

Ex Nihilo

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the University of Texas at Austin

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Ex Nihilo

**The Undergraduate Philosophy Journal of
the University of Texas at Austin**

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An Analysis of the Anthropic Principle and its Place in Modern Science

Steven Harms

University of Texas

(Winner: Matchette Essay Contest)

Introduction

In the beginning of the twentieth century, the academic and scientific communities faced a crisis in physics. Confronted with revolutionary implications from the empirical research of Edwin Hubble and theories of relativity of Einstein, the science of the day was forced to rapidly face one of the most significant paradigm shifts known in the modern age. In its wake, new sciences such as cosmology appeared and new methods of explanation such as quantum mechanics systematized the new knowledge.

Beginning in the mid-1970's, a subset of cosmologists broke away from the empirical tradition and devised a series of principles that attempted to explain the seemingly inexplicable properties of the universe. These principles, collectively known under the title, "The Anthropic Principle", are philosophical, not empirical, in nature. They offer a new and largely unexplored method of explaining the universe's properties. Cosmologists turned to logical conclusion-drawing versus trial experimentalism. In the Anthropic Principle, cosmologists proceed in an order of investigative steps exactly opposite to scientific tradition – from conclusion to premises. The question is: "Is this choice a change for the better?" This essay seeks to evaluate these principles by examining their meanings, pertinence, scientificity, and explanatory power. It aspires to conclude whether or not the Anthropic Principle has a valid place in cosmological research; and if so, what sort.

The Anthropic Principle Defined¹

The Anthropic Principle is classified into two super-classifications: the Weak Anthropic Principle (WAP) and the Strong Anthropic Principle (SAP). The SAP is further divided into four sub-

¹ Barrow and Tipler's work (Barrow, John D. and Tipler, Frank J. The Anthropic Cosmological Principle. Clarendon Press, Oxford, 1986.) is the most definitive book on the subject of The Anthropic Principle. As such, I have taken their presentation of the anthropic principle and will be using it as the source for my definition of the AP. Particularities in interpretation are noted in the footnotes.

Steven G. Harms is a 4th year MIS/Philosophy major at the University of Texas. His interests include, among others, the pre-Socratics, the history of science and the relationship of information technology and man..

classes: the teleological-theological model, the Participatory Anthropic Principle, the Participatory Anthropic Principle - 2, and the Final Anthropic Principle.² These latter three are 'flavors' of their super-classification - the SAP.³ The following are the direct citations from Barrow and Tipler's book and define the forms of the Anthropic Principle.⁴

WAP: The observed values of all physical and cosmological quantities are not equally probable but they take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirement that the Universe be old enough for it to have already done so.

SAP: The Universe must have those properties which allow life to develop within it at some stage in its history.

PAP: Observers are necessary to bring the Universe into being.

Many Worlds (PAP2): An ensemble of other different universes is necessary for the existence of our Universe.

FAP: Intelligent information processing must come into existence in the Universe and once it comes into existence it will never die out.

The ethos of the above definitions is readily apparent and of great importance. That is, "Knowing I (a carbon-based organism / a human) am existent in the universe, the Universe must have already had such properties that allowed a life form such as myself to develop."⁵

² I have divided the Participatory Anthropic Principle in two according to interpretation of Quantum Mechanics (Copenhagen Interpretation or Many Worlds). For a description of the interpretations see Casti, John L., Paradigms Lost: Images of Man in the Mirror of Science. Morrow, New York, 1989.). PAP2 is my own identification and will be used throughout this work. In Barrow and Tipler it is simply referred to as letter B of the SAP division.

³ Barrow and Tipler present the FAP as something independent of the SAP. In my opinion, this is done for aesthetic reasons. The FAP uses the same terminology "...life must come into existence..."(Barrow and Tipler, p. 23) and thus is a variant of the SAP. I feel Barrow and Tipler gave it its own bracket as it assumes the SAP's truth and it possesses a highly speculative nature. As such, the FAP does not belong at home with the two "blasé" scientific categories. I have denied the FAP this distinction as its philosophical definition places it in the same category with the other subclasses of the SAP.

⁴ The following citations should all be attributed to Barrow, John D. and Tipler, Frank J. The Anthropic Cosmological Principle. Clarendon Press, Oxford, 1986, pp. 16,21,22-23.

⁵ For a more precise definition of 'properties' see the following section

This ethos will prove a vital criterion for considering the validity of various subcomponents of the AP.

Barrow and Tipler's presentation of the AP as quoted above lacks the rigor of language necessary for a philosophical inquiry. As such, the following section will be devoted to establishing a vocabulary such that we can present clarified versions of the aforementioned definitions. To this end, a small analysis of the method and vocabulary of the modern law-forming science follows.

The Universe and its Vocabulary in Terms of Cosmological Research and Mathematical Modeling

The universe is the closed system in which humans and matter are located. Phenomena (the reactions between matter) in the universe are governed by *laws of nature*. The universe's *laws of nature* are quantified by human scientists into mathematical expressions called *laws*.⁶

What is a Law? How is a Law made?

Laws parallel real-world phenomena's relationships through quantified, mathematical representations (equations) of said relationships. Consider the example of the process of translation from phenomenon (and correlate *law of nature*) to *law*:

Given: The moon orbits the earth. It holds its orbit due to a gravitational attraction between the two objects.

- **Real-World Happening:** "The moon orbits the earth." This is assumed to follow from an immutable law of nature.
- **Law (in hypothetical phrasing) Formation:** "The gravitational force exerted between the two bodies is inversely proportional to the square of the distance between them."⁷

At this point experimental testing is performed and the hypothetical law is found to be upheld in comparison to phenomena in

⁶ The distinction between *law of nature* and *law* is a semantic choice. A *law of nature* was written by The Author of The Universe and is, most likely, not expressed in mathematical terms. A *law* is written by men and parallels the phenomena which results from said Author's law. This work will be concerned with the latter sort of *law*.

⁷ Verbal definition of The Inverse Square Law taken from - Goodman and Russell. The Rise of Scientific Europe 1500-1800. Hodder and Stoughton, England, 1991, p. 254.

the real world. At this point, the result of the *law of nature* is translated into the language of mathematics and becomes a *law*.

Mathematical Representation (law status): $F = k (m1) (m2) r^2$

Components of an Equation

To aid understanding of the following distinctions, an example for consideration will be introduced. The following formula represents Newton's Inverse Square Law.⁸

Ex. 1: $F = k (m1) (m2) r^2$

Laws are composed of constants and variables

Constants⁹

There exists a finite, albeit possibly inconceivable, number of *constants*. The number of constants and their values are determined by whatever force or being created the universe. *Constants* possess values. They are required in the construction of *laws*. In the Universe, the assigned value for a constant is permanently fixed; examples are π , k , or G . In cosmological modeling there is no difference between *constants* and *variables* - the cosmologist performing the modeling operation can freely assign whatever *values* he chooses.

Values

Values are represented by a number on the number line from negative infinity to positive infinity. In the example, k is a constant that possesses a numerical *value* located in the domain of $-\infty$ to $+\infty$. Neither *constants* nor *variables* have an *a priori* reason for preferring any given value.

Variables

Variables are "temporary-constants." All *variables* possess *values*. In the example, variables are F , $m1$, and $m2$. Unlike constants, they have no permanently assigned value in the "real world." In addition, they are equally susceptible to the value assignment whims of cosmologists. This lack of permanent value affixation is also true in mathematical representations (the equations) of *laws*. It is precisely this impermanence of value assignment and interdependence of some variables on other constants and variables in an equation-law that allows the effects of the *laws* and their constituent *constants* to be seen. For

⁸ Formula taken from - Goodman and Russell. The Rise of Scientific Europe 1500-1800. Hodder and Stoughton, England, 1991, p. 254.

⁹ Cosmologists occasionally differentiate between physical and cosmological constants. This difference will not be of note in this work.

the researcher, the possibility of changing a variable and seeing a quantifiable change in the *dependent* variable (the value of F) is where the explanatory power of a *law* lies. Only a *dependent variable* is able to reflect, through changes of value, the phenomenon the *law* seeks to mirror. As such, all laws necessarily contain *variables*. By studying the mathematical relationship between constants and variables in the *law*, the researcher learns how the *law of nature* and the phenomenon relate to each other.

How do variables receive values?

Some *variables* can be assigned by the person using the formula (the cosmologist doing the modeling). In modeling, some variables are assigned values by the cosmologist, while other values, have their values assigned (*dependent variables*) to them via the solution of the *law's* correlate equation. Using the example, the values of $m1$ or $m2$ may be changed according to the will of the person using the formula. The value of F is mathematically dependent and assigned as a result of the chosen values for $m1$ and $m2$.

What is the Role of the Cosmologist?

The principle work of the cosmologist is modeling. He builds representative models of the universe with the aid of computers. The models assume the truth (and are comprised of) of the *laws* which describe the interaction of matter within the Universe. These *laws form* the foundation in his modeling. The cosmologist is free to set the values of variables and constants as he pleases. The cosmologist could, in theory, assign $\pi=5.5$. All things are possible in modeling. Such silly assignments, of course, go against the cosmologist's best interest as he attempts to model the universe in which he finds himself.

With this, I retire the discussion of the manner of procession of the modern law-forming science, and return to the subject of the inquest: the evaluation of the APs.

Translation of Barrow and Tipler's Presentation of AP

It has already been noted that Barrow and Tipler's definitions lack linguistic rigor. In need of clarification are the definitions of WAP and SAP. Given the terms defined in the previous section, a clearer version of both is possible.¹⁰ These terms will also be presented in a manner slanted relative to cosmological research as that is the subject of this inquest.

¹⁰ Henceforth, references to WAP or SAP will refer to the following definitions and no longer to those presented above in the citations of Barrow and Tipler.

WAP: In cosmological modeling, values for physical and cosmological constants may be freely chosen; however, the laws and models composed of said constants **must yield** a universe such that carbon based life evolves and that the Universe be old enough for such a universe to have already done so.

SAP: In cosmological modeling, the physical and cosmological constants **are required** to be such that life evolves therein at some point in history.

The answers to the “why *are* the constants required to be so” is what prompts the sub-versions of the SAP. The answers being either rooted in a teleological / theological / design argument answer or a quantum mechanics argument. The sub-definitions’ original phrasing is acceptable and needs no further clarification. Issues presented by the SAP will be discussed after the WAP is handled.

Evaluation of the Weak Anthropic Principle

The WAP offers the following contentions. First, it contends that all constants’ and variables’ values may be freely chosen from the domain of numbers. Further, it says that if cosmologists wish to render a universe like ours, the values of these constants and variables must be such that the laws allow two things to happen. First, carbon-based life forms must be able to come into being. Secondly, the universe must be old enough (either by assignment or as mathematical result) so that carbon-based life can already have evolved.

The WAP simply expresses something that everyone who is “alive” is aware of. Namely, the universe must have been such (carbon making and old enough, etc.) that humans could exist or else there would be no humans here to discuss whether it was so or not. This statement essentially resolves to a well accepted fact regarding all investigative instruments: “when... measuring anything, [it is] necessary to take into account the particular properties of the measuring instrument.”¹¹

The mandate that the WAP delivers to cosmologists is:

- All the research and all the models you make must be such that human life is allowed to form. It merely limits the choice of values which cosmologists may apply to constants and variables.

¹¹ Casti, John L., *Paradigms Lost: Images of Man in the Mirror of Science*. Morrow, New York, 1989, p. 479.

- By the time the modeled age of the universe matches the current actual age of the universe life should have already come into existence.

Values are, of course, also limited by information acquired through other areas of empirical research.

This AP is surely true in all cases and most cosmologists will accept this as true despite some bitter foot shuffling and commentary that the AP “smacks of tautology.”¹²

The WAP’s Status in Terms of “Scientificity”

The standard of scientific investigation goes from specifying the initial situation and the laws of nature, to predicting subsequent states of the system.¹³ The WAP operates in exactly the opposite manner. It takes the subsequent fact, “We are here” and deduces the initial conditions and the laws that govern the system such that the subsequent fact will be fulfilled.¹⁴ Some sentiment against the AP may be an aesthetic disregard for violation of traditional scientific methodology. Critics also charge that wisdom gained by using the WAP does not explain all universes, just the one all humans find themselves in, and that this hypothesis is untestable as there are no “test universes” wherewith to experiment. The role of the cosmologist already establishes that the cosmologist seeks to describe the formation of the universe wherein he finds himself. As such, this criticism is baseless. Such complaints are not grounds for rejection of the principle. The WAP cannot be ruled out for “unscientificity.”

Explanatory Power of the WAP

The WAP lacks a certain “robust” explanatory power. It is highly unlikely that in mathematical research regarding the universe’s interactions the WAP will play any role. A day when a cosmologist programs the WAP into a universe modeling computer and the computer makes use thereof in a groundbreaking discovery is not imminently foreseeable.¹⁵ The WAP has *dismissive* power and has value as a scientific research tool, but it fails to explain why things are as they are. It does not take the mystification out of problems. It is essentially an instinctive truth that everyone - to some degree or another - accepts as a requirement for their own existence. It will never

¹² Ibid., 481.

¹³ Ibid., 480-481.

¹⁴ Ibid., 480.

¹⁵ This assuming a meta-logic idea such as the WAP could be programmed without running into Gödelian self-reference issues.

be used to arrive at particular values - its best function is as a razor, trimming bad explanations away leaving fewer bad explanations and the correct explanation.

How may the cosmologist use the WAP?

If the WAP proceeds against the general investigative pattern of science and it seems to lack mathematical appeal, how can it be of use in modern cosmology? It can be beneficial as a rejection-algorithm. It is an algorithm that helps reduce the choices of possibilities to the answer (provided, of course, that the disjunctive series is exhaustive). An answer can be found by empirical research and that answer's value is found to such and such or an answer can be found by removing all incorrect values until only the correct value remains. This "reverse-answering" process is how the WAP is best applied in research.

For example, Robert Dicke's employment of the WAP as a confirmation of Paul Dirac's value for the age of the universe is a shining example.¹⁶ The age of a universe is represented by a value constant (remember: difference between constants and variables is insignificant in universe modeling as the universe created is dependent entirely on the cosmologist's input and the pre-programmed laws) and thus could possess any value from the domain of numbers. The choices from $-\infty$ to 0 were ruled out, as the time value would necessarily be positive. Dicke took the ethos of the AP and asked, "We are here, what must the universe have been?" Banking on the accepted idea that heavier, life-necessary elements are cooked into existence within the nuclear furnace of stars or supernovae, Dicke was able to establish a bottom boundary value, $\cong 10^{10}$ years.¹⁷ Having established this, all cosmological models could be built in such a way that the age of the Universe would have to be greater than 10^{10} . In addition, a time could also be found at which all stars would be burnt out. Such value would establish the top boundary for the age of the Universe - were such a value so high; cosmologists would not be here to discuss it. An acceptable and fruitful zone for experimentation has been determined by the WAP. A large number of values have been dismissed by use of this AP and a boundary on the range of values has been established. Through the Anthropic Principle, the boundary of $10^{10} \leq \text{age of the Universe} \leq \text{time that all stars burn out}$ has been established.

¹⁶ The story of Dicke's plan is taken from Casti, p. 480.

¹⁷ This would be the estimate of how long it would take for organic molecules to be made and free from their stellar incubator.

The Verdict on the WAP

It is obvious and rather blasé, but philosophically and logically sound. It is a dismissive algorithm rather than a theory that helps construct new ideas and theories. The WAP is able to dismiss theories. While this is not a particularly preferred route wherewith to pinpoint a value, it does indeed help arrive at the correct value. The WAP is worth keeping as a cosmological explanation technique. Its use is valid. Like it or no, most scientists will allow its presence within the vocabulary of scientific explanation

Distinction between the WAP the SAP

What is the difference between the WAP and the SAP? The difference between the highlighted words "**must yield**" and "**are required**" seem minor. An example will illustrate the difference in strength between the two versions.

Suppose the gravitational constant G were a million times larger than it actually is. Then the lifetime of a star in its light-giving phase would be about a million times less... If an observer exists in such a universe he would see a universe whose mass would be a trillion times smaller than ours. Question: would life arise in such a vastly accelerated universe? The WAP is totally silent on this issue; the SAP says no, life can exist only if the fundamental constants have values very close to their observed [current] levels.¹⁸

The SAP was proposed in 1974 by Brandon Carter and is much more speculative than the non-controversial WAP.

Evaluation of the SAP

"An implication of the SAP is that the constants and laws...*must* be such that life can exist."¹⁹ In other words, there is no possible universe in which life does not develop, and all cosmological models *must* always yield universes with carbon-based life because the cosmological constants *must* have values very close to those currently observed. The immediate question is "*why must these values be so?*" The varying answers to that question are the source of the radically different interpretations that spawned the different subclasses of the SAP. Two answers hinge on quantum mechanics while the other hinges on a teleological/theological/design argument basis.

¹⁸ Ibid., 481.

¹⁹ Barrow, John D. and Tipler, Frank J. The Anthropic Cosmological Principle. Clarendon Press, Oxford, 1986, p. 21.

The Teleological - Theological - Design Argument

Teleological Answer: The universe must have such values because it is the universe's purpose to create human life and its constants' values must accordingly produce and sustain human life.

Teleology asserts that everything in the universe has a "final cause" or a higher purpose. Everything possesses a *telos* or a goal which is that thing's reason for existence. This style of reasoning found its origin in Aristotle who stated all things have a higher purpose that they seek to fulfill. In accordance with its *telos*, the universe has assigned its composite constants values compatible with the production and sustenance of its *telos*-fulfilling end -- human life. This is a dated attitude that has no place in modern science. It is widely disregarded. This answer to the question "*Why must the values be such to produce life?*" of the SAP is unsatisfactory. While the WAP lacked certain robustness, this version of the SAP lacks credibility and believability. It is outright directly rejected.

Theological Answer: *The Universe's constants must have the values they do because of God's Plan*

Present or implied in virtually every religion is that God deliberately made the universe and the earth specifically for the domicile of the human race. Naturally, the constants and the laws of the universe and the universe itself have been made at the behest of the Creator for his creation. Accordingly all constants would be perfectly aligned because of the perfection of God's vision and the supreme mastery of His design. This obviously has no relevance to modern science in any way. Modern science takes place in an atheistic vacuum. This is a personal matter of faith and religion. This fails to answer the "*why must the values be such to produce life?*" question in a fantastic manner.

Design Argument

The design argument rests essentially on three key points: that order and harmony are worth appreciating, the classical "watch analogy", and probability. The watch analogy goes as follows. Were one to come across a beautiful Swiss watch, Tag Hauer for example, and one had never seen such a device before, one would be forced to conclude one of two things:

- Some agent created this masterwork of chronographic engineering.

- Through an exceedingly colossal accident this masterwork spontaneously came into existence.

Proponents of design arguments claim that one would naturally assume that it was designed by an agent because the probability of a chronographic marvel, such as the Tag, spontaneously coming into existence would be incredibly small. Proponents assume that the finder of such a device would have a 18th century - Newtonian appreciation for craftsmanship and order and accordingly appreciate the order, harmony, and precision encompassed in the object. The parallel, proponents state, is obvious. The universe - like said chronograph - operates in order, everything is perfectly related in a flawless manner, such majesty could not exist without the hand of an author.

This group of proponents also has modern disciples like Fred Hoyle. While studying nuclear resonance levels in carbon and oxygen Hoyle remarked:

I do not believe that any scientist who examined the evidence would fail to draw the inference that the laws of nuclear physics have been deliberately designed with regard to the consequences they produce inside the stars. If this is so, then my apparently random quirks have become part of a deep-laid scheme...²⁰

At this point, the modern example and the Newtonian run into a small problem. At logical end, the design argument necessitates an omnipotent force and overlaps - although far less dogmatically - into the theological division's problems. It suffers from putting God into atheistic science. The Design Argument has a much more scientific subterfuge over its underlying theological core. As such, like the theological sub-class, it must be dismissed as well. In addition, there is no proof that rules out the possibility that a harmonious and orderly universe is not a natural effect of the big bang or any other happening(s) within the universe.

The teleological, theological, and design argument versions of the SAP have failed to explain why the Universe *must* produce life. New life came into the science world's lungs at the turn of the 20th century - quantum mechanics. Quantum mechanics offers recussitation to the ailing corpse of the SAP. In quantum mechanics, the modern day proponents of the SAP found a route by which to justify *why the Universe's constants must have the values that they do*. Their only problem was that quantum mechanics turned out to be slightly more complicated than originally thought. Quantum mechanics came forth in two forms or *interpretations*: The Copenhagen (or standard proposed

²⁰ Ibid., p. 22.

by Niels Bohr) Interpretation and the Many Worlds Interpretation (proposed by Hugh Everett).²¹ The Copenhagen Interpretation is associated with PAP while the Many Worlds Interpretation is associated with PAP2. The two PAP versions of the SAP will now be handled.

PAP: Observers are necessary to bring the Universe into being.

This version of the SAP relies on the Copenhagen Interpretation. According to the Copenhagen Interpretation a quantum occurrence is expressed in the form of a wave function. This wave function “collapses” when an “observer” performs an act of measurement and the quantum occurrence is given a value. A simple example would be the spin of an electron. The two options are spin up and spin down. The value of the electron exists in a quantum state called *superposition* where the electron technically exists in a state of both spin-up and spin-down. When the observation is made, the wave function collapses and a value is given: spin-up or spin-down (represented by +.5 and -.5, respectively).

The way the Copenhagen Interpretation forms the PAP is by assuming that the Universe would exist in a similar state of superposition until the wave function is collapsed by an observer. In such a universe the “observer brings the Universe into being” - so maintains the PAP.

This belief goes directly against the entire ethos of the Anthropic principle and therefore must be disqualified (see initial definitions section in this work). The ethos maintained that because humans exist, the Universe must have already had such properties and been in such a state that humans would be brought into being. Quantum mechanics asserts “Because humans exist and collapse the Universe’s wave function, the Universe’s constants are given values.” Even if this conflict with the ethos of the AP were not to disqualify it from the set of Anthropic Principles, quantum mechanics itself presents several problems.

What is an observer? In quantum radioactivity experiments it is usually a photographic plate. Is that qualified enough to be an observer? Is a mouse qualified? Is a mentally incapacitated human? Is a blind human? The questions are literally endless.

There are logical problems as well. If all properties and all quantum events exist in a state of superposition until an observer brings them into being, how does the observer come into being? If all quantum states are in superposition are they still able to form observers? This

²¹ If the reader needs to more information regarding the interpretations of quantum mechanics he can find information in Casti’s book in

view removes every thing to a world of superpositioned potentiality and fails to cite a genesis-actualizing act.

Further, assuming an observer can be brought into existence, as soon as the observer comes into being, he will collapse all the necessary wave functions necessary to bring a universal image into existence. The world will look to the observer (assuming he is conscious) like it was perfectly designed to bring him into existence -- the world will appear to be congruent with the necessary conditions for his existence. He will discover the WAP and the WAP will illustrate its intractable truth.

There are many other questions brought up within the science of quantum mechanics which, simply and regrettably, do not have answers. The most important conclusion is that even if there were no direct conflict with the AP ethos and even if one could manage to tolerate the great gray areas in quantum mechanics and even if one chose to accept the Copenhagen Interpretation, the observer will ultimately see a world compatible with his own existence. The observer will be aware of the truth of the WAP. Due to its vagueness and ethos contradictions, PAP is hereby rejected as an unsatisfactory answer to the question “*why the Universe’s constants must have the values that they do?*”

PAP2: An ensemble of other different universes is necessary for the existence of our Universe

The PAP2 finds its root in the Multiple Worlds theory. As above, this version of the AP is rejected out of hand due to its non-congruence with the ethos of the AP. Were that violation to be set aside it comes to the same end as the PAP1, as we shall see. Following Hugh Everett’s description of quantum mechanics each quantum act of measurement (each collapse of the wave function) splits the Universe into so many universes as there are options. Considering the example the electron spin measurement, the measurement act creates two new universes: one where the value for the electron is spin-up and another where the value for the electron is spin-down – each equally real. Ultimately the same results surface as in the PAP1. In whichever of the infinitely growing universes an observer emerges, he quite naturally sees a universe designed and directly compatible with the his existence. He validates the truth of the WAP for himself.

Further, the language of this principle seems to be in contention as well. The definition stated that an ensemble of worlds was necessary to bring our habitable world (or, in a larger sense *any* habitable world) into existence. This assertion is certainly not shown to be necessary in the Multiple Worlds theory. If there is one more or one less quantum event in the universe, which induces one more or one less split in the

universes, it is hardly apparent that the habitable universes would be maligned by said event.

The Final Anthropic Principle²²

The FAP is the most speculative of all AP's and the strongest version of the SAP. The FAP accepts the SAP as true and then uses a logical conclusion to assume the permanence of human life in the Universe. The FAP consists of this statement: "As it is the Universe's goal (in one way or another) to support our life, it is impossible for the human race to die out, lest the Universe negate its success by killing its goal."

- In the theological version, God would not eradicate His creation.
- In the teleological versions, the universe would not negate the success of achieving its telos.
- Design arguments follow the same logic. Humans are considered part of the harmony and have the role of appreciating the majesty and order in the universe. As such the universe would not eradicate humans. It can also rely on the theological as, ultimately, The Author of the universe is the same as God.
- PAP1 concludes that human life can't die out lest the Universe throw itself back into a superpositioned no man's land.
- For PAP2 it makes no difference because given that all combinations of all possibilities are represented life will necessarily emerge in one of the many universes. Persons who believe in PAP2 can always take shelter in the fact that there's a universe where everyone is happy and the human race will live safely and happily in peace forever. The universe will also find this a pleasant arrangement as it guarantees it an observer.

Not only can life not be destroyed after so long, but it will accumulate all the bits of information knowable in the universe and truly have a "mind of God." This is speculative garbage.

In the end, The Final Anthropic Principle is over-investing in the speculation of the SAP. As the SAP was rejected in all its forms, the FAP must be rejected as well. In the least case, the FAP is already far too speculative in its own right.

²² Earlier I stated that I would treat the FAP as a part of the SAP. I have given closing remarks over the SAP in the previous paragraph because those comments hold for all the SAP sections, while not the FAP. The FAP should still be seen as a extremely strong version of the SAP. Due to its phenomenally speculative version I will handle it this separate section. It is an organizational convenience, not a philosophical division

The Verdict on All SAP Subclasses

The theological/teleological/design arguments have been rejected due to their lack of substance. The quantum mechanics versions have been rejected due to the fact that their nature is directly against the ethos of the AP and because the science in which they are rooted leaves far too many questions and discontinuities to be counted as a dependable theory. In addition, both quantum versions -- regardless of interpretation and the science's vagueness -- reduce to the fact that any observer simply sees a universe consistent with this existence -- regardless of interpretation.²³ Fortunately for proponents of the WAP, the SAP upholds the truth and universality of the WAP.

Conclusion

After considering all the varying varieties of the Anthropic Principles known to modern cosmology, the SAP's mandate "That the constants *must* possess the values they currently possess" was found not to be upheld by any of its composite three sub-classes. The SAP is removed from consideration entirely. The FAP was also quickly removed for its speculative and, quite simply, unrealistic ideas. The only AP to withstand this investigation was the Weak Anthropic Principle. The Weak Anthropic Principle is a principle which cosmologists may apply to their research without coming into philosophical error. The WAP must be used as an excluding principle -- it is a winnowing tool. With the WAP cosmologists can exclude values and come closer to finding the answers they seek. In all, however, the AP is a very weak tool and can only help provide a very preliminary narrowing of possible values. While it offers an interesting inversion of the traditional steps involved in scientific inquiry, empirical research offers a more reliable and generally more accepted route of inquiry.

²³ Were there no ethos violation with the PAPs they would actually answer the question "why must.." The answer would be because in both of those states -- a superpositioned universe and a multiple worlds universe -- an observer must ALWAYS come into existence. This is due to the fact that all outcomes for all quantum events are represented. The observer will always come into being and will of course see that the constants could not be any different lest he not be there. By covering the entire area of possibilities, quantum mechanics guarantees itself an observer.

Christopher Furlong
University of Texas

(Winner: Matchette Essay Contest)

I

In "Frege on Knowing the Third Realm," Tyler Burge argues for a realist reading of Frege's philosophy. He characterizes as realist any philosophy that accepts the existence of non-spatio-temporal entities that are independent of any kind of human activity, social or mental. Burge argues that, for Frege, numbers and thoughts, among other things, are non-spatio-temporal objects that exist independently of human beings and that therefore Frege is a realist. Hans Sluga and Joan Weiner have rejected this traditional reading of Frege and argue instead that while Frege does deny that thoughts and numbers are physical or mental entities he does not think that they are completely independent of the mind. Rather they are "constitutive of the mind" in that they, in some sense, structure our cognition and make it possible. In this paper I will consider these two readings of Frege and argue that Frege is a realist. I do not, however, entirely agree with Burge's reading. For Burge, Frege's realism is a naïve pre-philosophical assumption wherein the existence of abstract objects¹ is uncritically taken as a starting point. I will argue instead that Frege is led to his ontology by his theory of meaning.

Before I move on to my analysis of various interpretations of Frege's ontology, I should point out that giving a list of entities whose existence Frege is committed to will not do as an explanation of Frege's ontological commitments, nor would a list of the properties of those entities remedy the problem. We certainly need to know what Frege would admit of as existent and we need to know what properties these entities have, but for an explanation to be complete we need to know how Frege *arrives* at them. We need to know their role in Frege's arguments. Are they the basis or the result of his arguments? Burge makes his position clear in his disclaimer:

Although I think that Frege maintained a metaphysical view about numbers and other such entities, I do not believe that this view

¹ Frege never (to my knowledge) uses the term 'abstract objects', and I'm not entirely sure what it means or what kind of philosophical baggage it brings with it so I'm a bit wary of using it. But for the sake of brevity and ease I will use it strictly as a short hand for 'ontologically independent, non-spatio-temporal objects' I reject any connotations the term may bring with it.

Christopher is a senior philosophy major at the University of Texas at Austin. He is primarily interested in the philosophy of language and epistemology. He plans to pursue a Ph.D. in philosophy after graduation.

dominated his thinking. His is, for the most part, the relaxed Platonism of a mathematician who simply assumes that there are numbers, functions, and so on, and who regards these as an abstract subject matter which can be accepted without special philosophical explanation.² (Burge 1997, p. 4)

For Burge, Frege starts out with abstract objects and builds from there. It will be seen, I hope, by the end of this paper why Burge's characterization is inadequate.

Burge argues for his interpretation in two ways. First he cites and discusses several passages from Frege's writings that support a realist interpretation. Second, he argues that Frege's argument for the possibility of communication and the objectivity of science require the independent, non-spatio-temporal existence of thoughts.

Burge begins by considering two Fregean analogies between abstract and physical objects. Frege writes about numbers:

Just as the geographer does not create a sea when he draws boundary lines and says: the part of the ocean's surface bounded by these lines I am going to call the Yellow sea, so too the mathematician cannot really create anything by his defining. (Frege 1964, p. xiii)

and about thoughts:

The grasp of a thought presupposes someone who grasps it, who thinks. He is the owner of the thinking, not of the thought. Although the thought does not belong with the contents of the thinker's consciousness, there must be something in his consciousness that is aimed at the thought. But this should not be confused with the thought itself. Similarly Algol itself is different from the idea someone has of Algol. [Frege 1997, p. 342]

These analogies suggest, according to Burge, that numbers and thoughts are independent of thinkers *in the same way* that physical objects are. In addition to comparing abstract objects to physical ones, Frege also makes unqualified claims about such objects and their independence from us. Again, with respect to numbers, he writes:

Numbers do not undergo change, for the theorems of arithmetic embody eternal truths. We can say, therefore, that these objects are outside time;

² In the debate over Frege's ontological commitments and concerns, interpreters on both sides of the issue seem divided over whether to use the term 'realist' or 'platonist.' As far as I can see, nothing turns on this disagreement. I will use the former term only because I think (perhaps erroneously) that it carries less unwanted philosophical baggage. I take the two terms to be interchangeable

and from this it follows that they are not subjective precepts or ideas. (Frege 1984, p. 230)

and with respect to thoughts:

What we want to assert in using that proposition [that the number three is prime] is something that always was and always will be objectively true, quite independently of our waking or sleeping, life or death, and irrespective of whether there was or will be other beings who recognize or fail to recognize this truth. (Frege 1984, p. 134)

In these passages Frege is quite clear on how he thinks of numbers and thoughts. Numbers are atemporal and objective as opposed to mental. Atemporality presumably entails independence from humans since humans could cease to exist. A thought (that which is asserted by a sentence) is true eternally and independently of us.

Burge's second argument deals with Frege's notion of objectivity. On Burge's interpretation, Frege's arguments for the objectivity of science and the possibility of communication presuppose that thoughts are abstract objects. In his essay "The Thought," Frege says that "if every thought requires an owner and belongs to the content of his consciousness, then the thought has this owner alone; and there is no science common to many." (Frege 1997, p. 336) Frege argues for this view in three ways. First, since if a true thought follows from other true thoughts then it always follows from them, then it follows that if a thought is true at all it must always be true. To account for the atemporality of entailment, thoughts (the bearers of truth and falsity) must be atemporal.

In the second argument, Frege claims that science and communication are not possible if thoughts are ideas in people's minds. After asserting that thoughts cannot be physical he argues that if thoughts (the bearers of truth and falsity and the aim of science) were ideas, then no contradiction between one person's science and another's would be possible. Any dispute over truth and falsity would be "idle" and "ludicrous." So for science to be objective, thoughts must belong to a non-mental, non-physical realm. "Anything belonging to this realm has it in common with ideas that it cannot be perceived by the senses, but has it in common with things that it does not need an owner so as to belong to the content of his consciousness." (Frege 1997, p. 337)

The third argument for thoughts as abstract objects starts with the claim that facts are required for science to have a "firm foundation." But for Frege, facts just are true thoughts. The work of science, then, is to discover true thoughts which must, for science to be possible, be independent of our "varying states of consciousness." One

thing to note about this argument is that a true thought is not *about* facts, in which case science would not require them to be independent of the mind. Rather "a fact *is* a thought that is true." (Frege 1997, p. 342, my emphasis) This oddity is purely terminological, not philosophical. As has probably already become clear, Frege does not understand by 'thought' what we normally do. A thought, for Frege, is more akin to what we mean by 'proposition'.

II

I will now consider two challenges to the view of Frege as a realist beginning with Sluga. The most charitable way to present Sluga's arguments for a non-realist interpretation is to consider them as a response to Burge's first argument which isn't really an argument but rather an inventory of isolated passages that seem to suggest a realist interpretation. The problem with Burge's strategy is that an interpreter such as Sluga can easily come up with a list of isolated passages that suggest a different interpretation. Consider for example, the following passage from *The Foundations of Arithmetic*:

I understand objective³ to mean what is independent of our sensation, intuition and imagination, and of all construction of mental pictures out of memories of earlier sensations, but not what is independent of the reason, --for what are things independent of the reason? To answer that would be as much as to judge without judging, or to wash the fir without wetting it. (Frege 1980, p. 36)

It seems that perhaps thoughts and numbers are not so independent of us after all. Burge repeatedly claims that Frege makes no qualification on the independence of abstract objects. He goes so far as to make the highly informative assertion that for Frege, "independence is independence." Unfortunately it is not informative enough. For all the seemingly clear talk of the independence of abstract objects, this passage calls into question Burge's claim that Frege's realism is unqualified.

Up until now, what Frege seemed to mean by saying that abstract objects are independent was that they are ontologically independent; that even if the mental and physical realm were to cease to exist, the third realm would be unaffected. But what does Frege mean by stating that abstract objects are not independent of reason?⁴ And

³ For Frege, what is objective includes both the physical realm and the "third" realm. Abstract objects, then, are objective.

⁴ I should note that Sluga's translation of the passage ends "...to say what things are like independent of Reason would be to judge without judging..." In this translation there is an ambiguity over whether independence from reason applies to

what does he mean by 'reason'? In Sluga's gloss to the passage above, he claims that Frege's point is that "it is inconsistent for us to try to say what things are in themselves, independent of our judgments." (Sluga 1980, p.120) To understand what Sluga means, and why he says it, we should consider his general view of Frege.

Sluga views Frege as a Kantian idealist of sorts and rejects the claim that he was concerned with or committed to any kind of ontology. In favor of his interpretation, Sluga enlists a large amount of non-textual evidence concerning Frege's personal associations, memberships in philosophical organizations and the general philosophical climate of late 19th century German academia. Very little textual evidence is given, making Sluga's arguments quite circumstantial and of questionable merit. While there is little question that philosophers are strongly influenced by the attitudes and beliefs of their times, evidence dealing with their historical context should never override textual evidence. Sluga would probably respond by saying that his interpretation of Frege proves its worth by allowing him to make sense of some otherwise cryptic passages. We shall see.

The piece of non-textual evidence that Sluga discusses at greatest length is the similarity between Frege's and Herman Lotze's view of objectivity. Sluga presents Lotze's view and, based on *some* explicit agreements with Frege's, concludes that Frege shares Lotze's ontological concerns or lack thereof. For Lotze, "the doctrine of objectivity is not to be taken as ontological, but rather as epistemological."⁵ Lotze is quoted as claiming that

In so far as we have and grasp ideas, they possess reality as events, as things that happen in us ... but their content, considered separate from the mental activity we direct towards it, is not something that happens. It does not exist in the way in which things exist; it is simply *valid*. (his emphasis)

One key point of agreement between Frege and Lotze is, according to Sluga, that "the objective is that which can be grasped by more than one human (rational being). The objective, in other words, is the intersubjective." Frege certainly holds this since he says that a

things or to saying what things are like. If Frege meant the latter, then there is no problem for the realist interpretation. I don't know German so I can't comment on this ambiguity, but I will be charitable to Sluga and assume that Frege means the former.

⁵ All the quotes in this exposition of Sluga will be from Sluga (1980), p. 117-121. I will mention in the text the cases where Sluga is quoting Lotze.

judgeable content⁶ is "something objective, that is, something that is exactly the same for all rational beings that are able to grasp it." This seems to support Sluga's claim, but Frege adds "...as, say, the sun is something objective." [Frege 1979, p. 7] Now certainly, the sun is not "simply valid."

In "Objectivity and Reality: Lotze and Frege," Michael Dummett suggests that Lotze's view of objectivity entails a three-way ontological distinction between what is not objective (such as subjective ideas), what is objective and real (such as the sun) and what is objective and simply valid (such as thoughts, in Frege's sense). Frege, however, "admits no category of the intersubjective intermediate between what is private to some individual subject and what is independent of all subjects." (Dummett 1982, p. 117) That is not to say, of course, that thoughts have the same ontological status as the sun since neither is the sun atemporal nor thoughts physical. Frege's view, like Lotze's, does entail a three-way ontological distinction between ideas, physical objects, and abstract objects. But unlike Lotze, Frege's third-realm entities are not simply valid. Physical and abstract objects are ontologically independent of judging subjects *in the same way*.

Frege's theory of objectivity does hold that what is objective "is that which can be grasped by more than one human (rational being);" that what is objective is intersubjective. But what is objective, be it thoughts or celestial bodies, is intersubjective only because it is entirely independent of us. Frege writes:

Not only do thoughts – e.g. natural laws – not need to be recognized by us in order to be true: they do not need to be thought by us at all. A natural law is not created by us, but discovered. And just as a desolate island in the Arctic Ocean was there long before it was seen by men, so the laws of nature and in the same way those of mathematics hold from eternity and not just from the time of their discovery. We may deduce from this that thoughts are not only true, when they are true, independently of our recognition, but that they are altogether independent of our thinking. (Frege 1979, p. 133)

According to Sluga, Lotze thinks that the claim that ideas exist separately but analogously to physical objects is "outlandish," and "...he believes with Plato that empirical knowledge of temporal, changing things presupposes some knowledge of non-temporal, non-changing things" making him an "epistemological platonist rather than an ontological platonist."

⁶ A judgeable content is just a thought and its truth value. By the time he wrote "The Thought," Frege had split up the notion of "judgeable content" into a thought and a truth-value. Thoughts and judgeable contents, presumably, have the same ontological status.

As we've seen, Frege would agree that knowledge of temporal, changing things presupposes knowledge of non-temporal, non-changing things. But when I considered Frege's argument for this view from "The Thought," I took it to be an argument that Frege is a realist. After all, if knowledge of temporal, changing things presupposes knowledge of non-temporal, non-changing things, then non-temporal, non-changing things must exist. Else, how could we have knowledge of them? Sluga seems to be confusing the issue of motivation with that of commitment. No one, I think, would say that Frege's motivations are ontological. Frege's project is not intended to give an ontological foundation for arithmetic. His motivation is epistemological. He wants to show that we *know* arithmetic in the same way we *know* logic. But it does not follow from this that Frege does not have an ontology. In fact, based on his views of thoughts and how they ground objectivity, he actually *needs* an ontology.

There is another problem with Sluga's interpretation of Frege. He views Frege as a Kantian idealist. What does this entail? On Kant's view, it is nonsensical to speak of things-in-themselves since most of what we know about objects is contributed by us. All we can know about the noumenal world is that it exists. Everything else we know about it, we actually know about, or as a result of, the structure our mind imposes on the it.

This would suggest a plausible interpretation of the passage from the *Foundations* quoted above since nothing of which we have knowledge is independent of the structure our mind imposes on it. But the interpretation loses its plausibility when we realize that Frege simply does not say enough. If Frege really was a Kantian idealist then we would expect him to discuss how his ideas fit into Kant's system. What role do thoughts and numbers play? Are they mind-imposed structures, are they phenomenal or are they noumenal? Not only does Frege not answer or suggest an answer to these questions, he doesn't even adopt Kant's terminology. To my knowledge, the only uniquely Kantian terminology that Frege does adopt are the terms for the analytic/synthetic and *a priori/posteriori* dichotomies over which he is in disagreement with Kant. If Frege discussed his disagreement with Kant in Kantian terms, does it not seem plausible to assume that if his agreement with Kant were substantial he would discuss that agreement in Kantian terms? There is, of course, a Kantian flavor to Frege's preference for 'thought' and 'concept' over 'proposition' and 'property'. But I do think Frege says enough about thoughts and concepts to preclude the possibility that they are in any way mental or mind-dependent as Kant would have them.

Non-textual evidence proves its worth in interpretation by yielding a coherent interpretation that explains certain textual evidence that could not otherwise be explained. For this purpose Sluga quotes, in

addition to the passage from the *Foundations* quoted above, (which he in fact does not explain) the following passage from "The Thought." I here quote the passage along with Sluga's gloss.

Frege notes that to say we grasp objective thoughts is to speak in a metaphor. 'What I hold in my hand can be considered the content of my hand, but it is the content of my hand in quite a different sense and is more alien to it than the bones, the muscles of which it consists, and their tension.' If we take this analogy seriously, it seems to imply that Frege does not hold that thoughts are in the mind as the bird is in the hand, but rather as the muscles and bones are in the hand. The objective is not something alien or external to the mind, but constitutive of it. It is its most characteristic possession. (Sluga 1980, p. 121)

On Sluga's reading, the bones and the muscles of the hand are analogous to thoughts and the hand is analogous to the mind. Dummett claims that Sluga misread the passage. For Dummett, Frege thinks that thoughts "are not mental contents, like ideas, that go to constitute our consciousness, but objects existing independently of us which we grasp in a sense analogous to that in which the hand may grasp a cricket ball." (Dummett 1982, p. 124fn) The analogy in question appears as a footnote to the following passage:

We do not have a thought as we have, say, a sense impression, but we also do not see a thought as we see, say, a star. So it is advisable to choose a special expression; the word 'grasp' suggests itself for the purpose. (Frege 1997, p. 341)

And is preceded by the following sentence:

The expression 'grasp' is as metaphorical as 'content of consciousness'. The nature of language does not permit anything else. What I hold in my hand... (Frege 1997, p. 341fn)

I think it is quite clear that what Frege meant was that while a thought "can certainly be regarded as a content of my [consciousness]; ...it is a content of my [consciousness] in quite another and more extraneous way than are the [ideas] of which [my consciousness] consists." Besides, if Frege meant that thoughts are contents of the mind as bones are contents of the hand, the word 'grasp' would not "suggest itself for the purpose." The fact is that Sluga simply does not make a convincing case for taking Frege to be a Kantian idealist.

In *Frege in Perspective*, Joan Weiner proposes an interpretation of Frege similar to Sluga's. She claims that "The Thought" is not about the possibility of objective knowledge or about the sense of assertoric sentences. Rather, "The Thought" provides another elucidation of the

view that there is a substantive logical source of knowledge without which ...even to think at all would not be possible."⁷ What she means is that Frege does not ground objectivity on thoughts as abstract objects but rather "on what is required for grasping a thought." That is to say, for someone to understand the thought expressed by 'Frege is bald', one must understand the basic logical laws. After all, "someone who claims that Frege is bald and that he is also not bald can be said not to understand the thought expressed by 'Frege is bald'."

Frege would agree that sense impressions alone are not sufficient to give us knowledge of the external world. In his anti-solipsism argument in "The Thought," he says that "having visual impressions is certainly necessary for seeing things, but not sufficient. What must still be added is not anything sensible." (Frege 1997, p. 343) Weiner suggests that "the obvious candidate [for this non-sensible thing that makes knowledge possible] is the logical source of knowledge." But what is the logical source of knowledge? All Weiner says by way of explanation is that it "can be tied to Kantian analyticity." (Weiner 1990, p. 71) Presumably what this means is that the logical source of knowledge is that which allows us to recognize the truth of analytic statements. Since, as we have seen, Frege thinks that the question of truth arises only for thoughts, the logical source of knowledge would have to be that which allows us to grasp a set of thoughts (those expressed by analytic sentences) as true. On Weiner's reading then, the argument of "The Thought" is that all knowledge presupposes or requires the ability to grasp a set of thoughts as true.

Suppose I grant this. After all, Frege does say that "to the grasping of thoughts there must then correspond a special mental capacity, the power of thinking." (Frege 1997, p. 341) All Weiner has established is that Frege thinks that all knowledge presupposes or requires the ability to think. What of it? Weiner seems to make the same mistake as Sluga in confusing questions of motivation with questions of commitment. I think it is quite clear that Frege's theory of objectivity is an epistemological theory. It is intended to answer questions regarding the kinds and possibility of knowledge. But none of Weiner's arguments establish (or even suggest) that Frege's theory does not have any ontological commitments. In fact if all knowledge requires the ability to grasp a set of thoughts as true, must not those thoughts exist? Else, what sense would it make to speak of such an ability? So even on Weiner's interpretation Frege is still committed to the existence of thoughts. That he thinks thoughts are abstract objects is clear from his arguments on the possibility of science discussed above.

⁷ All the quotes in this exposition of Weiner will be from Weiner (1990), p. 166-169] unless otherwise noted.

III

Weiner has another, more challenging argument for questioning the interpretation of Frege as an unqualified realist. In the *Foundations of Arithmetic*, Frege asks at one point "how are the numbers given to us?" (Frege 1980, p. 73). On a realist reading of Frege, this seems like a natural question to ask. After all, if numbers are neither mental nor physical objects but are objects nevertheless, then how is it that we come to know anything about them? But Frege reformulates the question as "since it is only in the context of a proposition that words have any meaning, our problem becomes this: To define the sense of a proposition in which a number word occurs." On a realist reading this does not seem to make any sense. Not only does the question not make any sense, but the fact that Frege substitutes one for the other makes even less sense. Weiner argues that "if the considerations that give rise to Frege's question concern only justification [of arithmetical propositions], his answer does not seem odd at all." (Weiner 1990, p. 186)

How is that? Well, if the question asks which logical laws are required to justify sentences in which number-terms appear, it seems reasonable to ask for the meaning of those sentences. I'm actually not entirely clear on how this can be an argument for not taking Frege to be a realist since we are still left asking for the meaning of a sentence which, for Frege is a thought; an abstract object. Nevertheless, Weiner seems to have a point in claiming that Frege's substitution of a question about epistemic access to numbers with one about the meaning of number-terms in the context of a proposition makes little sense on Burge's reading of Frege as an unqualified realist.

Also, consider Frege's admonition in the *Foundations to*

...never to ask for the meaning of a word in isolation, but only in the context of a proposition.... if [this] principle is not observed, one is almost forced to take as the meanings of words mental pictures or acts of the individual mind. [Frege 1980, p. x]

It seems that what Frege is guarding against is the method of defining numbers wherein one takes an isolated number-term and metaphorically looks around for something to attach it to. So the formalist, empiricist and psychological mathematicians that Frege inveighs against are led into the mistake of offering up the numeral itself, collections of physical objects or mental images as the referents of number-terms by ignoring this admonition (hereafter: context principle). Then what about the realist mathematician? Does he not define number-terms out of the context of a sentence by offering up abstract objects as the referents?

So we are faced with two challenges to taking Frege as a realist. (1) Why would he take a question about epistemic access to numbers to be equivalent to a question about the meaning of sentences in which number-terms occur? And (2) how can Frege be a realist (taking the meanings of number-terms to refer to be abstract objects) and avoid violating the context principle? I think its pretty clear that both these problems concern the meaning relationship between words and sentences. So before I answer them I should discuss Frege's view of that relationship.

I'll begin with the context principle. The first thing to determine is whether the context principle is about sense or reference. Given his subsequent distinction between sense and reference, it is unclear what Frege means by "the meaning of a word." Are we to not ask for the sense or the referent of a word in isolation? Well, since sense determines reference, the principle is clearly about reference. The only question to ask is whether it is also about sense. Of course we need to keep open the possibility that the sense-reference distinction was intended to replace the context principle. After all, they were both at least partly concerned with the meaning relationship between words and sentences. I will tentatively, however, take the principle as one about reference.

The next thing to determine is the motivation behind the context principle. What was Frege concerned with when he included it as one of his fundamental principles? I suggested above that he was concerned with avoiding formalist, empiricist and psychological accounts of the meanings of number-terms. But surely this was only the symptom, not the cause. It seems that the cause was misunderstanding the relationship between the meanings of words with meanings of sentences. The formalists, empiricist and psychological mathematicians took the meaning of the word to be primary. That is, words mean what they do as a result of some non-linguistic fact or event (convention, stipulation, etc.). Sentences, on the other hand, mean what they do because of the words they contain. I think the context principle is clear enough that we can safely rule out any interpretation of Frege that commits him to the view that sentences are entirely dependent on words for their reference. But I also do not think we should go too far the other way and claim that Frege viewed words as entirely dependent on sentences for their reference. Consider the following passage from the *Basic Laws*:

The name of a first-level function of one argument has a *referent* (*refers* to something, succeeds in *referring*) if the name that results from filling its argument place by a referring object name always has a referent. An object name has a referent if the name which results from filling with it

the argument place of the referring name of a first-level function of one argument always has a referent. (Frege 1964, p. 84)

This is a rather dense passage, but its import is that since a sentence is a name of an object, the reference-dependence relation between words and sentences is symmetric. As the context principle suggests, words depend on their sentential context for their reference. But additionally, sentences depend on their component words for their reference.

As a side-note, the sense-dependence relation is also symmetric. Frege's view in "On Sense and Reference" that sense is compositional, and lines such as "It is enough if the proposition as a whole has a sense; it is this that confers on its parts also their content," (Frege 1980, p. 71) suggest that the relation also goes in the other direction.

So what have we determined? We have established that words refer to what they do because of the truth-value of the sentences in which they occur and that sentences are true or false because of the referents of their component parts.⁸ The same relationship holds for sense. But if the meaning of a sentence confers meaning on the words in it, and the meanings of words confer meaning to the sentences in which they occur, then where does meaning come from? More specifically, how do number-terms and/or sentences about numbers come to be about numbers? How are the numbers *given* to us?

I am now ready to answer the first challenge to taking Frege to be a realist, but I should first say that a completely satisfactory response would require an adequate account of Frege's epistemology which I do not have. But I think we can establish enough to make it likely that Frege's comments do not jeopardize his realism. Frege is concerned with how we have access to numbers. At the time of the *Foundations*, he held that words have meaning only in the context of a sentence.⁹ Given his logicism, it would seem that Frege's answer to the question "how are the numbers given to us" would be: "through reason." Also since Frege's characterization of ontological categories (concepts and objects) in terms of their representation in language suggests a linguistic-representationalist epistemology, I think it is likely that Frege thinks that our knowledge of numbers is somehow mediated by

⁸ Recall that the reference of a sentence is a truth-value.

⁹ The compositionality of sense and reference is nowhere to be found in the *Foundations of Arithmetic*. It isn't until "On Sense and Reference" that Frege suggests that sense and reference are compositional. In fact, in addition to the context principle, Frege makes several other statements that suggest he saw the meaning relation to be asymmetric.

