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# A Postulate on the Physical Basis of Mental Life: Special Relativity and the Brain

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## Abstract

A physical model of consciousness is proposed wherein the 'mental', as distinct and separate from its brain under structure, exists as an epiphenomenal part of it, fully explainable by the physics of special relativity and quantum mechanics. A methodology based on the "auditory rabbit" and the "cutaneous rabbit", sound wave physics and the principles of time dilation is then outlined to either support or falsify this conclusion. Specifically, a quasi-inequality or test is created the satisfaction of which would falsify the hypothesis.

**Keywords:** Consciousness; Mind; Special relativity; Philosophy of Mind; Acoustics; Psychology; Physics; Sound Waves, Light Waves, Doppler effect

## Introduction

This article crafts a hypothesis regarding consciousness that would be amenable to the scientific method, while taking care not to veer off into metaphysics except where it be possible to incorporate same into reasonable scientific certainty or, at minimum, render it moot herein. Since the advancement of our scientific understanding of the mind continues to be dependent in no small measure upon authentically incorporating as much philosophy into science as possible, I begin with some background in philosophy of mind.

## I think, therefore I am.- Rene Descartes

With this phrase, one of the greatest philosophers of mind, Rene Descartes (1596-1650) [1] proclaims the undeniability of his existence in the universe. Undeniable because by his reasoning, he may plausibly call into question the existence of everything around him, in fact everything in the universe, as the product of say, a demonic entity hellbent on deceiving him, he may even question the veracity of his own beliefs as a product or outgrowth of the 'Matrix" but what he may not doubt is his own doubting because that undoubtedly would still leave him doubting [3, 1]. Since the agency or independence of his thoughts, as distinct and certain in this way, is the one thing that by collapsing in on itself must be true, his existence must also be true. I think, therefore I am.

Having established himself as a conscious entity with mental life, Descartes proceeds to frame the problem in terms of two types of 'stuff', the mental and the physical, mind/matter duality, wherein the former somehow interacts with the latter. Without recapitulating the entire history of philosophy of mind, suffice to say that some 370+ years after Descartes the jury is still out on Cartesian duality; specifically, how 'the mind', lacking any physical substance, can possibly interact with the physical, even while knowing full

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well that it does. The prevailing contemporary models find commonality in the functional theories of mind [3] where the mind is viewed as "brain states" in series or as a neural network overlaid on its brain understructure leading to some functional outcome or purpose much as computer software runs on computer hardware circuitry producing an output. Think of a hand made into a fist, the fist being a conformation of the hand for a specific purpose yet not existing independent of it, although Descartes may have believed that it did.

Critics of the functional approach to mind and consciousness are quick to point out that a brain state defined by function alone cannot possibly capture subjective experience, such as what it is like to experience a sunrise, an ocean view, or a stadium of 100,000 noisy partisans. As such they argue, it is incomplete, omitting the very thing it attempts to describe, consciousness. There must be more to it than mere function they argue. I agree. It is meaning given to conscious experience as it pertains to an individual in a given space, time and circumstance, i.e., the appreciation of the experience, plus whatever function derived from the state of the brain that led to the experience, in its entirety, that counts as consciousness. Any theory that cannot account for all aspects of consciousness including quiet enjoyment is either incomplete or an anti-theory, an argument against a separate thing in the mental realm called consciousness and its corollary, free will [4].

The Functionalist rebuttal is noteworthy, however. It argues that neurophysiological organization of the brain towards a functional result intrinsically generates, by accident or evolution, consciousness and conscious experience; the functioning brain yields a (physical) whole that is greater than the sum of its parts. Whether any of this is by evolution, design, or chance, is no concern of mine. What interests me is how such a theory might be proven on evidence that is objective and reproducible. Re-stating the problem, if consciousness is something that the brain serves up in integrating functional brain states into a physiologic whole, could it be that (the experience of having) consciousness is not 'mental' at all? Might it not be subsumed under biology, specifically neurobiology? If biology reduces to chemistry, chemistry to physics and physics to quantum mechanics/ physics1, might we not then have the basis for a scientific theory of consciousness whose truth or falsity could be objectively verified by the scientific method?

Several neurological phenomena in normal brains as well as psychologically abnormal brains, point to potential explanations of consciousness in terms of the laws of physics, specifically the physics of Einstein's [7] special relativity as it applies, to the microscopic world of quantum physics [2]. Anyone familiar with the theory of special relativity is familiar with the terms time dilation, time relative to a moving body, length contraction, proper length in a moving frame at relativistic speeds and so on. While these terms have been in use mostly to describe the macroscopic world of objects traveling at high speed, it is interesting to extrapolate how they would apply to the microscopic environment of the brain-the quantum brain [10], and what it would imply for the mind. If we accept the proposition that consciousness, conscious thought, occurs as an epiphenomenon of the brain, then could it be that in this neural network, this hologram that is the mind, electrons approach relativistic speeds producing time dilation and all other effects of special relativity?

To appreciate this paradigm, consider the visual phenomenon of a piece of paper with a pattern and an X on it. When the X is centered over the blind spot, it disappears yet there is no interruption in whatever pattern was there in the background. An optical illusion? If no changes are reported in the pattern, whatever it happened to be, it would militate against it being an optical illusion. Perhaps the effect could be better explained by the difference between the angle subtended by the paper's edge when drawn against an imaginary perpendicular line from the piece of paper to the fovea (as seen by the mind) and the actual angle subtended. Since the X on the actual length paper subtends at a different angle, when over the blind spot it disappears into the pattern on the piece of paper giving the appearance of a sensory illusion. Reproducing something analogous to this phenomenon has been accomplished reliably in other senses [4]. However, demonstrating the physical evidentiary basis for it mathematically has not been done to my knowledge, and would refute the claim of it simply being an illusion.

But if they are not illusions then what are they? It gets to the heart of the central dilemma that has vexed many scientists and it is of course: Is it a particle or is it a wave [5]? If this appears at first blush off the topic, or worse, as if we have here a substrate for another debate about reality, perhaps so but that is not where I wish to take the discussion. In tribute to Descartes, my interest is in demonstrating a specific reality, that thinking, specifically my thinking and the mind that thinks my thoughts is real, undoubtable and privileged to me. But to do so in the digital age requires a step beyond simply retracing Descartes' exercises of logic, it would require proof, physical proof of my capacity to think, and of my mind. As with Descartes, if I establish this as independently true by modern standards, then many other truths may follow from it and the cause of science and medicine hopefully nudged forward.

If you accept the proposition that the mind exists physically (granted, a presupposition, but central to the hypothesis) then what the special senses tell us and what the mind perceives must be very different. It MUST be different to establish physical evidence of mental life. It gets tricky here because if you cannot believe what your senses tell you then what can you believe? I think therefore I am is sufficient. Rene Descartes has already been there ahead of us so let's lean on him and work forward. If we exist by virtue of our

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consciousness, then consciousness itself exists. If we can discard the notion of the mental as distinct from the physical, consciousness is something physical. To exist at all therefore, it must differentiate from the understructure of function and neuroanatomy it is in meta position to. This MUST be true, since it would meld into and become indistinguishable from its physical and functional understructure were it not true. The differentiation could be in form of what special relativity tells us about time and length, specifically time dilation and length contraction generated by movement of electrons at relativistic speeds. Let us now seek the means of proof.

Since the ability to dilate time is the hallmark of this model, there would be ratios of relative time and distance; these are space and time as it occurs in the conscious mind vs space and time as it occurs in the brain which for the sake of simplicity and clarity, we will consider to be the same as in the environment.

For time, the problem can be set as:

$t_{conscious\ self} : t_{brain}$ or $t_s : t_{earth}$ where : represents the ratio and $t_{brain} = t_{earth}$.

The Lorenz equation for time dilation mathematically elaborates this as:

$t_b = t_b$ 1/ where v= velocity of electrons (particles), and c=speed of light and $v < c$.

For simplicity we can express this as:

$t_s / t_b = q$, time dilation quotient.

But since we can't directly observe the physical constituents of mind (consciousness, unconscious or collective unconscious), we extrapolate from Einstein that time dilation and length contraction are the mind's reflection of the environment in ITS frame, and no frame has privilege over any other (debates over whether or how [in what form] reality can exist without consciousness notwithstanding and left for discussion at another time). Therefore, the actual numbers are not important at the moment, what is most important is to drive home the concepts. For example, if for every 1 second that passes in the perception of the conscious mind, 3 seconds pass on earth the ratio is 1/3. Also remember, special relativity says that when time is slowed, length is contracted. If you accept the commonly held premise in physics that everything in the universe is essentially granular, then external 'reality' is particles, particles that the mind only perceives as analog, as a continuous wave, because of the limits of our conscious perception8, limits defined by $t_s/t_b$ a time dilation quotient. The smaller the quotient the higher the propensity for conscious thought, but also, to perceive things as continuous not discrete.

We may choose a time dilation quotient, but a length contraction quotient could equally apply and express the goal with equal if not better clarity. The goal of course, is to simulate the numerator in the length contraction quotient (or time quotient if you prefer) to achieve unity or close to it. It might appear as though any attempt by an observer to demonstrate that relativistic effects are at play in consciousness would be vitiated by the observer's own consciousness when in fact, all that is required is to show that the mind exists in a different frame and demonstrate the difference objectively. This just might also put an end to the man in the machine dilemma.

To do this however, requires a huge conjecture, a huge assumption or postulate on our part; that it is possible to "fool" the mind by introducing actual (proper) times and lengths (not length or time to the mind) into its frame as a uniform measure to overcome the ratio problem.

Consider the example of what has been referred to as the cutaneous rabbit3. Applying pressure at a point on the forearm results in the localized sensation of touch or pressure at that point. Applying sequential pressure more rapidly along the forearm results in the pressure being felt at locations in between, as in a rabbit running across the forearm. The brain somehow "filled in" the extra sensation of pressure at points where pressure was not applied. Illusions again? After all, how could you have felt a sensation where no pressure was applied? What body and brain tell the mind vs what the mind experiences, however, might be different things, because the mind can dilate time. Indeed, since the sensory nerves in the forearm require time to send impulses to the thalamus which then processes and directs stimuli for the mind's interpretation, time dilation might be a required feature of consciousness, necessary to view the external world as continuous rather than frame by frame. If the mind exists in a separate relativistic frame from the body, then time dilation would 'distort' the perception of time by the Lorentz transformation. As a result, you would feel pulses from the cutaneous rabbit that are out of phase with the processing time which for the sake clarity will be referred to as the time cadence, a time cadence which is quantifiable (for an individual). Time dilation for the mind thus implies that the impulses felt occur much closer in time than the mind perceives so what you perceive (in 'mind' time) has already occurred and is in the past.

Not only that, but because of differences in processing speed by the special senses, e.g. touch vs sight, what is seen and what is felt are out of phase by the time each are consciously perceived. Thus, an extra sensation is produced as a 'synesthesia' if you will, because your mind has taught itself to ignore the processing time differential so that the perception of touch and sight occur together. This time differential is part of the subconscious mind and can be quantified in study participants for all other observers.

But remember, if time is dilated in the mind, then length is contracted to it, meaning your forearm appears contracted to you. Because the perception of sight and touch are staggered in consciousness by the differences in processing speed, a

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sensation is produced at the real time position where pressure was applied on your forearm which your conscious mind is only now able to sense. Since length is in conscious visual awareness of the study subject, and, synesthesia or not, is reinforced by touch sensations of the pulses, it's contraction, as given by the Lorentz transformation ratio, should already be accounted for, therefore the study of either of time or length in isolation would be sufficient to account for the rabbit effect since both are offset by the Lorentz factor ɣ. But we don't actuality know what the value for ɣ is so we must rely on the time differential which is measurable for all other observers

Mathematics tells us that if the value 1/f (f the symbol for frequency of pulsation along the forearm) is greater than or equal to the processing time, then no rabbit effect should be observed. If the device is timed so its frequencies pulse such that their inverse, 1/f divides by whole numbers into the processing time, then in time the rabbit effect ought to be abolished here also, since each pulse would soon align precisely with sensory nervous impulses. This statement is complicated by the aforementioned Lorenz transformations which, if the hypothesis is true and applicable, would distort the perception of both time and length, and as mentioned, since we don't actually know the value of the Lorentz factor ɣ , we must rely on the time differential to derive it, which is measurable objectively (for all other observers). If the rabbit effect is not abolished as predicted (without a Lorentz correction multiplier), this result might support the underlying hypothesis that is the basis of this article.

Consider now the model of "the auditory rabbit"[6]. The auditory rabbit is like the cutaneous rabbit but is constrained by the invariant speed of sound through air, its medium. Two speakers are separated by distance, generating a series of dichotic clicking sounds with a time difference (time cadence) which the mind perceives as traveling across the space between the speakers. What we have are stimuli of the same frequency and type (sound), traveling at the same speed (speed of sound) but staggered by the time cadence.

To appreciate how this schema might mathematically simplify things, consider Figure 1 below. Here we need only be concerned with frequencies or pitch of sounds and their associated wavelengths, or vice versa. Any variation in frequency necessarily varies the wavelength by an inverse proportion because the speed of sound through its medium is always constant. This allows us to derive data without needing to control for speed as an additional variable. In this way all observers, experimenters and participants alike, are naturally blinded.

The goal is to simulate the numerator in the length contraction quotient (or time quotient if you prefer) to achieve unity or close to it. Since no frame of reference in special relativity has privilege over any other, as was alluded to earlier, it might appear as though any attempt by an observer to demonstrate that relativistic effects are at play in consciousness would be vitiated by the observer's own consciousness when in fact, all that is required is to show that the mind exists in a different frame and demonstrate the difference objectively. This just might also put an end to the man in the machine dilemma.

As stated previously, we may choose a time dilation quotient, but a length contraction quotient could equally apply and express the goal with equal if not better clarity, but to do this requires a huge conjecture, a huge assumption or postulate on our part; that it is possible to "fool" the mind by introducing actual (proper) lengths (not length to the mind) into its frame as a uniform measure to overcome the ratio problem.Recall that special relativity requires that the distance d between fovea and blind spot (optic nerve root), and distance d' between the ears in the auditory rabbit, contract to the observing self as elaborated by the Lorentz transformation for distance. We must suppose therefore that under the proposed special circumstances those and only those distances (and time cadences for the cutaneous rabbit), having not been captured in awareness, would be uniform across frames yielding objectively quantifiable data (for all other observers).

For sound, this is easy (easier); we vary the pitch (alter the frequency). What we want to know is whether doing so would expose a quantifiable discrepancy between perception and 'reality' (what the physics says) in terms of the saltation or displacement, much as hypothesized above in the cutaneous rabbit and in the visual exercise of the paper with the x on it.

## Relationships

Consider the Figure 1 again. Here the sounds are emitted simultaneously (no phase shift) from each sound source. Speakers A and B have a distance d between them.

The speakers emit semi-circular sound waves whose displacement through distance as longitudinal waves is approximated as a straight path from each speaker to the arc wall detector.

θ is the angle between d and a perpendicular line connecting the paths of each speaker to the arc wall. Another smaller right triangle can be drawn bisecting the larger one with angle θ' and we take d cosθ' since we are most interested in the influence of angle on sound amplitude and sin0=0 which is clearly not the case here, i.e. the sounds could be heard maximally at angles of zero, not conversely.

Since wavelengths λ and d cosθ are both measures of distance, it follows that the one is simply a multiple of the other as expressed by:

$K\lambda = d\cos\theta$, and therefore,

$\lambda = d\cos\theta/K$ where K is the correction factor or multiplier.

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If the wavelength λ is varied, the angle θ at which minimum or maximum (destructive and constructive) interferences would occur along the arc would be different for a given multiplier K.

Also, since f= v/λ, and

λ=dcosθ/K, then

f= Kv/dcosθ.

The same type of relationships can be formulated on the receiving (listening) end shown in Fig. 1 where d' would represent the distance between left and right ears. Now let's proceed with the experiment, the "auditory rabbit"; the two widely spaced speakers emit a series of equally balanced clicking sounds generating the saltation effect.

If the effect of loudness on saltation can be controlled for or minimized, it might be expected that at a particular frequency $f_1$ (where $f_1$ is the fundamental frequency), wavelength λ and angle θ, the saltation would be abolished since varying the frequency will eventuate in integer multiples n of $1/f_1$ aligning exactly with the time cadence, Δt. There is a second time cadence however, the aforementioned processing time difference Δt', between sounds hitting one ear and the other. The experiment may be designed so that multiples n (i.e. analogous to the K multiplier elaborated in the diagram) of $1/f_1$ (or $f_1$) align perfectly with both cadences Δt and Δt' to create a maximum in one ear and a minimum (noise cancelation) in the other. Maximums should occur at n (λ/2) since maximums (or minimums) occur every λ/2, with the distance between a maximum and a noise cancelation being λ/4. Hence, for n (λ/4), odd integers of n give rise to a maximum in one ear followed by a noise cancelation in the other ear, whereas even integers would give rise to two maximums. The fundamental frequency $f_1$ and its wavelength λ can be calculated for any angle θ without doing any experimentation at all.

Now suppose listeners are moving towards the sound source, how fast would they need to move to abolish the saltation? The doppler equation for such an occasion is as follows:

$f' = f_0(1+u/v)$ where $f_0$ is the original sound frequency, f' the new frequencies, u the speed of travel and v, the speed of sound. Here, only the new frequencies can be known with certainty and that requires running the experiment. These cannot be known beforehand.

This is apparent when deriving the doppler equation in its final form: If generally speaking f=v/λ, then f according to a participant traveling towards the sound source is $u+v/\lambda_0$, which is to say, no variable can be known with certainty until he/she reports the frequencies that first abolishes the saltation. Of course, $f' = u+v/\lambda_0$ reduces neatly to $f' = f_0(1+u/v)$.

Still, you can predict and would expect frequencies $f_1$ and $f'_1$ across each arm to be the same. If these frequencies and effective wavelengths associated with them are consistently not the same, then this could constitute objective evidence that the special relativity model of mind is correct, or that at least, the mind is doing something different than the brain and environment says it should be. In actuality, motion is not a requirement here, the doppler equation is evoked only to demonstrate a caveat to Einstein's special relativity that is at once crazy and obvious: No frame has privilege over any other, unless one frame has consciousness, and the other frame doesn't.

Finally, let us return to the visual system. How could we possibly formulate a similar experimental model here? Firstly, depth perception is an incredibly complex task involving recruitment of extraocularmuscles, ocular muscles and visual neural circuits. Thankfully, it is not necessary to delve into this since the geometry and peculiarities of light waves alone may be sufficient to give us the answer we seek.

The theory of general relativity states that time dilates the closer one is to earth's surface. This effect is overcome by objects traveling at very high speed around the earth's orbit. The transverse doppler effect occurs when objects are at their points of closest approach. An object in stable orbit will typically have no longitudinal velocity relative to a receiver on earth's surface, thus the point of closest approach will be at a right angle as the object passes overhead. Light emitted from such a source will be redshifted in the receiver's frame indicating time dilation relative to the receiver. This is useful to know because it means length is contracted also in the direction of motion, i.e. always perpendicular to an earth observer. Although satellites travel at a fraction of the speed likely required to achieve results here, it is interesting to theorize how redshifted light from a satellite in orbit could be used here.

The transverse doppler effect is purely due to time dilation but the speed of light remains constant for all observers regardless of frame of reference, so imagine a series of pulse bursts of electromagnetic energy made up of wavelengths necessary to cover every color of visible light, the color burst separated by a time interval ϕ between them. These pulses, which ordinarily would appear to the naked eye as pulse bursts of white light, would need to include non visible electromagnetic radiation from the ultraviolet range of the spectrum, but if the satellite was traveling at a high enough speed to cause sufficient time dilation, such pulses of electromagnetic energy would separate into the colors of the spectrum at the earth receiver end, as though they were traveling through a prism. The degree of time dilation necessary for this to occur must be large enough that the dilated time interval ϕ' between the rays of color pulsed would be equal to or greater than the time interval required to distinguish each color in the visual nervous system. Any subsequent pulses bursts of the aggregate generated would thus need to be at a time interval of 7 times this (representing each color of the spectrum).

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If the processing time is measured beforehand and is known, then the amount of time dilation required can be predicted and hence the speed at which the satellite must travel at closest (perpendicular) approach. Here again, If what is seen by observation is not the same as predicted, meaning the colors don't separate as predicted, this is perhaps additional evidence that it is because the mind is already dilating time. Cartesian duality could be true after all.

## Epilogue

For those with insatiable curiosity, the universe gives back a hundredfold in large measure because of the accumulated knowledge of all those who came before us1. That is Epistemology, the Theory of Knowledge in a nutshell. To the extent that this article delivers on that premise to an even miniscule degree I am humbled and delighted to no end, for the Universe still has a lot to teach us and we've only just begun.

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