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Naturalising Logic. The inference-marker view[1]

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1 The project of naturalism

The project of naturalisation is an essential aspect of the general project of analysis. Naturalising a theoretical domain amounts to redefining its essential notions and relations in terms of a different domain, that is considered acceptable by the standards of natural science. Thus stated, the project is compatible with several different proposals with varying degrees of radicalism.

Mathematics and logic challenge the general project of naturalisation precisely because of their formal character. Being formal implies that, from an epistemological perspective, mathematics and logic are also a priori. It is hard to accommodate a priori knowledge within a naturalistic framework. The reason is that, most of the time, the endorsement of a non-empirical way of acquiring knowledge goes along with the acceptation of methods, procedures and skills — introspection and intuition, among others — that are not sanctioned by the current state of natural

science. The kind of formality proper of logic is nevertheless different from the kind of formality proper of mathematics, and the same happens with the way in which they can be said to be a priori. Consequently, the enquiries on the status of mathematics and logic in the general context of the naturalisation project have distinctive aspects and are logically independent.

In this paper I am only concerned with the project of naturalising logic. In order to assess the project's viability it is not necessary to change the view we all have of logic as a science, although a better understanding of some well-established ideas about the nature of logic is required. Logic is the science of valid inferences, inferences are sets of propositions, and propositions are the outputs of speech acts that have the force of claims. This characterization of logic is not in dispute, as it is not the claim that validity is a property of arguments, a property that is independent of the empirical features of the external world. Nevertheless, although logic can be argued to possess the mentioned independence, the inferences that are its subject-matter are not independent of our linguistic practices. For this reason, the project of naturalising logic is relative to the more basic project of naturalising some relevant components of human linguistic activity such as the meaning of terms and expressions and the content of speech acts. Naturalising logic comes, so to speak, on a second step. The foundational level of a completed process of naturalising logic is the naturalisation of content and meaning, i.e. the naturalisation of our linguistic practices and their results, on which it is reliant. In turn, the project of naturalizing meaning and content is an aspect of the general project of naturalizing normativity. M. Bickhard (*in this volume*) proposes to change from substance and object metaphysics to a process metaphysics. His proposal places normativity at the core of the natural world offering thus a scientifically sound way out from the Cartesian dichotomy.

I will not directly argue for the possibility of naturalising logic, instead, I propose a conditional argument: *If* meaning and content can be naturalised at all, so can logic. In spite of being conditional, the argument offered here is very strong, since the whole project of naturalism rests on the possibility of the truth of its antecedent. If meaning and content turned out to be nonnaturalisable, naturalism would not be possible. The naturalisation of meaning and content is thus the possibility condition of the naturalisation of logic and, in general, of the whole naturalisation project.

Let's assume then that a naturalistic account of meaning and content can be given. In the following pages, I will present an explanation of how the meanings of logical constants arise from the aims of some of our linguistic acts. Part of our linguistic activity imbues logical terms with their significance, which appears in scenes as a product of our use of language. To show how logical terms emerge, the relation between material inferences and formal inferences must be made clear.

There is however a previous concern, which is the already mentioned characterization of logic as a formal science. This will be the topic of the next section. In Section 3, I will work out the process by which formal inferences supervene from material ones, explaining thus in which sense logic results from the ordinary use of language and how logical terms acquire their meanings from what we, agents, do with words. In Section 4, I will display the main features of the two contemporary competing paradigms in the philosophy of language, i.e. truth-conditional semantics and inferential semantics, and contrast my view on logical words against them. Finally, in Section 5, I will offer my definition of what a logical constant is.

2 What does it mean that logic is a formal science?

My examination of the way in which logic is formal will proceed by focusing first on the traditional claim that logical constants are syncategorematic terms, and in relation to this, on the claim that logic is topic-neutral.

Logic-as-a-science is concerned with the inferential relations among propositions irrespective of their subject matter, and this fact has motivated the idea that logical constants are *syncategorematic* and that logic is *topic-neutral*. Both terms, correctly understood, pick up an essential aspect of logic. According to the classical definition, *syncategoremata* are terms that can be neither subject nor predicates in a sentence. Medieval logicians that defined logical constants this way considered, following Aristotle, that being either the entity named by the subject or the property expressed by the predicate were the only two possible elements of a proposition. Therefore, according to this view, syncategorematic terms didn't contribute a component to the proposition at the same level as subject and predicate do. A modern variation of this view on logical con-

stants is found in Wittgenstein's *Tractatus*[2]. It picks up an essential facet of logical terms, i.e. that they are not names of anything; their meaning is expressive as opposed to representational. Representational meaning is the aspect of the significance of words that is connected either with entities in the world or with their characteristics. Besides depicting the world, speakers may use language with many other purposes. Some of these purposes have to do with the different ways in which an agent can affect their natural or social surroundings. The pragmatist tradition in the Philosophy of Language, the speech act theory for instance, has offered detailed explanations of these alternative kinds of meaning. Coming back to logic, the meaning of logical constants is of this pragmatic kind. By using them, speakers convey information other than the merely descriptive. In particular, logical constants serve to display the structure of an inference. In the current Philosophy of Logic, this view is known as "logical expressivism". Robert Brandom (Brandom 1994) is presently a renowned defender of it, as was Wittgenstein in his time, and it is congenial with relevant parts of the medieval treatments. Kneale and Kneale (Kneale and Kneale 1962: 233) explained syncategoremata in the following terms: "*Syncategoremata* are words such as 'and', 'or', 'not', 'if', 'every', 'some', 'only', and 'except' which cannot function as terms but are of special importance in logic because they show the forms of statements." William of Ockham and his followers provide an example of this view on logical words. They defended a kind of "ontological liberalism", as Klima (Klima 2006: 8) calls it, that attached to syncategoremata reduced degrees of reality. Syncategoremata did not refer, in this view, to the external reality but rather to some mental acts that modify the way in which categoremata signified.

According to tradition, logic is *topic-neutral*. The insight that this characterisation attempts to capture is that logically valid arguments are logically valid independently of their subject matter. Topic-neutrality is another essential aspect of logic, although it has not always been correctly understood, and has often been confused with the (false) claim that logical constants have no meaning. Logical terms do not name, it is true, but

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[2] "My fundamental idea", Wittgenstein said in 4.0312, "is that the 'logical constants' are not representatives." In Wittgenstein's view what there are are atomic facts and their components. Logical words are not components of facts. It would be possible to completely describe the world, any world, without using logical constants. Listing the true atomic propositions would be enough. I am not particularly fond of Wittgenstein's metaphysical style, but I consider his insight about logical constants correct. And it defines the theoretical position known as "logical expressivism".

there are other kinds of meaning besides naming. Logic's topic-neutrality is not relative to the expressions that function as logical terms but to the *meanings of the propositions* that function as their arguments. It is claimed that these propositions can be part of valid arguments no matter what their particular meanings are.

That logic is topic-neutral does not suggest either that logical relations hold between uninterpreted strings of signs, but that any proposition whatsoever independently of its meaning may work as an argument of a logical constant. The confusion of these two ways of understanding topic-neutrality is in part responsible for the widespread belief that logic deals with syntactic items.

That logic is a formal science is thus a short way of making a cluster of claims; among them, (i) that logical constants are not names of anything — the old syncategorematic characterization and the most recent expressivist view — and (ii) that their arguments are propositions of any kind — the old topic-neutrality of logic. Putting all these insights together, the shortest claim that correctly embodies the thesis of the formality of logic is that logical constants are *higher order functions used to mark the structure of inferences*.

Mathematics is another formal science. Nonetheless, the ways in which mathematics and logic are formal are entirely different. Logic doesn't deal with uninterpreted strings of signs. Logic is a relational enterprise concerned with the inferential relations among truth-bearers. The items related by logical relations —the relations of consequence, equivalence, incompatibility — are *begriffliche Inhalten*, i.e. judgeable contents, to use Frege's terms, and not uninterpreted structures. In *Begriffsschrift*, Frege, the father of modern logic, attempted to offer a "formula language of pure thought modelled upon the formula language of arithmetic". This is the subtitle of the booklet. The resemblances of *Begriffsschrift* to arithmetic are limited, however, to the use of a symbolic language and to the use of the categories of argument and function instead of the older subject and predicate. Frege was aware of the superficiality of the resemblances: "The most immediate point of contact between my formula language and that of arithmetic is in the way letters are used." (Frege 1879: 104). I doubt then that Frege would share the equation introduced by Sher (Sher 1991: 133): "The difference between the new conception [her view of logic] and the 'old' logicism regarding mathematical constants is a matter of perspective. Both approaches are based on the equation that being mathematical = being formal = being logical." And the rejection of

the equation does not imply an automatic rejection of Frege's logicism. The basic mathematical notions might have been defined in logical terms, and mathematical truths defined in terms of logical truths, without being the task of logic identical to that of mathematics. Logicism is false, we know now, but if it were true, it still wouldn't guarantee that logic and mathematics are formal in the same sense.

Mathematics works on syntactic structures, whereas logic does not. What is often called "logical syntax" is not grammar, but conceptual structure. Logical syntax is independent of the grammatical rules of particular languages. Logical syntax as opposed to grammatical syntax is what logic is about, and logical forms represent the logical category of the ingredients of the conceptual contents expressed by sentences and the way in which they are put together[3]. Mathematics is formal because it is concerned with structures, whereas logic is formal because its operators are used to *mark* the structure of inferences among items that possess content. Since structures are relevant in both cases, the word "formal" is justified in both cases.

3 Formal inferences

In the last few decades, there has been intermittent debate about whether material inferences are logical inferences at all (Sellars, Brandom, Harman). The standard opinion among logicians and philosophers of logic is that material inferences fall short of being logical inferences for they are incomplete arguments, "enthymemes" in the traditional terminology. An enthymeme is a truncated argument with at least one hidden premise. They are valid or not in a derivate sense, depending on whether they can be restored to become instances of formally valid structures. This is the classical view that I will confront.

If the semantic definition of validity, i.e. that an argument is valid if, and only if, it is not possible that its premises are true and its conclusion false, is taken seriously, then material inferences have to be accepted as genuine inferences. On this definition, the following arguments are incontestable:

(A)$_{material}$ Today is Friday,
          tomorrow is Saturday

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[3] I shall not pursue this point further. For an already classical explanation of this line of thought, see Etchemendy (1983).

(B)_{material}   Victoria is a girl,
           Victoria is a human being.

The question now is to decide whether (A)_{material} and (B)_{material} are logical inferences or not. Obviously the answer depends on what one means by "logical inference". The standard explanation of why (A)_{material} and (B)_{material} are not logical inferences is that they do not instantiate a valid form.

What are ultimately the differences between (A)_{material} and (B)_{material} and their corresponding formal counterparts, (A)_{formal} and (B)_{formal}?

(A)_{formal}   *If* today is Friday, *then* tomorrow is Saturday
           Today is Friday
           Therefore, tomorrow is Saturday.
(B)_{formal}   *All* girls are human beings
           Victoria is a girl,
           Therefore, Victoria is a human being.

At first sight, there are logical constants in the surface of (A)_{formal} and (B)_{formal}. Material inferences do not include expressions that signal their status as inferences. Their premises and conclusions are inferentially connected because of the meanings of the concepts involved and the information we possess about the reality they purport to represent. Possessing the concept Friday implies familiarity with the sequence of the days of the week, possessing the concept girl implies the knowledge that it designates a stage of a female human being's development. This information is part of the inferential meaning of Friday and girl.

Although material inferences don't essentially use logical constants, they can be presented as formal inferences simply by placing the relevant logical words in the relevant places. (A)_{formal} and (B)_{formal} are qualified as logical inferences because they instantiate logically valid structures, i.e. structures that are valid by virtue of the meanings of its logical words. This, although correct, is hardly informative. (A)_{material} and (B)_{material} are as truth-preserving as (A)_{formal} and (B)_{formal}. The only difference between them is that in the formal cases the principle of inference at work is explicitly displayed. Neither the conditional sentence in (A)_{formal} nor the generalization in (B)_{formal} should be seen as further premises. They are principles of inference, rules; neglecting this distinction would lead us to the infinite regress of the paradox of Achilles and the Tortoise[4]. Formal inferences, in conclusion, are inferences the inferential status of which

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[4] The statement of the paradox is due to Lewis Carroll (Carroll 1895); but the underlying distinction between premises and principles of inference is found in the thought of the best philosophers of logic, Frege (1879) and (1884), Peirce (1932) and Prior (1976) among them.

has been made explicit by the use of logical constants. The propositions expressed by the sentences in (A)$_{material}$ and (B)$_{material}$ are inferentially related. By asserting the first one, one is committed to assert the second, for because of the meanings of the terms in them the second follows from the first. Even if this is so, a hearer might overlook this relation, or the speaker might have reasons to stress it. In these cases, logical constants enter the scene: logical terms are used for the purpose of bringing into the open the inferential relations among propositional contents. Claiming that only formal inferences are logical inferences might be correct in some sense, but the sense that makes it a true claim also makes it a trivial one. Material and formal inferences can both be truth preserving; the difference is only that the latter, unlike the former, are explicitly presented as inferences. And they are material inferences the ones that lend support to formal inferences, and not the other way around. Valid material inferences are not logically valid insofar as they can be seen as instances of formal structures, but the other way around. Valid formal inferences display the implicit inferential structure of already valid material inferences[5].

4 Truth-conditional semantics vs. inferential semantics

The notion of inferential meaning has been mentioned in connection with valid material inferences. All concepts, logical or not, have their dose of inferential meaning. But, in spite of some similarities, there is a contrast between the way in which run-of-mill concepts signify and how logical words do. I am not going to argue for the contrast, which has been neglected by the realist accounts of logic and, generally, by the naïve views of language that assume that the basic word-world relation is that of naming. The contrast is, nevertheless, widely recognised and it lies behind the medieval distinction between categorematic and syncategorematic terms.

How run-of-the-mill concepts acquire their meaning and express a content[6]? There are currently two paradigms that account for the process

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[5] Overlooking the relationship between material and formal inferences leads to the disconnection between logic and human reasoning, a view that I consider completely unjustified, but that has been argued for by philosophers such as Harman: "My conclusion is that there is no clearly significant way in which logic is specially relevant to reasoning" (Harman 1986: 20).

[6] The meaning of a word is the linguistic information that the speakers systematically relate to it; the content is the contribution of the word to the proposition expressed by the sentences in which it occurs. In general, meaning is related to expressions and content to their utterances. A more technical account of the distinction is given by the Kaplanian pair

of meaning acquisition: one of them is truth-conditional semantics and the other is inferential semantics. In truth-conditional semantics, and in its contextualist follow-up, truth-conditional pragmatics, the core explanatory notions are those of *reference*, *representation* and *truth*. Terms acquire their meanings because they are connected one way or another to extralinguistic entities; sentences represent states-of-affairs, they are models of possible situations. When the modelled situations are actual, the sentences in question are said to be true. Philosophers such as Wittgenstein, Tarski, Quine, and Davidson belong to the tradition of truth-conditional semantics, as do the followers of possible world semantics, such as Stalnaker and Lewis. This has been the dominant view in the twentieth century Philosophy of Language. Recanati and Carston endorse its pragmatist version; the difference between the two, which will be neglected for our present purposes, lies on the role of context in the determination of the content of utterances.

Inferential semantics, on the other hand, places the notion of *inference*, together with the normative pragmatic notions of *commitment* and *entitlement* at the basic level. The content of an utterance is defined by the propositions form which it follows and the propositions that follow from it. In other words, a propositional content is determined by the circumstances that entitle a speaker to assert it and the commitments the speaker acquires by its assertion. The content of a concept are the circumstances and consequences of its application. Inferential semantic is argued for in (Brandom 1994 and 2000).

It is now time return to the discussion of naturalism. Both paradigms of meaning acquisition and content expression have naturalistic versions. As a general claim, externalism, the view on meaning that stems from the works of Putnam and Kripke in the 70s, is an attempt to offer a naturalistic interpretation of truth-conditional semantics, as they are the more specific theories on concepts defended by Fodor, Drestke, Millican, Prinz, the Churchlands, etc. Brandom's normative pragmatics, on the other hand, is an attempt to naturalise inferential semantics, making meaning and content rest on the activities that connect speakers with other speakers and with their natural milieu. The acts of the speakers gain content by means of the commitments undertaken by the linguistic agents to act in a certain way as a result of their linguistic actions.

My view on logical constants is that their meaning emerges from the speaker's intentions of showing as a formal inference a previous material inference whose validity or invalidity rests on the non-logical concepts

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of *character* and *content*, or by the more traditional distinction, used by Austin and Strawson, between a sentence's *linguistic meaning* and the *statement made* by its utterances.

involved in it. The inferential behaviour of speakers makes possible the use of logical constants, which become completely defined by the kind of inferential commitments and entitlements assumed by the speaker when she explicitly presents an inferential transition between propositions. The presence of logical words does not add anything to the content of the propositions expressed, they signal conceptual movements either endorsed or permitted by the speaker. Here lies the interest of this view of logic for the general project of naturalism. The principles of inference in $(A)_{formal}$ and $(B)_{formal}$ just show the propensity of the agent to connect the concepts involved in the way indicated by the argument, and by displaying these principles overtly she is both showing her inferential dispositions and giving permissions to others to borrow them. Therefore, if propositions can be naturalised, formal inferences can be too. And from the naturalisation of formal inferences, logic also becomes naturalised. Formal logic is only an artefact, a human creation that purports to model real linguistic practices.

The other disturbing feature of logic for the naturalist project is the assumed fact that logical relations are known and assessed a priori[7]. Logic is an a priori science, but the sense in which it is so is quite harmless and, in any case, it does not present any challenge for naturalism. Again, the argument here is conditional: if our knowledge of language does not suppose a problem for naturalism, our knowledge of logical relations is not a problem either.

The point of departure is linguistic competence. Every proficient speaker of English knows that she cannot assent to $(A.1)_{material}$

$(A.1)_{material}$ Today is Friday,

and dissent to $(A.2)_{material}$

$(A.2)_{material}$ Tomorrow is Saturday,

in the same context, if she wants to be consistent. The crucial point here is that "consistency" is not an a priori formal relation, but the basic notion of rationality. Rational behaviour consists of being aware of the consequences of one's actions and undertaking them. Otherwise, communica-

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[7] The sense in which *a priori assessment* or *a priori knowledge* is needed in this context is not new. It is exactly the sense that L. Warenski (this volume) takes from Burge and attributes to Kant: "A priori justification is justification that does not rely upon the particulars of sensory experience for its justificational force. The locution 'justificational force' is due to Tyler Burge. (Burge 1993; 1998), and it makes explicit Kant's original understanding of a priori justification as justification that is independent of the particulars of experience, but allowing that experience may be needed to acquire the relevant concepts involved in an a priori claim." Warenski p.

tion would not be possible. By understanding the content of other agent's linguistic actions, one can infer her subsequent acts, and some of her previous assumptions. And both speaker and hearer are placed in the position of taking part in the game of giving and asking for reasons. Being consistent in this way is not a formal luxury, demanded by sophisticated logicians, but the condition of possibility of rational behaviour[8].

Once it is assumed that the transition from $(A.1)_{material}$ to $(A.2)_{material}$ is obliged by the meaning of concepts concerned and by the background requirements of rational behaviour, it should be obvious that the correctness of $(A.1)_{formal}$

$(A.1)_{formal}$ *If* today is Friday, *then* tomorrow is Saturday,

is also obliged by the same reasons.

There are several different senses in which a piece of knowledge can be said to be a priori. The most radical sense in which a priori means "independent of all experience" is hardly applicable. Most of time, the concept is relative to some kind of experience or other. Then, if there is a sense, acceptable to naturalism, in which linguistic knowledge can said to be a priori, the same sense also covers logical knowledge.

So far, I have outlined a way out of the difficulties of naturalising logic. My purpose has not been to defend naturalism, but to offer a conditional argument: logical terms are parasitic to ordinary concepts, and logical behaviour is parasitic to rational linguistic behaviour. Thus, if meaning and content can be naturalized, logic does not present an added difficulty. If, on the other hand, meaning and content were not naturalizable, the whole project of naturalism would collapse (and logic would not present an added difficulty either).

The argument defended here depends on a view of logic that is independent of the problems derived from naturalism. In the next section, I will offer a brief outline of what is, in my opinion, the syntactic status, the semantic meaning and the pragmatic role of logical constants. I will leave many topics untouched, many discussions open and many difficulties unanswered, for presenting a completed view on logical terms is not the aim of this paper. Nevertheless, the following outline will serve as the theoretical background of the topics addressed here.

5 Logical words as inference-markers

The meaning and role of logical terms emerge from the practice of drawing material inferences. As mentioned in Section 2, the logical expressiv-

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[8] This connexion between rationality and behaviour has been stressed from different philosophical perspectives. Ramsey and Brandom defended it.

ist view that I take from Wittgenstein and Brandom amounts to the following claims: that logical words do not name entities and that they don't contribute a component to the proposition expressed by the use of sentences in which they appear. From a pragmatic point of view, logical words are inference markers, their role is stressing that an inference is in progress.

My proposal is to return logic to language, its natural home, and to place the philosophy of logic within the philosophy of language. What logic is cannot be decided by backing out of the inferential linguistic practices of human beings, and the same can be said of the task of identifying the features that make a term a logical constant.

The users of natural languages bring logical words into play for a purpose, and their formal features have to adapt to it. The main purpose is making explicit inferential connections among concepts and propositional concepts; this is the pragmatic role of logical constants. Making explicit inferential connections is not only possessing inferential meaning. All concepts have inferential meaning to some extent, and the inferential meaning justifies the material inferences in which they are involved. In this sense my proposal goes further than Gentzen's and Prawitz's, for it is not that the meanings of logical constants can be given as sets of rules, introduction and elimination rules, but rather that the pragmatic significance of logical constants is being used as inference-markers.

[DEF]   Logical constants are higher-order predicables that have 0-adic predicables as arguments. They don't name any kind of entity but rather are natural language devices for making explicit the inferential relations among concepts and propositional contents.

DEF involves a syntactic claim, that logical constants are higher-order; a semantic claim, that they do not name; and a pragmatic claim, that by using them a speaker signals the presence of an inference. The semantic claim is sometimes called "logical expressivism" and has been defended by Wittgenstein and Brandom. The pragmatic claim can be dubbed "the inference-marker view".

Being higher-order is only a necessary condition for being a logical constant. The same thing occurs with the semantic aspect. In language, there are many different expressions that don't name anything, and shouldn't be catalogued as logical constants for this reason alone. But as logic is the science of inferences, logical constants are essentially inference-markers; particular logical constants mean the specific inferential movements they allow.

A 0-adic predicable is a predicable with 0 argument places, i.e. a proposition. That logical words are higher order predicables that have

propositions as arguments should be obvious if one recalls, as has been stressed in Section I, that the basic notion of logic is validity, that validity is a property of inferences, and that inferences are sets of propositions.

An immediate objection to my definition is that, although it fits sentential connectives well, it leaves out identity and first order quantifiers. Let's see if this is so. But before answering the objection, let me state the terms of my commitment with DEF.

DEF is not intended to be *ad hoc*. It has not been developed to fit a rigidly determined set of expressions, or abstracted to cover the more general aspects of a selected group of terms, although it has been guided by some pre-theoretical intuitions that include reference to some expressions. A philosophical account of logical constants that aims for any depth has to begin by asking what the task of logic is, and by comparing it with the pragmatic significance of the terms that belong in the intersection of most available accounts of them: quantifiers, truth-functional connectives, and also modal and epistemic operators. Its concern should be to understand why these terms have enjoyed logicians' favour. The direction of an enlightening inquiry has to run contrary to Quine's "list view". For what is at stake is not a formal characterization that may have extensional success, which in any case is impossible, since there is no generalized agreement about what the set of logical constants is, but rather a general philosophical understanding capable of illuminating their status as such. And what I submit is not an explanation of what makes them logically *interesting*, but the cluster of features that makes them *logical* terms. If I am right, we should count as logical constants any terms that fit the definition, and only these, with the only proviso that I am not concerned with the project of understanding non-standard expressions of Twin-English as used by silicon-based rational creatures, but with the project of finding a philosophical account that sheds light on the meaning and use of some ingredients of our everyday language.

Besides, DEF can have two readings, one weaker that the other. They are the following,

[DEF]$_{weak}$ Logical constants are higher-order predicables that can admit 0-adic predicables among their arguments. They don't name any kind of entity but rather are natural language devices for making explicit the inferential relations among concepts and propositional contents.

[DEF]$_{strong}$ Logical constants are higher-order predicables whose arguments are 0-adic predicables. They don't name any kind of entity but rather are natural language devices for making explicit the inferential relations among concepts and propositional contents.

[DEF]$_{weak}$ predicates logical constanthood of types, while [DEF]$_{strong}$ predicates it of tokens. Under the former, a type, say a quantifier, is a

logical constant if, among other characteristic, it has tokens that are functions of 0-adic predicables. Propositional quantification would be an obvious case that would provide quantifiers with the required feature. Under the stronger definition, what is classified as a logical constant is a token, i.e. a particular instance of a type together with its particular aspects. If one selects exclusively [DEF]$_{strong}$, it makes no sense asking whether quantifiers or any other kind of expression are or are not logical constants.

Fortunately, it is not necessary to choose one of the two options and reject the other. We can assume the charitable position of classifying types as logical constants in a weak sense if, and only if, they have tokens that are so in a strong sense.

DEF assembles three aspects that are individually necessary and jointly sufficient for being a logical constant. Removing some aspect while leaving others, we get broader sets of expressions still related to the class of logical constants. Table 1 shows different expressions with different sets of properties.

My definition rules out:

(i)   First-order predicables, and hence it rejects first-order identity and membership as logical constants

(ii)   Predicate-formers such as some cases of negation, conjunction and disjunction, higher-order identity and the reflexivity operator

(iii)   Monadic sentential operators that act as circumstance-shifting operators, such as modal, epistemic and temporal operators

(iv)   Monadic sentence-formers, such as monadic quantifiers

Nevertheless,

(v)   DEF doesn't imply that first-order identity, conjunction and disjunction should be removed from standard calculi. They shouldn't. They all have jobs to perform there.

(vi)   It doesn't imply that modal, epistemic and tensed logics shouldn't be considered as logics. They are, although they all include at least two sets of constants, genuine logical constants, which earn them the title "logic", and specific constants that make them modal, or epistemic or tensed logics, in each case.

(vii)   DEF doesn't imply that quantifiers are not logical constants. Rather, it distinguishes different kinds of quantifiers. Monadic quantifiers don't act as inference-markers, but binary quantifiers standardly do. This does not mean any rejection of Frege's (1884) account. Frege rightly understood the na-

ture of numerical expressions as higher-order concepts, and rightly defined existence as an expression of quantity. Neither does my point signify any criticism of Mostowski's insights that monadic quantifiers help us to construe propositions out of propositional functions, or that logical quantifiers cannot be used to single out individuals. Both theses are correct. But none of them define logical constants.

All these apparent difficulties of my view on logical constants can be answered, and it can be argued that the inference-marker view, with its syntactic, semantic and pragmatic aspects, fits surprisingly well into our intuitive understanding of logic. It is compatible with the Fregean account of logical constants and quantifiers, with the Wittgensteinian view of logic and with our ordinary practice as linguistic agents and as working logicians. It, nevertheless, is at odds with some theoretical positions on logic that place it in the realm of syntax. In any case, it is more difficult for syntacticists to explain how their view is compatible even with the basic definition of validity and in which sense is their syntactic proposal is useful for our inferential practices, than for me to demonstrate why syntacticism in logic should be abandoned.

To conclude, I would insist that logic is an essential part of our rational behaviour, and that its significance and the meanings of its concepts cannot be understood by ignoring the kind of actions the speakers use logical terms for. There is no isolated problem that logic poses to the project of naturalism. Inferential practices are just a kind of linguistic actions. If the latter are naturalistically explainable, so are the former.

References

Brandom, Robert (1994). *Making it Explicit. Reasoning, Representing, and Discursive Commitment*. Harvard University Press.

Carroll, L. (1895), "What Achilles said to the Tortoise". *Mind*, 15, 279-80

Drestke, F. (1995). *Naturalizing the Mind*. Cambridge, Mass.: The MIT Press.

Etchemendy, J. (1983), "The doctrine of logic as form". *Linguistic and Philosophy* 6, pp. 319-334.

Frege, G. (1879), "Conceptual Notation. A formula language of pure thought modelled upon the formula language of arithmetic". In Frege, G., *Conceptual Notation and Related Articles*. Translated and edited with a Biography and Introduction by Terrell Ward Bynum, Oxford, Clarendon Press, 1972, pp. 101-203

Frege, G. (1884), *The Foundations of Arithmetic*. Oxford, Basil Blackwell, 1980

Frege, G. (1892), "On Concept and Object". In Geach, P. and Black, M. (eds.), *Translations from the Philosophical Writings of Gottlob Frege*. Oxford, Basil Blackwell, 1952.

Gentzen, G. (1969), *Collected Papers*. Amsterdam, North-Holland

Harman, Gilbert (1986), *Change in view. Principles of reasoning*. Cambridge, Mass.: The MIT Press.

Klima, G. (2004), "Syncategoremata". In *Encyclopedia of Language and Linguistics* vol. 12, 2nd edition, ed. by Keith Brown. Oxford: Elsevier, pp. 353-356.

Kneale, W. and Kneale, M (1962), *The Development of Logic*. Oxford: University Press

Kornblith, H. (ed.), (1985), *Naturalizing Epistemology*. Cambridge, Mass.: The MIT Press.

Koslow, A. (1992), *A Structuralist Theory of Logic*. Cambridge, Cambridge University Press

Mostowski, A. (1957), "On a Generalization of Quantifiers". *Fundamenta Mathematica* 44, pp. 12-36

Peirce, C. S. (1932), *Collected Papers of Charles Sanders Peirce*. Edited by Charles Hartshorne and Paul Weiss. Volume II. Elements of Logic. Cambridge, Harvard University Press

Prawitz, D., 1978. "Proofs and the Meaning and Completeness of the Logical Constants." In J. Hintikka et al. (eds.), *Essays in Mathematical and Philosophical Logic*, 25-39. Boston: Reidel.

Prawitz, D. (2006), *Natural Deduction. A proof-theoretical study*. Dover Publications.

Prior, A. (1976), "What is logic?". *Papers in Logic and Ethics*. Amherst, University of Massachusetts Press

Quine, W. v. O. (1986), *Philosophy of Logic* (2nd ed.). Cambridge: Harvard University Press.

Sellars, W. S. (1963), "Empiricism and the Philosophy of Mind". Reprinted in *Science, Perception, and Reality.* London: Routledeg and Kegan Paul.

Sher, G. (1991), *The Bounds of Logic. A Generalized Viewpoint*. Cambridge, Mass: The MIT Press.

Warmbrod, K. (1999), "Logical Constants". *Mind* 8, pp. 503-538.

Williams, C. J. F. (1992), "Towards a Unified Theory of Higher-Level Predication". *Philosophical Quarterly* 42 (169), pp. 449-464.

Wittgenstein, L. (1922), *Tractatus Logico-Philosophicus*. London: Routledge and Kegan Paul. First edition in German (1921), *Logish-Philosophische Abhandlung*, Annalen der Naturphilosophie, 14

Wittgenstein, L. (1978), *Remarks on the Foundations of Mathematics*. Edited by G. H. von Wright, R. Rhees, G. E. M.

Anscombe. Revised edition, Cambridge, Massachusetts. The MIT Press.