THE MEANING OF LOGICAL CONNECTIVES AND PRIOR'S TONK ARGUMENT

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In "The Runabout Inference-Ticket," the New Zealand-born philosopher and logician Arthur N. Prior presented the tonk argument as a case against the inferential role view of logical connectives – the view that the meaning of a given logical connective is completely determined by its roles in deductively valid arguments. This paper evaluates the salient literature surrounding Prior's argument to draw some insights into what precisely it is supposed to show. In particular, it argues that combined with Prior's later thoughts expressed in "Conjunction and contonktion revisited," the tonk argument suggests a more metaphysical-cum-epistemic rather than just a purely (meta) logical view of the nature of logical connectives.

Keywords: Arthur N. Prior, inferential role view, logical connectives, logical realism, tonk, truth-table view

INTRODUCTION

Arthur N. Prior (1960) presented the famous tonk argument against the inferential role view of logical connectives (IRV). IRV tells us that the syntactical rules or inferential roles of logical connectives determine entirely their meaning. Prior argues that if IRV is correct, there could be a logical connective – *tonk* – whose inferential roles (viz., for any two statements A and B, from A derive A *tonk* B, and from A *tonk* B derive B) may yield invalid arguments – i.e., arguments that have true premises but a false conclusion. If this is so, then IRV must be wrong.

Many scholars have responded to Prior's tonk argument, some of whom have presented a "logical" response. For instance, J. T. Stevenson (1961) pointed out that Prior's rules for *tonk* are semantically unsound. On the other hand, Nuel Belnap (1962), Ian Hacking (1979), Roy T. Cook (2005), Denis Bonnay & Benjamin Simmenauer (2005), and David Ripley (2015) share the common claim that connectives are not defined "*ab initio,* but rather in terms of an *antecedently given context of deducibility*, concerning which we have some definite notions" (Belnap 1962, 131). As defined, Prior's *tonk* seems inconsistent with the background context of deducibility of the target logical system. Finally, some other scholars, notably Steven Wagner (1981) and Theodore Sider (2011),

argue that Prior's primary concern in the tonk argument is not about the meaning of logical connectives *per se* but their metaphysical and epistemic nature.

In this paper, I re-examine the salient literature surrounding Prior's tonk argument to draw some insights into what exactly it aims to prove. In particular, I argue that combined with Prior's later thoughts expressed in "Conjunction and contonktion revisited" and other posthumous works, the tonk argument suggests a metaphysical-cum-epistemic rather than just a purely (meta) logical view of the nature of logical connectives. This view implies a kind of logical realism, where some elements of logical vocabulary figure in true principles about things in the world.

I divide the paper as follows. In the next section, to set the necessary backdrop of the topic, I discuss the philosophical problem of the meaning of logical connectives. In the third section, I present the answers by TRV and IRV in more detail. In the fourth section, I rehearse Prior's tonk argument as a case against IRV. In the fifth section, I highlight the "logical" responses by Stevenson (1961), Belnap (1962), Hacking (1979), and others and argue that they missed the tonk argument's central philosophical insight. In the sixth section, I reconstruct Prior's logical realism as evidenced by the thoughts in his later work. Finally, in the seventh section, I conclude by considering a possible objection that might be raised against my reconstruction.

A PROBLEM WITH THE MEANING OF LOGICAL CONNECTIVES

Ludwig Wittgenstein once remarked that the fundamental problem in logic is determining the meaning of logical connectives. In a letter to Bertrand Russell in 1912, he (1961, 119) writes:

> What troubles me most at present is not the apparent-variable-business, but rather the meaning of "∨" "⊃" etc. This latter problem is—I think—still more fundamental and, if possible, still less recognized as a problem.

The logical connectives at stake in Wittgenstein's question are those found in first-order logic, which include ~, ∨, ∧, →, and ↔.[1] For some philosophically inclined logicians, logical connectives represent logical *notions* in natural languages. For instance, ~ represents ordinary expressions of negation (it is not the case that), ∨ represents disjunctions (either, or), ∧ conjunctions (and), → the material conditional (if, then), and ↔ the material biconditional (if and only if). Others, like Gottlob Frege, think that these connectives do not represent logical notions. Instead, they represent logical *objects* (Garrett 2014, 139). Thus, ~ represents the logical object "not" and ∨ the logical object "or."

These two views imply the same simple answer to Wittgenstein's question, which we may call the representational view of logical connectives. According to this view, logical connectives derive their meanings by representing something. If one holds the view that logical connectives represent logical notions, then since ∨ represents "or" in English. On the other hand, if one has a more Fregean view, ∨ represents the logical object "or." This simple answer, however, is not without its problems.

One such problem is about logical connectives being representatives. Does ∨ represent the logical notion/object "or"?[2] It does seem so. A ∨ B seems to represent the

statement, "Either the table is grey, or the chair is brown." Each of its parts represents a particular aspect of the statement. A and B represent "The table is grey" and "The chair is brown," respectively. The connective ∨ represents "or."

Some scholars have objected to this simple view. Unlike other (linguistic) expressions, logical connectives do not seem to represent anything. Names represent objects. For example, "Pedro" represents the person who bears that name. On the other hand, statements (declarative sentences or propositions) represent facts. Thus, "The chair is brown" represents the fact that the chair is brown. If the chair *is* brown, then the statement comes out true. Otherwise, it comes out false. However, can we say the same thing about logical connectives? Does ∨ represent "or" without intending this to be a trivial translation? Most contemporary philosophical logicians say no. Logical connectives do not represent any object or fact. This comes with a price, however. If logical connectives do not get their meaning from representing logical notions/objects, how do they get their meaning? This is the core of Wittgenstein's question.

THE TRUTH-TABLE VIEW AND THE INFERENTIAL ROLE VIEW

The two competing answers to Wittgenstein's question are the truth-table view (TRV) and the inferential role view (IRV).[3] TRV tells us that logical connectives acquire their meanings by their truth tables.[4] Note well that TRV rejects the idea that logical connectives represent anything. Only elementary (atomic) statements are the sole carriers of meaning. In this sense, meaning implies the capacity of statements to represent facts.[5]

To illustrate, consider the statement, "The chair is brown." Its meaning designates the conditions by which it latches on a particular fact in the world – viz., that the thing is a chair and that it is brown (Sider 2010, 28). For this statement to be true, the world should contain the fact that the chair is *indeed* brown. The statement is false if the world does not contain such a fact. Thus, the meaning of an elementary statement is its truth conditions – the ways the world would have to be for the statement to be true.

Now, logical connectives get their meaning (their truth conditions) through the meaning of their component elementary statements. As syncategorematic expressions, these logical connectives signify nothing by themselves (MacFarlane 2015). That is, ~, ∨, and the other logical connectives cannot have meaning alone. Their component statements determine their meaning. Consider what this picture implies about the meaning of ~. To assert an elementary statement, A, is to assert the conditions by which A is true. To deny A is to affirm ~A. We could represent this using a table:

~	A
0	1
1	0

The above table represents the truth values we could get when we assert or deny A. Suppose 1 represents the true value, and 0 is the false value, then if A has the value 1, ~A has the value 0, and vice-versa. However, the truth table for ~ does not only give us the values for ~A; it also gives us the meaning of ~. The table defines the meaning of ~ as a

function of the meaning of A. That is why logical connectives are often characterized as truth-*functions*.

The same story goes for the other logical connectives. Consider ∨. For any two statements, A and B, A ∨ B has the value 1 just if either A or B has the value 1; otherwise, A ∨ B has the value 0. Thus, the following truth table defines the meaning of ∨:

A	∨	B
1	1	1
1	1	0
0	1	1
0	0	1

On the other hand, A ∧ B has the following truth table:

A	∧	B
1	1	1
1	0	0
0	0	1
0	0	1

Thus, A ∧ B has the value 1 just in case both A and B have the value 1; otherwise, it has the value 0.

TRV, then, answers Wittgenstein's question in a simple way. The meaning of a logical connective is just the function of its component statements through a given logical connective's truth table. In short, truth tables completely determine the meaning of logical connectives.

On the other hand, IRV tells a different story. Logical connectives get their meanings solely through their inferential roles.[6] These roles are completely exhausted by their introduction and elimination rules (the so-called I- and E- rules of a given logical system).[7] I-rules tell us when to "introduce" a given logical connective, and the E-rules when to "eliminate" it. Consider the two rules for ∧ (where ⊢ represents deducibility or the derivation relation):

(∧I) A, B ⊢ A ∧ B
(∧E) A ∧ B ⊢ A, B

(∧I) tells us that if we have A and B, we could derive A ∧ B. On the other hand, (∧E) tells us that if we have A ∧ B, we could derive either A or B.

Now consider the rules for ∨:

(∨I) A ⊢ A ∨ B
(∨E) A ∨ B, A → C, B → C ⊢ C

(∨I) tells us that if we have A, we could straightforwardly derive A ∨ B. On the other hand, (∨E) is a bit complicated. It implies that if we have A ∨ B and either A or B implies a further statement C, then we could derive C from either, thus eliminating ∨.

Finally, the rules for ~ assume a *reductio ad absurdum* reasoning:

(~I) A, A → ⊥ ⊢ ~A
(~E) ~A, ~A → ⊥ ⊢ A

(~I) tells us that if we have A and it leads to a contradiction ⊥ (of the form, B ∧ ~B), then it means that ~A. On the other hand, (~E) tells us that if we have ~A and it leads to ⊥, then A.

Thus, IRV's answer to Wittgenstein's question is that each logical connective's I- and E-rules completely determine its meaning. Note here that "meaning" does not imply the truth conditions of these connectives, per TRV. Rather, these rules characterize each logical connective's role in a given argument or proof, and these inferential roles determine the meaning of logical connectives.

It is well-known that TRV and IRV complement each other. For example, the truth table for ∧ validates its I- and E-rules, and vice-versa. However, some philosophers think we must choose between TRV and IRV since one is considered more fundamental. The question is which. Is it a logical connective's truth table or its inferential roles?

PRIOR'S TONK ARGUMENT

It is in this context that Prior presents his tonk argument against IRV. He understood IRV as the view "that there are inferences whose validity arises solely from the meanings of certain expressions occurring in them" (Prior 1960, 38). He then presents the logical connective – *tonk* – defined by "analytically valid" I- and E-rules. The *tonk* rules are as follows:

(I-*tonk*) A ⊢ A *tonk* B
(E-*tonk*) A *tonk* B ⊢ B

Notice that (I-*tonk*) looks like (∨I), while (E-*tonk*) looks like (∧E). I-*tonk* implies that from A, one may derive A *tonk* B, while E-*tonk* implies that from A *tonk* B, one is permitted to conclude B.

One might think that Prior cannot just introduce *tonk* and stipulate its rules on a whim. However, proponents of IRV would be fine with this since they claim that logical connectives get their meaning solely from stipulated rules (Cook 2005, 217). This means that *tonk* is an acceptable logical connective by IRV's lights. But this leads to an absurd consequence since employing *tonk* yields invalid arguments with true premises but a false conclusion.

To illustrate, consider the true statement, 2 + 2 = 4. Given the *tonk* rules, we could derive the false conclusion, 2 + 2 = 5, from 2 + 2 = 4 as follows:

(1) 2 + 2 = 4   premise
(2) 2 + 2 = 4 *tonk* 2 + 2 = 5   1, I-*tonk*
(3) 2 + 2 = 5   2, E-*tonk*

Of course, the crucial steps in this argument, viz., (2) and (3), are those permitted by the *tonk* rules. However, deriving 2 + 2 = 5 from 2 + 2 = 4 is invalid since it implies deriving a false conclusion from a true premise. Since the only thing that permits this derivation is *tonk*, there must be something wrong with it. But *tonk* is acceptable, given the tenets of IRV. So, the idea that inferential roles suffice for the meaning of logical connectives must be wrong. Thus, IRV is not the right view of how logical connectives get their meaning.

Let us make the dialectic of Prior's tonk argument more explicit. IRV claims that the inferential roles of logical connectives completely determine their meaning. Prior's *tonk* questions this. Using *tonk*, one may derive a false conclusion from true premises. Thus, IRV cannot be the whole story of how logical connectives get their meaning. There must be something more to the meaning of logical connectives than merely stipulating inferential rules for them.

One might think that this "something" might be what TRV implies. The logical connectives' respective truth tables completely determine their meaning. However, as we shall see later, while Prior's tonk argument questions IRV, it does not necessarily support TRV.

THE "LOGICAL" RESPONSES TO PRIOR'S *TONK*

As mentioned in the introduction, many scholars have responded to Prior's tonk argument, most of whom questioned the adequacy of *tonk* as a *logical* connective. We could divide these "logical" responses into those focusing on *tonk*'s soundness, on the one hand, and those focusing on its consistency with an antecedently given context of deducibility, on the other hand. The response of Stevenson (1961) exemplifies the former, while the responses of Belnap (1962) and others exemplify the latter. Let us consider them in turn.

Stevenson (1961) argues that IRV should never have been understood as the view that the inference roles of logical connectives completely justify their meaning. To be completely justified, these rules must also be sound. That is, they must be truth-preserving. This means that completely justified inference rules for logical connectives must not yield invalid arguments. Consider it a soundness test to determine whether a logical connective is completely justified. A connective that passes the test is completely justified and thus is meaningful; otherwise, it is not meaningful.

Since *tonk*'s I- and E-rules permit deriving a false conclusion from true premises, they are not truth-preserving. As such, *contra* Prior, the *tonk* rules are not completely justified. Thus, *tonk* is not a meaningful connective. Since *tonk* is not a meaningful connective, IRV survives Prior's tonk argument.

However, while Stevenson's argument seems to have some pull, it still does not address Prior's tonk argument. Stevenson's point ultimately depends on truth-preservation,

which presupposes TRV's story of how logical connectives get their meaning via truth tables.

Consider, for instance, the soundness of ∧. Deriving A from A ∧ B is valid since A cannot have the value 0 while A ∧ B has the value 1. On the other hand, deriving A ∧ B solely from A is invalid since A might have the value 1, but A ∧ B might still have the value 0, given that B has the value 0. Note that ∧'s truth table guarantees both of these evaluations. So, while Stevenson's argument is well taken, it does not address the issue that Prior's tonk argument is concerned with, viz., the fundamental ground of the meaning of logical connectives, of which TRV and IRV are the main protagonists.

Perhaps we could relax Stevenson's point and take it as not aiming to support IRV *per se* but offering a midway between IRV and TRV. The thought is that the inferential roles of logical connectives only *partially* determine their meaning. A soundness – truth-preservation – test is needed for a complete justification. Prior might accept this relaxed reading of Stevenson's point since the tonk argument only aims to question the plausibility of IRV as the ultimate basis of the meaning of logical connectives. As such, Prior's tonk argument still pushes through, with a caveat that it now supports TRV.

While Stevenson's point implies that along with inferential rules, a truth-preservation test is necessary to determine the meaningfulness of logical connectives, Belnap and others think that such a test of "meaningfulness" need not presuppose TRV's truth table story since IRV's conceptual resources already suffice for this. The latter's key thought is that logical connectives are not defined in a vacuum but against a logical system's antecedently given context of deducibility (Belnap 1962, 131).

To illustrate, consider classical logic, which has transitivity and reflexivity as part of its given context of deducibility. Transitivity is the meta-logical (aka structural) rule that:

(TRANS) If A ⊢ B and B ⊢ C, then A ⊢ C

while reflexivity is the rule that:

(REF) A ⊢ A

If classical logic assumes TRANS and REF, so must its connectives. For instance, consider the role of ∧ in deriving A ∧ C from A ∧ B and C ∧ D in this logical system.

(1)	A ∧ B	premise
(2)	C ∧ D	premise
(3)	A	(1), ∧E
(4)	C	(2), ∧E
(5)	A ∧ C	(3), (4), ∧I

This derivation is valid in classical logic because it assumes TRANS and REF. These two structural rules are necessary for steps (3) to (5) to be valid. This means that the inferential role of ∧ adheres to classical logic's background context of deducibility.

The demand to adhere to a given logical system's background context of deducibility also applies to any *new* logical connective that may be added to that system. Consider the case of Belnap's *plonk*. Adding *plonk* to a given logical system *extends* it so that this "new" system now allows new deducibility statements (i.e., derivations) that contain *plonk*. Suppose that the original logical system assumes TRANS and REF, just like in the case of classical logic. Then, such an extension is *conservative* if those *plonk*-derivations adhere to TRANS and REF. On the other hand, the extension is *non-conservative* if these *plonk*-derivations do not adhere to the system's assumed context of deducibility.

For Belnap and others, the constraints of conservative extension may serve as a "demand for the consistency of the definition of the new connective" (Belnap 1962, 132), where "consistency" means adhering to a logical system's antecedently given context of deducibility. This implies that to test whether a new logical connective is meaningful, one must see if it is a conservative extension of a particular logical system. If it is, then that new logical connective is meaningful. If it is not, then the new connective is not meaningful.

Given the conservativeness test, Belnap argues that Prior's *tonk* is not meaningful since it is inconsistent with the given logical system's background context of deducibility. Prior's tonk argument assumes a logical system that adheres to TRANS and REF. These structural rules are necessary for the tonk argument to work. However, the *tonk* rules do not adhere to these rules since they permit the derivation of B from A, for any arbitrary A and B (e.g., deriving $2 + 2 = 5$ from $2 + 2 = 4$). Thus, since *tonk* does not adhere to TRANS and REF, it fails the conservativeness test because its addition to a TRANS-REF-adhering logical system is non-conservative. As such, it is not a meaningful connective by Belnap's lights.

Of course, adding *tonk* might be conservative if the starting logical system is not TRANS-REF-adhering (Belnap 1962, 133). For instance, consider nontransitive logical systems devised by Cook (2005) and Ripley (2015). These logical systems are *tonk*-friendly since adding *tonk* is consistent with their background context of deducibility.[8]

To illustrate, suppose that our starting logical system is nontransitive. That is, it adheres to a context of deducibility where:

(NONTRANS) A ⊢ B and B ⊢ C, but A ⊬ C.

It is easy to see that Prior's tonk argument is valid given NONTRANS. After all, applying I-*tonk* and E-*tonk* need not be transitive in this logical system. This implies that while Prior's derivation of $2 + 2 = 5$ from $2 + 2 = 4$ via *tonk* might be invalid in a TRANS-REF-adhering logical system, it is valid within a NONTRANS-adhering one.

Given the conservativeness test, Prior is then presented with a dilemma. Either *tonk* is inconsistent with a TRANS-REF-adhering system and, thus, is not meaningful within this system, or else it is consistent with a NONTRANS-adhering system and, thus, is meaningful within that system. In either case, the tonk argument does not sufficiently present a case against IRV.

One problem with conservativeness, however, is that while it does account for the meaning of *new* logical connectives, it does not seem to account for the meaning of *old* ones. Conservative extension constrains how new connectives can consistently be added

to a logical system, given a background context of deducibility. For instance, a system with a *plink* connective is a conservative extension of classical logic if it adheres to TRANS and REF. However, this extension presupposes that we already have the meaning of ~, ∧, and ∨. But where did we get their meaning in the first place?

A *conservative* account may look like this. Start with the logical system's background context of deducibility. Let us assume TRANS and REF are part of that background. Then, to follow the conservativeness criterion, any logical connective introduced into this system must also adhere to TRANS and REF. Say we introduce ~, ∧, and ∨ to the system. If they adhere to TRANS and REF, they are meaningful connectives within the system.

Suppose that we want to add more logical vocabulary into the system. Say we want to add the *blonk* connective proposed by Bonnay & Simmenauer (2005). *Blonk* is meaningful within the system if it adheres to TRANS and REF. We may iterate this process to any other logical connective we want to add to our TRANS-REF-adhering system. These connectives are meaningful in the system if they adhere to TRANS and REF. If they are inconsistent with this antecedently given context of deducibility, they are not meaningful.

However, the conservative account outlined so far seems to imply that old and new logical connectives only have meaning within a logical system. To be precise, logical connectives have meaning only within a given system's background context of deducibility. This context is necessary for meaning. Without this context, there is not much sense in talking about the meaning of ~, ∧, and ∨.

PRIOR'S LATER THOUGHTS ON CONTONKTION

The view that meaning is determined by context (or contextual use) is familiar in philosophy, particularly in metaphysics, epistemology, and the philosophy of language. This view has come to be known by many names: "formalism," "pragmatism," "contextualism," "conventionalism," etc. But this is precisely what Prior puts into question in his reply to Stevenson and Belnap. If we were to treat Wittgenstein's question about the meaning of logical connectives as a "purely symbolic game," we could indeed have a soundness or conservativeness test to determine how these connectives work in this game. However, "to believe that anything of this sort can take us beyond the symbols to their meaning, is to believe in magic" (Prior 1964, 191).

For Prior, it is one thing to define ~, ∧, and ∨ as symbols used in a logical system and quite another to define *not*, *and*, and *or*. We may indeed define ~, ∧, and ∨ in terms of their truth tables or I- and E-rules and play the logic game accordingly. For instance, we may define A ∧ B as ~(~A ∨ ~B). But this does not give us the meaning of negation, conjunction, and disjunction. It does not tell us what *not*, *and*, and *or* are. It only tells us how ~, ∧, and ∨ are used in the game of logic. This is what the tonk argument wants to bring to the fore.

Prior's real concern in the tonk argument is not the semantics and syntactical rules of logical connectives. Rather, it is about their very nature and how we come to know them (Wagner 1981, 292). But we cannot just say that logical connectives are what a given logical system's background context of deducibility says them to be since this would make

questions about meaning a matter of convention (Sider 2011, 103). But not all questions about meaning can be decided by *fiat*. Matters of (actual) fact decide some of them.

Some scholars, e.g., Wagner (1981, 293), speculate that for Prior, Frege's logical objects (as outlined above) are the abstract things that may settle the question about the meaning of logical connectives. According to this conception, Prior's tonk argument must be understood as a case for a Fregean theory of meaning. However, understanding the tonk argument this way contradicts Prior's commitment to logical realism. In "A statement temporal realism," a posthumously published work, he writes,

> Philosophy, including Logic, is not primarily about language, but about the real world. For example, the very simple logical truth that if John is sick then John is sick is not a truth about the sentence, 'John is sick' but a truth about John. It is not, of course, peculiar to John that if he is sick he is sick; it is true of everyone that if he is sick he is sick. Still it is true of John, and that is what the sentence says. Formalism, i.e. the theory that Logic is just about symbols and not about things, is false. (Prior 1996, 45)

As this passage implies, Prior is no formalist. For him, logical facts are mind- and language-independent. These facts are not just a product of our cognitive processes or linguistic conventions. But neither is he a Fregean. Logical facts are indeed objective, but they are not about *abstracta*. Rather, they are about things in the world. Prior's example seems to illustrate this realist conception. The logical truth that if John is sick, then John is sick is a truth about the real person, John, and not a truth about the statement "John is sick." For Prior, then, logic is about the extra-symbolic world, and the point of a logical system was always that it had a subject matter – a subject matter that is found in the real world (Joaquin 2022, 163-164).

However, Prior's version of logical realism must be contrasted with the simple representational view that logical connectives represent something. It is not the view that ~, ∧, and ∨ represent some logical object or fact. Rather, his logical realism implies that some elements of logical vocabulary are used to express true principles of inference. In his "What is logic?," another posthumously published work, he writes,

> So far as I can see, a truth which is being used as a principle of inference *must* be a universal implication – it must be that in order to function as a *rule* at all. Universality and implicativeness, therefore, are common to all principles of inference, however 'material' or 'non-logical' they might be; so we might define logical truths as ones in whose statement all signs occur vacuously except signs of universality and implication. And this does give us something pretty comprehensive. If 'implication' be used in the minimum sense, we can introduce negation as a complex of implication and universality – 'It is not the case that p' amounts to 'If p then anything at all' – and the whole logic of truth-functions can be developed in terms of implication and negation, and with universality and negation we have the whole theory of quantification. (Prior 1976, 127)

According to this picture, an "ordinary and obvious" true principle is always expressed as a universal implication (Joaquin 2023, 7). For instance, "For every A, A implies A" is true and is expressed by a non-logical variable "A" and the logical terms for universality, "for every…" and implication, "implies."[9] Notice that two logical constants are used in this true principle: the universal quantifier and the conditional. These two constants and the non-logical variables constitute the primitives or undefined elements of the logical vocabulary. From this primitive set, ~A will be defined as "A implies anything." Since ~ is now part of the vocabulary, we can define ∧, ∨, and a host of other logical connectives in terms of ~ and the conditional.

Prior's logical realism implies that the meaning of logical connectives is derived from a primitive set of logical constants whose elements are necessary for expressing true principles of inference. The picture here is a metaphysical-cum-epistemological rather than a logical one. We do not get the meaning of logical connectives via their semantics (truth tables) or structural rules (I- and E-rules). Rather, we derive them from ordinary and obvious true principles of inference. Of course, for pedagogical purposes, we may characterize these primitive logical constants in terms of their semantics or structural rules (Prior 1964, 194). But their meaning is not grounded on these semantics and rules.

Prior's picture here can be compared with Sider's attempt to "write the book of the word." Like Prior, Sider (2011) grounds the meaning of logical connectives via metaphysics-cum-epistemology. However, instead of deriving logical vocabulary from ordinary and obvious true principles of inference, he derives them from a fundamental language that describes reality as such. His basic strategy is this. Our best theories of fundamental physics (even fundamental metaphysics) cannot dispense away with some primitive logical concepts. Since these logical concepts figure in the best theories about fundamental things, they are themselves fundamental (Sider 2011, chap. 10).

This argument strategy is an argument for the best explanation. Something (fundamentally) exists if it is our best way to explain some phenomena. This strategy, plus the idea that we need not restrict our catalogue of what exists to things and properties, makes a good case for the fundamentality of some logical concepts. That is, we need not restrict our ontology to things and properties. We must go beyond them (Sider 2011, chap. 6). If this means including logical concepts in the language of our fundamental theory, then so be it.

CONCLUSION

Sider and Prior share the same metaphysical answer to Wittgenstein's question about the meaning of logical connectives. Some logical connectives are primitive, undefined concepts constituting a fundamental language or obvious and ordinary true principles. Other logical connectives are defined in terms of these primitives. The metaphysical answer also implies that though these primitives can be pedagogically characterized in terms of their truth tables or I- and E-rules, their meaning is not grounded on them. Rather, it is determined by true metaphysical principles about the structure of reality.

One might worry that Prior's (and, to some extent, Sider's) metaphysical picture makes a crucial assumption about how other logical connectives are defined. Suppose Prior is right that the universal quantifier and the conditional are the only logical primitives. According to this picture, ~A is defined as "A implies anything," while the rest of the logical connectives are defined in terms of ~ and the conditional. But in defining ~, Prior assumes the classical principle of explosion as the background context of deducibility. Explosion tells us that only a false statement may imply anything. As such, Prior's (and Sider's) picture already assumes classical logic at the get-go.

This worry is well taken. It is instructive to point out that Prior and Sider are strong proponents of classical logic. As Sider writes, "Logic is *ultimately* classical" (2011, 231). Be that as it may, the worry might be understood as not about how the logical primitives (those derived from metaphysical principles) get their meaning. Rather, it is more about how the other logical connectives are defined. So, this is not a real worry for a metaphysics-first view of how logical primitives derive their meaning. After all, the non-primitive connectives may be defined classically or non-classically from the metaphysically-grounded primitives.

However, one may understand the worry differently. Instead of thinking that the worry is a question of how non-primitive connectives are defined from the primitive ones, one may think of it as a question of what, ultimately, the right theory of logical consequence is. Is it classical or non-classical? If this is what the worry is, then Belnap is right to say that Prior's tonk argument is like the problem of justifying deduction, where "no solution will ever be universally accepted as *the* solution" (1962, 131 fn. 2).[10]

NOTES

1. First-order logic includes both standard propositional logic (a.k.a. the logic of statements) and predicate logic (a.k.a. the logic of terms). Logical connectives, like ~ and ∨, figure prominently in propositional logic. Quantifiers, like "for every" and "for some," are important logical concepts in predicate logic. However, we will focus more on the logical connectives in propositional logic, particularly ~, ∨, and ∧. Moreover, I will also set aside the issue of what counts as a logical connective or constant and simply accept propositional connectives as exemplars. For a survey of this latter issue, see MacFarlane (2015).

2. Wittgenstein (1974) was the first to raise this objection, see especially 4.0321.

3. The difference between these two views can be seen to imply the difference between the syntactical (proof-theoretic) and semantic (model-theoretic) approaches to first-order logic.

4. The works of George Boole, John Venn, C. S. Peirce, and, to some extent, Frege, contain the germ of the idea of TRV. However, many philosophers attribute its complete formulation to Wittgenstein's *Tractatus* and the work of the American logician Emil L. Post.

5. Note, however, that the very idea of meaning is controversial. Not all philosophers accept it; see, e.g., W. V. Quine (1986, 1-3).

6. Defenders of IRV include Karl Popper, William Kneale, P. F. Strawson, Paul Lorenz, and Gerhard Gentzen, see Hacking (1979, 303) and Prior (1960, 38).

7. The discussion here follows Hacking (1979, §5) and Sider (2010, §2.5).

8. For a criticism of such *tonk*-friendly logical systems, see Heinrich Wansing (2006), particularly his idea of a more trivializing connective, *super-tonk*. For a reply to Wansing's *super-tonk*, see Ripley (2015, §5).

9. Notice that "For every A, A implies A" generalizes "If John is sick, then John is sick."

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