especially regarding what we have said about Pr (H<sub>a2</sub>), *in particular the necessity and sufficiency for existence of the equivalence between mind and matter. In*

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<sup>8</sup> Hameroff, S.R. 2006. *The entwined mysteries of anesthesia and consciousness*. *Anesthesiology* 105 (2): 400–412. doi:10.1097/00000542-200608000-00024. PMID 16871075. See also Penrose, R. 1989. *Shadows of the Mind: A Search for the Missing Science of Consciousness*. Oxford, UK: Oxford University Press.

<sup>9</sup> Stevenson, I. 1974 (2<sup>nd</sup> Ed.) *Twenty Cases Suggestive of Reincarnation*. Charlottesville, VA: University Press of Virginia.

<sup>10</sup> Jaworski, W. 2016. *Structure and the Metaphysics of Mind: How Hylomorphism Solves the Mind-Body Problem*. Oxford, UK: Oxford University Press, p. 97

*the context of hylomorphism in the version proposed by Jaworski, the focus on necessities of formal structure determine that the constitution of matter is structured into form and thus (read: therefore or through this process) generates, or at least supports, mental activity. Of course whether this activity accounts for mindful or conscious activity is to be understood in psychological terms, nevertheless rooted in matter, according to naturalistic hylomorphism and its view of substance-attribute basis, in ontological terms, for its metaphysics. In other words and applied to critical neuroscience, our “self” is such and perceived as such by us and others, when it is supported by (its) form. In this context we are (hylomorphically intended) “more than the sum of our parts.” This metaphysics doesn’t actually require anything particularly supernatural, in the sense that I would lose my self if all the components which constitute the (form of) my (for instance) neuroanatomical structures were*

*to be “crushed” so that each building block will still be there (thus, matter would be preserved) but the “general organization” (i.e. the hyle defining-creating my self) would be lost. In any case, if the self is still intact, all those psychological processes at the basis of cognition, perception, memory, computation, behavior, and other are also still there –albeit in multiple and diversified levels and with different characters or traits varying from individual to individual and (in a sociological sense) from group to group– and are at least in part and in the view of Atmanspacher (2015) required for an understanding of neuroscience, even in the context of ulterior theoretical models as in quantum mechanics:*

*“One rationale for the focus on psychological phenomena is that their detailed study is a necessary precondition for further questions as to their neural correlates. Therefore, the investigation of mental quantum features resists the temptation to reduce them (within scenario A) all-too*

*quickly to neural activity. There are several kinds of psychological phenomena which have been addressed in the spirit of mental quantum features so far: (i) decision processes, (ii) order effects, (iii) bistable perception, (iv) learning, (v) agency, (vi) semantic networks, and (vii) super-quantum entanglement correlations.”<sup>11</sup>*

And it is exactly from observations of semantic nature in the context of quantum theory that proposals such as the one by Ishikawa (2017) for the final solution to the mind-body problem originate. More in detail, Ishikawa suggest that quantum language represents the only possible solution to the mind-body problem in that it provides a scientific method to (re)examine the problem under the lens and as a linguistic problem, rather than an epistemological one. We find this solution very appealing and presenting

some very useful elements for a better understanding of the mind-body problem, but the proposed solutions fails, in our opinion under a) a Post hoc ergo propter hoc fallacy, and b) presents some tautological components. Ishikawa starts from consideration on the very nature of quantum language in relation to the Copenhagen and Born’s probabilistic interpretations of quantum mechanics, the causality axiom, and posits that there is an equivalency between idealism (although it remains to be understood why the author puts a particular weight on dualistic idealism as “the mainstream of philosophy”, p. 50) and metaphysics adefined as non verifibale experimentally. The philosophical analysis continues by presenting the *measurement axiom* [axiom 1]:

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<sup>11</sup> Atmanspacher, H. 2015. *Quantum Approaches to Consciousness*. Stanford, CA: Stanford Encyclopedia of Philosophy.

$\in X$  obtained by  $M_N 0 := (X, \mathcal{F}, F), S_{[\rho]}$

belongs to a set  $\Xi (\in \mathcal{F})$  is given by  $\rho[F(\Xi)]^{12}$

In this axiom Ishikawa also uses quantum mechanics as a mathematical basis for the investigation of the mind-body problem. More specifically, in this case the X defines a “metaphysical” (in parenthesis given the aforementioned definitions) space in relation to the *movement vs. presence* of a particle. In detail, the axiom proposes that the probability density of finding such particle at a given spatial-temporal (quantum-based) point is “proportional to the square of the magnitude of the particle's wavefunction at that point” which is the same (and Ishikawa acknowledges that) as Born's law for Schrödinger's equation, thus:

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<sup>12</sup> Ishikawa, S. 2017. A Final Solution to the Mind-Body Problem by Quantum Language. *Journal of Quantum Information Science*, 7, 48-56, p. 50

<sup>13</sup> I.e. “When the H-define Hamiltonian ‘operator’ is acting on the wave function  $\Psi$ , and the result is

$$\hat{H}|\psi(t)\rangle = i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle$$

Of course, in the case above, Schrödinger suggested that, starting from the Hamiltonian operator  $\hat{H}$  (defining the system's total energy/set-spectrum of possible outcomes when there is a measurement os the total energy of a system), there are quantum effects playing a significant role in the the way a physical (most importantl , *observable*) system changes over time. In fact, the equation above is time-dependent, as opposed to the time-independent version:

$$\hat{H} \Psi = E\Psi^{13}$$

We should note that the equation focuses on  $\hat{H}$  acting on  $\Psi$  (the wave function), where  $\hat{H}$  represents a set / system / spectrum. In philosophical terms, these words represent

proportional to the same wave function  $\Psi$ , it follows that the wave function above is a stationary state, and the proportionality constant, E, is the energy of the state  $\Psi$ .”

three different levels of interpretation within the interpretation itself, respectively:

- a)  $\rho[F(\Xi)]$ ,
- b) σύν + ἵστημι [to stand(up) / (still), set (up) stop-stay, check, es-tablish  $\rightarrow$  *stō + bilis*], thus involving an operator-observer-actor *in* vs. *on* such system, and
- c) It is truly the center of a double hermeneutics in quantum mechanics, thus viewing, observing, reflecting, mirroring.

The latter term mirroring is especially important in this context, as it relates to the applicability of the theoretical framework of quantum mechanics to the vast realm of neuroscience. Etymology aside (although we doubt that such operation could be fully justified in this context), in quantum terms, who/what observes also becomes integral part of whom/what is observed, in a mirroring

process which makes a lot of sense on the neurological level as well, for instance in the case of the role mirror neurons play in terms of cognitive processes related to emotion appreciation, understanding, production-reaction, and response. Of course, we could argue that such (semantic vs. observable mechanism-based) “jump” from theoretical frameworks to (level 1) neurological functioning and (level 2) further philosophical justification of mind-matter definitions of existence/essence might not provide warrant, or even logical sense, *tout court*. Now, Born's law states that the probability density  $p(x,y,z)$  of finding the (vs. a!) particle at a given point is proportional to the square of the magnitude of the particle's wavefunction at that point. This means that the mirror / spectrum component of such probability (i.e. that a measurement on this system –defined in quantum terms/parameters– will yield a *given* result) is

in itself part of such predicament, as it certainly (e.g. by definition) is:

probable = able to be proven;  $p = F_a(p)$

However, we could certainly go back to our first hypothesis  $H_{a1}$ :  $x \equiv y$  and tautologically infer that  $p \equiv F_a(p)$  since “just because the word says so, it must be true” which is again not true logical *stable* ground (upon which) to establish such paradigm, except if we are willing to consider metaphysical, even theological elements as in “ἐν ἀρχῇ ἦν ὁ λόγος.” Of course, we cannot use this argument here, so we must rely on our human logic to attempt to entangle these problems. As it is, Born’s rule states that – following what we said above– if an observable (i.e. a measurable dynamic variable) corresponding to  $\hat{H}$  with discrete spectrum is measured in a system with normalized wave function  $\Psi$ , it follows that *the measured result*

*will be one of the Eigenwerte  $\lambda$  of  $\hat{H}$ , and that the probability of measuring a given Eigenwert  $\lambda$  will equal  $\langle \Psi | P_i | \Psi \rangle$ ,  $P_i$  being the projection onto the Eigenraum of  $\hat{H}$  corresponding to  $\lambda$ .* Ishikawa starts from Born’s rule to reach Axiom 1 and continue with the causality axiom (Axiom 2): “Let  $t_1 \leq t_2$ . The causality is represented by a Markov operator  $\Phi_{t_1, t_2}: A_1$ .”<sup>14</sup> What is truly interesting about this perspective is that Ishikawa talks about Axioms 1 and 2 as “kinds of spells”<sup>15</sup> in the sense that they do contain an important feature for practical use, i.e. the use in itself, as opposed to a (true) understanding. To be sure, this does not mean (although Ishikawa does not state it openly) that they do not *mean* (i.e. do not have an intrinsic meaning *of vs. for* value), but simply that they cannot (this is what *does not make sense*) be verified experimentally. I we applied this interpretation, which Ishikawa

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<sup>14</sup> Ishikawa, S. 2017. A Final Solution to the Mind-Body Problem by Quantum Language. *Journal of Quantum Information Science*, 7, 48-56, p. 50

<sup>15</sup> Ibidem.

defines as *linguistic*, our statement about probability would not hold anymore:

$$p \neq F_a(p)$$

Thus, we will have to find another route. Very notably, Ishikawa also suggests that there is progression in philosophy, and this progression is scientific in the full meaning of the word, most specifically from Plato, through Descartes, Locke, and Kant, to Quantum language, which is the only possible way out of the empasse, as Ishikawa suggests that the denial of substance dualism found in “going” from Kant (K) to Husserl (H) is to be rejected, unless it moves on to a philosophy based on cognitive science, a scientifically based philosophy of mind ( $\varphi_M$ ). This appears to be a contradiction in terms, as we just said that:

$$(K) \rightarrow (H), (K) \leftarrow (H) \Leftrightarrow (H) \rightarrow (\varphi_M)$$

Ishikawa suggest that there is actually compatibility –better, non-contraddiction– between (the acceptance of) substance dualism

and the denial of substance dualism, *because of* quantum language: “describe any monistic phenomenon [...] by dualistic language (=quantum language).”<sup>16</sup> We could thus rephrase the above as:

$$(K) \rightarrow (H) \cup [(K) \leftarrow (H) \Leftrightarrow (H) \rightarrow (\varphi_M)]$$

Of course, this non-contraddiction does not necessarily mean union (as in this example), as we could see how we might fall prey of tautology:

$$(A_1 \cup A_2): (K) \rightarrow (H) \cup [(K) \leftarrow (H) \Leftrightarrow (H) \rightarrow (\varphi_M)] \leftarrow (A_1 \cup A_2)$$

$$(A_1 \cup A_2): (K) \rightarrow (H) \cup [(K) \leftarrow (H) \Leftrightarrow (H) \rightarrow (\varphi_M)] \leftarrow (A_1 \cup A_2)$$

$$(A_1 \cup A_2) \leftarrow (A_1 \cup A_2)$$

$$\neg(A_1 \cup A_2) \vdash \perp$$

To be sure, Ishikawa appropriately points out that the definition of validity depends on the defining process itself, in the sense that language defines the limits of the perspective, because:

<sup>16</sup> Ibid., p. 54

- a) Linguistic limits (limitations)  
 $\leftrightarrow$ World(view) limits (limitations),  
 and
- b) Measurement  $\leftrightarrow$  Measurer  
 (brain)

These considerations represent the main reason why in Ishikawa's view the mind-body problem should not be *viewed as* an epistemological problem, but a linguistic problem. Of course, Ishikawa is not the first scholar to attempt a solution to the mind-body problem by way of quantum theories. In fact, the term "quantum mind" has nowadays become very popular, not always in a positive sense, given some truly pseudoscientific claims in regard to supposed existing processes justifying consciousness in this way. In fact, for some philosophers "quantum mind" could also be synonym with a reductionist quantum theory, in the sense that this arbitrarily posited (without *contradictio in se*) quantum underpinnings of consciousness still do not provide warrant. A similar non-

reductionist (non-reductible) view is embraced by David Chalmers, and to some extent also by Walter Freeman, Victor Stenger, Giuseppe Vitiello and John Taylor, albeit with vast differences. More specifically, for Chalmers those proposed quantum justifications of consciousness do not make much sense, not because they are intrinsically wrong, but because the *hard* problem of consciousness can be *hardly* solved by certain *hard* sciences, more specifically new physics. Freeman and Vitello instead provide a model to represent the mind-body problem from the perspective of a dialog between the classical (with major differences, as in the rejection of psychoneural representations as basis for cognitive and behavioral processes) and the quantum parts (base on quantum field theory specific to their proposal) of the brain. Stenger's rejection of quantum theory for the solution of the mind-problem is as radical as Chalmers, but from a completely opposite point of view, as the very existence of a quantum mind is in his case viewed as complete pseudoscience. Taylor's views on the mind-body problem are to



some extent similar, in the sense all the possible non-physical (immaterial) explanations are eliminated in favor of physical reductionism. Taylor's view moves from a thorough analysis of multiple views, including various degrees of dualistic and monistic perspectives in order to achieve a completely physical explanation *from* physical activity. In detail, Taylor identifies the Corollary Discharge of Attention Movement (CODAM) model as the best explanation for consciousness originating in physical processes. The main support for this view comes, in Taylor's opinion, from both physically-based experimentation such as EEG/MEG as well as from philosophical analysis, most importantly from "inner experience" in the conceptualization by Husserl. This analysis (Taylor, 2012) presents CODAM first as a model for consciousness through sensory attention in terms of engineering control. Attention is thus interpreted as a function, or better as a series of functional modules, which in turn physically (procedurally) create the (subjective) experience of "ownership" through efference

copy/corollary discharge of the attention movement control signal. Of course, another whole set of definitions is open given these premises:

$$[\exists C (\in A, O, F) ] \cap S_M$$

Where Consciousness  $C$  is vs. belongs to a set identified as Attention  $A$ , Ownership  $O$ , and Focus  $F$  (cognitive vs. computational) intersect with the concept of "Self as Monitor" ( $S_M$ ). Of course, this is a general analysis of the connection between a common conception of consciousness and the model proposed within CODAM. Of course, for each of these elements we could identify a (dualistic) dichotomy, one for Attention  $A$ , one for Ownership  $O$ , and one for Focus  $F$ . Quite interestingly, Taylor starts his analysis of the mind-body problem exactly from this core-defining dualism (2012):

"The mind is composed of mental fragments - sensations, feelings, thoughts, imaginations, all flowing now in an ordered sequence, now in a chaotic fashion. There are

also non-conscious components involved in early brain processing of stimuli (as in lower level processing in vision, such as in V1) or in emotions not yet in consciousness. On the other hand the body is constructed under the underlying laws of physics, and its components obey the well-enumerated laws of physiology.”<sup>17</sup>

The comparison here is obviously between the planes of “effectors and interpretators” as it is often found in other models of consciousness, such as:

- Coalitions of neurons
- Dynamic core & IIT
- Field models
- General Quantum (mind) models
- Global workspace models
- Higher-Order Thought - HOT
- Information integration
- Multiple drafts theory

- Recurrence Model
- Sensorimotor theory
- Subcortical models
- Thalamocortical rhythms
- Internal simulation and self-modeling (Retinoid model, Self-model theory of subjectivity, World simulation metaphor, and others)
- Cognitive / cognition(attention)-based models (Intermediate level theory, Cognitive and Affective - CogAff, Consciousness as Attention to Memories, Corollary Discharge of Attention Movement - CODAM, Supramodular interaction theory, Multilevel feedback, Radical plasticity thesis).

Let us examine them more in detail:

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<sup>17</sup> Taylor, J. 2012. A Final Solution to the Mind-Body Problem. *Journal of Mind Theory*. 1(1)25-58, p. 25

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