IS THE SPEED OF LIGHT KNOWABLE A PRIORI?

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ABSTRACT

Given the current "definition" of the concept of *meter* a simple argument appears to show that some scientists could come to know the answer to the question "how many meters does light travel in a vacuum in one second?" without having to do any observations or calculations. It would then seem that their knowledge of the speed of light would have some unusual epistemic properties such as being certain, infallible and indubitable, and perhaps also analytic. What is more shocking is that we may also be able to conclude that these scientists know the speed of light a priori. This appears to be a new version of the puzzle about how long the "standard meter bar" is, which Wittgenstein discusses in his *Philosophical Investigations*, later taken up by Saul Kripke in *Naming and Necessity* yielding the puzzling conclusion that certain contingent truths are knowable a priori. In this talk I discuss how the new version of the puzzle differs from the old one, why Nathan Salmon's and Keith Donnellan's "solutions" to the old puzzle are really not solutions, how the current literature on mental files can be employed to approach the puzzle. I then argue the notion of *apriority* employed in the argument requires further elaboration so that we may conclude, following Nenad Miscevic, that "interesting a priori knowledge cannot be gotten for cheap."

Naming by description gives rise to some puzzling results. If you define 'meter' as the length of a certain stick, then the question about how long the stick is appears to be a very strange one. The issue was perhaps first brought to attention by Ludwig Wittgenstein in his *Philosophical Investigations* (§50) where he famously remarked:

> There is one thing of which one can say neither that it is one metre long, nor that it is not one metre long, and that is the standard metre in Paris.-But this is, of course, not to ascribe any extraordinary property to it, but only to mark its peculiar role in the language-game of measuring with a metre-rule.[1]

Years later the matter was resurrected by Saul Kripke in *Naming and Necessity* who complained that "this seems to be a very 'extraordinary property' for any stick to have"

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[1] Wittgenstein's intention here, is not to present a new philosophical riddle, but to give an example of how a language game is based on following a rule. His point is that such a rule makes *saying* possible, and therefore, it *cannot be said* with the language game.

(p.54).[2] The stick after all is a physical object with a certain length, and that length could be nothing other than one meter, given the way in which the term 'meter' was "defined" at the time. The definition does not provide a synonym for the term 'meter', Kripke argues, rather it merely determines the length to which the term refers: it does not fix the meaning of the term, but it merely fixes its referent. After the naming ceremony the name 'meter' refers to the same length in all possible worlds making it a rigid designator of a certain length. The reference-fixing description 'the length of the stick at t', on the other hand, refers to the same length in the actual world, but only accidently, given that it is not an essential property for any stick to be of a certain length. In other words there are possible worlds in which the description refers to lengths longer or shorter than a meter, and thus it is not a rigid designator. We may now merge the name with the description to construct an identity statement expressed by a sentence such as "the length of the stick at t is one meter". Now though it is clear that the stick has no extraordinary property as Kripke claims, it appears that such a sentence does have some very unusual characteristics. First and foremost it appears that the reference-fixer could come to know that it expresses a truth without having to do any measurements. Such an argument, Kripke claims, shows that there are contingent truths that are knowable a priori.

After Kripke gave this argument, the term 'meter' was redefined in 1983 by the *International Committee for Weights and Measures* (CIPM) as *the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second*. Following Kripke we may say that the experts at CIPM re-fixed the reference of the term 'meter' by this description, and preserved its rigidity. The definite description used in the new definition is again not rigid, at least not metaphysically or logically. That is because it seems that that there is no contradiction in imagining a counter-factual situation in which the speed of light in vacuum is faster or slower than it actually is. Now it may be the case that the speed of light being what it is, is physically necessary. In other words the assumption that the speed of light being slower or faster than the actual magnitude may in fact violate the laws of physics. If so then the description may be said to refer to the same speed in all possible worlds in which the laws of physics are the same with that of the actual world. In

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[2] Kripke also does not present this as a puzzle; rather he wishes to show that not all a priori knowledge is of necessary propositions. See also fn.4.

that sense we may say that it is physically a rigid designator, which of course would be welcomed by scientists. Nonetheless from a metaphysical or merely logical point of view the description is an accidental designator. So now we have an instance of a new identity statement expressed by the following sentence:

S. The length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second is one meter.

Though S expresses a contingent truth, it appears again that the reference-fixers are in a privileged position to know the proposition expressed by it a priori. In fact not just the actual reference-fixers, but anyone who is aware of the new definition and understands it would thereby be in a position to know that it expresses a truth without having to do any measurement or calculation, or it would seem.

Kripke's claim that such definitions merely fix the reference, finds support from the fact that a majority of the users of the term 'meter' today are totally unaware of the reference-fixing description. If the description had become a synonym for the term as a result of the definition, we would have had to conclude that the normal users of the term 'meter' either do not grasp the meaning of the term, or that they use it to mean something different from what the experts mean by it. In fact even the ones who are aware of the definition may have difficulty grasping it, for there is another technical term it, namely 'second', which also has its own definition. CIPM defined the duration of a 'second' in 1967 as "the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom." Many, including the present author, know close to nothing about the cesium 133 atom, and what a hyperfine level is, and what a ground state of an atom is etc. Only a handful of experts presumably are able to grasp the definition of 'second', and consequently of 'meter' which is defined in terms of it. Nonetheless we have no problem in using such terms in daily or even in scientific discourse, which gives some support to Kripke's thesis that such names are not mere abbreviations for their reference-fixing descriptions.

The new puzzle differs from the old one in several ways. First Wittgenstein's cryptic remark about the standard meter bar would appear to be even more obscure once we apply it to the new definition. This time we would have to conclude that the speed of light is

ineffable in meter-talk. Secondly, the claim that it is possible to know a contingent fact a priori sounds even more startling now for it is not the length of a stick, but the actual speed of light that would turn out to be knowable a priori. Thirdly a popular counter-argument which tries to block the apriority of the proposition in question that appears to have some prima facia plausibility in the case of the old puzzle seems to loose some of its force in the case of the new one. The argument, due to Nathan Salmon, is based on the premise that the reference-fixer has sense-experience of the length of the stick prior to introducing the term 'meter', which, so it is argued, plays a role in the justification of the reference-fixer to come to know that the stick is one meter long, making that piece of knowledge a posteriori.[3] It is not clear how such an argument could plausibly be applied to the new puzzle. Did the reference-fixers have sense experience of the distance that light travels in vacuum during a time interval of 1/299 792 458 of a second?

Putting the problem in terms of the popular category of the contingent a priori is somewhat misleading.[4] If the mere introduction of a name does give us knowledge, it is what we may call "effortless" knowledge, and in that sense it ought to be a priori. Obviously not all a priori knowledge is effortless. Coming to know Fermat's Theorem required more than 300 years of careful research by some of the brightest minds, and though this piece of knowledge is also a priori it is what we may call "demanding" a priori. This is one reason why putting the puzzle in terms of the a priority of the acquired knowledge does not

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[3] Among the various reactions to Kripke's argument for the contingent a priori, two stand out, one is Salmon(1988) and the other is Donnellan(1979). Interestingly in their arguments against Kripke, Salmon only concentrates on the meter-case, whereas Donnellan focuses only on the Neptune-type of examples. See Inan (2012) *Chapter 12-Limits of Curiosity and its Satisfaction* for a discussion of the differences between these two types of examples, and an account of why these "solutions" are not satisfactory.

[4] This should not be taken as a criticism of Kripke, for, as I read him, Kripke's main purpose in *Naming and Necessity* in giving this controversial argument was to provide support for his thesis that the a priori/a posteriori distinction is an epistemic one, whereas the contingent/necessary distinction is a metaphysical one. Kripke showed that the Kantian prejudice we have that all a priori proposition are necessary, and that all a posteriori propositions are contingent, is ill-grounded. His examples of a posteriori propositions which are necessary convinced the philosophical community fort he most part, though his other category of the contingent a priori was taken to be a puzzle to be solved.

capture its essence. What we need is, not the general distinction between a posteriori and a priori knowledge, rather, the more subtle distinction between effortless and demanding knowledge. Secondly the puzzle is not how we can come to know a *contingent* proposition effortlessly either, for it could have been equally puzzling if the proposition in question had been necessarily true. In fact we can easily generate the same puzzle by using, for instance a mathematical example, concerning a proposition which we may agree in advance to be both necessary and knowable a priori. Once we introduced the name "π" we were in a position to come to know that π is the ratio of the circumference of a circle to its diameter without even having to calculate what number that is. Ones who have acquired this name in general would know that it refers roughly to a number slightly larger than 3.14, but this is not required for them to know that π is the ratio of the circumference of a circle to its diameter. When asked what that ratio is, one can truthfully respond by saying "it is the number π, but I have no idea what number that is". If by merely naming an entity by description automatically gives us access to a piece of knowledge, then it would seem that we could answer any what-question about any entity to which we can refer. What is the 98th prime number? Let us name that number "α"; now we know that α is the 98th prime number. What planet is perturbing Uranus? Let us call that planet 'Neptune' now we know the answer[5]; who is responsible for mailing these bombs? Let us call that person "the Unabomber"; etc. [6] Even for empirical examples putting the puzzle in terms of the contingent a priori would not always do, for we may think of cases in which the reference-fixing description refers to the named entity through one of its essential properties. It is not the contingency of the proposition per se, but the nature of its content that seems to matter; that is the proposition in question does not strike us as being trivial at all, in fact it appears to have substantial content. One source of our puzzlement may then be expressed

[5] This is Kripke's other example for the contingent a priori where we roll back to the time to when Le Verrier hypothesized that there was a unique planet perturbing the orbit of Uranus.

[6] Kripke was aware of this problem. In a lecture he gave in Mexico in 1990's on the contingent a priori (which to my knowledge has never been published) he jokingly said that if someone were to ask him how tall he was, he could respond by saying "I am one *Kripke* tall" by introducing the term 'Kripke' as a unit of measurement that refers to his actual height.

in general as this: it appears that we can come to know that a certain proposition is true merely as a result of a linguistic stipulation, despite the fact that the proposition in question appears to have substantial content corresponding to a substantial fact in reality. This fact can be an empirical fact—as in the case of the Unabomber or Neptune—or it could be a mathematical fact—as in the case of π and the 9th prime number—or it could be any other kind of fact. Given that the linguistic stipulation involved in these cases is simply the introduction of a name, we may pose the crucial question as: how can the mere introduction of a name give us access to effortless knowledge of a substantial fact?

To learn that an object has a certain property, under normal circumstances, gives one substantive knowledge. Let us call a property a *knowledge-enhancer* relative to an entity just in case when that property is predicated of that entity it extends our knowledge of it. We may model this in mental-file talk.[7] For every entity that we can think and talk about, we have a mental file of that entity which includes a list of some of its properties. We extend our knowledge of the entity by adding new properties to that list. Every property in the list could be a knowledge-enhancer. This simple model of learning seems to collapse when a name is introduced by description. Given that the constituent properties of the description are used to fix the reference of the name, the file in question, soon as it is opened up, will automatically contain all the relevant properties. The name 'helium', for instance, was first introduced as the chemical element causing a specific bright yellow line that was observed in the solar spectrum. The naming ceremony allowed the interested scientists to open up a helium-file in their minds[8] long before helium was discovered. This is what I call *inostensible reference*. It is a powerful tool that allows us to represent unknown or unexperienced entities in our minds, to become curious about them, and then to inquire into them.[9] Now the helium file back then had to include all the properties included within the reference-fixing description. For instance if the description included the property of *being a chemical element*, then it must have been included in the file as well. Same for the

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[7] For a rigorous account of mental files see Recanati (2012).

[8] I am assuming that it was a happy speech act which I believe there is good historical and philosophical evidence to think so.

[9] For the distinction between ostensible and inostensible reference see Inan (2012).

property of *causing the bright yellow line in the solar spectrum*. Scientists did not *learn* that helium had these properties by adding them to their helium file, for it was through these properties that they opened up the file in the first place. Given its peculiar role we may call the description used to fix the reference in such a case a *file-opener.* Now one source of the puzzle is that a *file-opener* can never be a *knowledge–enhancer*. This however is not the end of the story, for it does not provide a satisfactory answer to our original question: "is the speed of light knowable a priori?"

This interrogative sentence in fact has two separate readings, giving rise to two different questions. If we take the verb *to know* in the propositional sense we get one reading; we may call this the de dicto reading. If, on the other hand we take *to know* in the objectual sense we get another reading which is de re. In the propositional sense the question asks: can one come to know a priori a true proposition in the form [α is the speed of light]? It seems to me that the argument that Kripke gives shows that the answer to this question—with a certain qualification—ought to be "yes", but that should not be all that startling. In the other reading the question asks: If α is the speed of light, can one come to know a priori of α, that it is the speed of light? The answer to this question is a definite "no". Obviously I am not a latitudinarian; de dicto knowledge of the speed of light does not entail de re knowledge of it. Now ones who think that the distinction between de dicto and de re knowledge, or the distinction between propositional and objectual knowledge is suspect would not be convinced by such an argument. There is another less technical and perhaps a more intuitive way to argue for a similar conclusion. This requires us to distinguish between *knowing that a proposition is true*, on the one hand, and, *knowing the fact that makes a proposition is true*, on the other. Once this intuitive distinction is countenanced, then we can show that it is possible to know that a proposition is true without knowing the fact that makes it true. One may, for instance, know that the proposition *the Unabomber mailed the bombs* is true, without knowing who the Unabomber is, and if not then one would not know the fact that makes the proposition true. So even if the truth of the proposition is knowable effortlessly (and in that sense it would be a priori), the same is not the case for the latter type of knowledge which would require empirical experience. The best way to substantiate all of this is to appeal to a distinction I have made in earlier work between two forms of propositional knowledge; what I call "inostensible"

versus "ostensible" knowledge respectively.(Inan, 2012). A term is ostensible for a subject just in case the subject has sufficient acquaintance of the referent of that term, so that the subject may be said to know the entity to which the term refers; otherwise the term is inostensible for the subject. The distinction applies to all referring expressions. The most intuitive kind of examples are definite descriptions. The term "my mom" in my idiolect is ostensible given that I have sufficient acquaintance with its referent, but for most of you who have never met my mom and know nothing about her--except that she is my mom--, the term is closer to the inostensible end of the scale. Certain important terms are inostensible for all of us, as for instance "the closest planet to earth on which there are intelligent beings". To convert such a term into an ostensible one would require a groundbreaking discovery. We not only do not know to which planet this term refers, but we do not even know whether it has a referent. If we were to discover that the term does indeed have a referent that would be a huge epistemic progress, though the term may still remain as inostensible if we still did not know which planet that was. At times we have sufficient justification to come to know that a term has a referent, though we do not know of any entity as being the referent of that term. We all know, for instance, that there must have been a cause for dinosaurs to become extinct, but this does not entail that we know what that cause is, and if not then the term "the cause of dinosaurs becoming extinct" is inostensible. If, following Frege, we take declarative sentences to be referring expressions, then the distinction between the ostensible and the inostensible would apply to sentences as well. The paradigm case of a sentence being inostensible is when the subject does not know whether it expresses a truth or a falsity. This could be nicely accommodated by Fregean semantics which takes sentences to refer to truth values. If, however, we take sentences to be referring expressions that purport to refer to portions of reality, then we get a different kind of picture. When we say that the earth is round, one part of our sentence refers to the earth and the other part refers to the property of being round, and the whole sentence then may be taken to refer to a fact that is composed of the referents of its parts. This may simply be taken to be the fact of the earth's being round. On the other hand when ancients said that the earth is flat, they wished to refer to a fact, the fact of the earth's being flat, but given that the earth is not flat and there is no such fact, they failed to

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refer. I call this simple theory the Referential Theory of Truth and Falsity.[10] The theory in a nutshell says that a sentence is true just in case it refers to a fact, and a sentence is false just in case it fails to refer. We may also say that the proposition expressed by a true sentence is made true by the fact to which it refers. This theory allows us to formulate the distinction between ostensible and inostensible knowledge more precisely. Concerning any declarative sentence that expresses a proposition in a given context, there are two separate things that one may know; the first is whether the sentence refers to a fact, and the other is the fact to which the sentence refers (assuming that it is true). Knowing a proposition could then happen in two different ways, in one case the subject knows both that the proposition is true, and the fact that makes it true. This is ostensible knowledge. In the other case knows that the proposition is true, but does not know the fact that makes it true. This is inostensible knowledge. Just to take a simple example, suppose a friend of yours says that his lover's eyes are his favorite color. If you take his word for it, now you know a proposition expressed by the sentence (in the appropriate context) : "his lover's eyes are is favorite color". Though you know that the proposition is true, you may still not know what make it true, that is, you may not know the fact to which the sentence refers. This would be the case if you do not know your friend's lover, or what his favorite color is, or both. The sentence would then be inostensible for you, not because you do not know whether it expresses a truth—you already know that it does—but rather because you do not know the fact to which it refers. The same proposition is also known by your friend of course but ostensibly, for he knows who his lover is, and her eye color. If unbeknownst to you his lover is Sue, and his favorite color is brown, then the sentence refers to the fact of Sue's eyes being brown. If you learn this, say by being introduced to Sue *as* the lover, and observing her eye color, then you could convert your piece of inostensible knowledge into a piece of ostensible knowledge. Quite obviously inostensible knowledge is a lot easier to attain, and when one attains it, one may need further experience to gain ostensible knowledge. Given this we are now in a position to see why the question of whether a given proposition is knowable a priori has two separate readings. Let us go back to the speed of light to see this.

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[10] I discuss this theory in detail in a new manuscript titled *Truth As Reference, Falsity As Failure* which is currently under consideration for publication.

Concerning the proposition expressed by the above sentence that states what the speed of light is, there are two distinct things one may know; one is whether it expresses a truth, and the other is the fact that makes it true (assuming that it is true). Similar to the lover-case, when a subject only knows the former, but not the latter, the knowledge in question would be inostensible. To know it ostensibly one would have to have some experience of the fact that makes the proposition true. My main thesis is then that even if the inostensible knowledge of this proposition could be said to be a priori—with a certain qualification that I will get to shortly— acquiring ostensible knowledge of it cannot be a priori. The reason for this is that the mere introduction of the name 'meter' gives rise to a priori knowledge of the truth of the proposition in question, but that does not entail that one also knows the fact that makes the proposition true. Now the fact is an empirical fact concerning the magnitude of the speed of light, and to know this fact requires empirical experience, and therefore is plainly a posteriori. The reason why we are puzzled is because we are conflating ostensible knowledge with inostensible knowledge here. When 'meter' was redefined in 1983, the relevant scientific community already had some partial knowledge of the speed of light based on careful measurements. That is why their knowledge of the proposition in question was closer to being ostensible. This is not always the case. Consider an example due to Miscevic. Suppose upon being asked what the cause of cancer is, one introduces the name "glub" for whatever is that cause. Now we may claim that we know the cause of cancer, it is glub. Unlike Donnellan (1979) I believe that there is nothing wrong with introducing such a name into language and using it. The name however would be an inostensible name assuming that we do not know the cause of cancer. As said previously there have been many such examples of the use of such names in history, and "glub" could have been another one. Knowing that cancer is caused by glub obviously would be inostensible knowledge, and in one sense it would be a priori. What is epistemically more valuable of course is to attain ostensible knowledge of this proposition, and that would require us to come to know the fact that makes the proposition true. To achieve that one would have to come to have knowledge of the referent of "glub". That is what we lack, and quite clearly such knowledge can only be attained by empirical inquiry. Similarly knowing the speed of light ostensibly requires more than simply introducing a name; it requires empirical data and careful measurements. Scientists had such experience prior to 1983. In fact the sole reason why they decided to fix the reference of the term 'meter' by a

description that involves such a precise number, is because they already had some experience of what the speed of light is, and given that it was believed at the time to be constant, it served as a secure way of defining 'meter'. In other words the reference-fixers did not choose this description arbitrarily; they already knew that it refers roughly to the same length as our old meter, and they knew this as a result of the scientific work conducted on what the speed of light is based on the old definition. Can we then safely conclude that no one is in a position to know a priori that the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second is one meter? In one sense we can, but in another sense we cannot. That is because, as I said, there are two different ways in which one can come to know this proposition; in one of these ways the knowledge in question will turn out to be a priori, in the other, it will not. Knowing the speed of light, in the sense of knowing the fact that makes the proposition true, was based on experience, and can never be a priori. The mere linguistic fact of introducing a name for some entity does not, by itself, give us knowledge of that entity. So acquiring ostensible knowledge of the proposition was not a priori. Having mere inostensible knowledge of the proposition is another matter, and with a certain qualification, it is a priori, but that is not an earth shattering result. It appears that anyone who grasps the definition of 'meter' could come to know that this proposition expresses a truth. If this is a priori knowledge, then it is not demanding, but effortless a priori, for it appears to be based merely on linguistic facts. As I said earlier this requires some qualification though, that is because the mere act of introducing a name by description does not guarantee that there is such a referent. Knowing that the description in question does indeed have a referent, is existential knowledge. For empirical matters, such as the speed of light, such knowledge is not a priori. Though on the surface the truth of the proposition appears to follow from the definition and in that sense it is effortless a priori, its ultimate justification will have to be based on our knowledge of certain existential facts which makes the proposition a posteriori. This is reminiscent of a distinction due to Miscevic between "superficial" and "deep" a priori:

> A belief in a proposition is superficially a priori if the proximal ground of its justification is non-empirical…A belief is deeply a priori if the distal and ultimate ground of its justification is non-empirical.

By appealing to this distinction Miscevic provocatively argues that propositions that involve conceptual analysis are at times superficially a priori, but deeply a posteriori. The same point can be made concerning the proposition expressed by S. On "proximal grounds" we may call it a priori, given that it can easily be derived from the definition of 'meter', but the "distal and ultimate ground" for its justification is empirical: it is superficially a priori, but deeply a posteriori. The reason for this is because when scientists re-defined the term 'meter' they already had reasons to believe that the speed of light in vacuum was constant, which obviously is a piece of knowledge that can never be attained on a priori grounds alone. If it turns out that they were mistaken about this, then the description in question would be what Russell called an "improper" definite description. It would be improper in that it would then not have a fixed referent. In general when a name is introduced by description sentences in which the name is used would have certain presuppositions among which is the presupposition that the name has a fixed referent, and this, quite obviously, is not knowable a priori in any sense of the term. Strictly speaking then what can be knowable a priori is only the truth of the conditional: "If the speed of light is constant in vacuum, then the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second is one meter". Knowing that the conditional is true on a priori grounds would give one merely inostensible knowledge, but there is nothing shocking about that given that it is trivial; coming to know even this conditional ostensibly is not trivial at all, and can only be based on empirical justification, and therefore is not a priori.[11]

ACKNOWLEDGEMENTS

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[11] Kripke does not conditionalize the meter-sentence, but in his other example concerning Neptune he does.

(especially given our mutual interest in curiosity), but also as a friend. It is thus a great pleasure to be contributing to this volume in honor of his work and all his achievements.

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