Logic as a (natural) science

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Abstract: The thesis that logic is a science is not too controversial – logic seems to be so close to mathematics that that its allegiance to science seems to be obvious. In this paper I argue that though logic is a science (or something close to science), it is not because it would be akin to mathematics; that it is much closer to a natural science like physics, for just like physics it accounts for some part of reality (in case of logic it is the rules of reasoning as an ongoing human activity) largely in terms of mathematical models. In the paper I consider some recent proposal for seeing logic as a theory of reasoning (T. Williamson, G. Russell) and I try to amend what I see as their shortcomings.

Keywords: logical laws; excluded middle, modus ponens, nature of logic; logical validity; reasoning

1 Is logic a science?

Logic was born from the rib of philosophy. It is true that, from the outset, its position within the network of philosophical disciplines was somewhat peculiar: unlike ontology or epistemology, logic was more of a tool ("organon") of philosophy than directly part of its subject matter. On the other hand, the link of logic to philosophy was, and was to remain for many centuries, rather firm – neither mathematicians, nor other scientists paid much attention to it.

It was only in the second half of the ninetieth century that logic started to attract mathematicians. Boole, Frege, Peano, etc., the ur-fathers of modern logic, were all mathematicians, which helped them raise logic to a new level of rigor. On the one hand, they wanted to employ logic to fortify the foundations of mathematics (especially Frege and Peano) and, on the other, they wanted, the other way around, use mathematics to advance logic, which they saw as an account for "the laws of thought" (Boole).

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Since then, logic has become quite entangled with mathematics, and even many logicians working in departments of philosophy do quite a lot of maths. Therefore, nowadays, it might seem that logic indeed is a science, namely that it is part of mathematics. In this paper I will defend the thesis that though logic is a science (or something close to science), this is not because it would be a part of mathematics. I think that logic is no more a part of mathematics than, say, physics is – that the massive ways in which it has come to rest on mathematical methods does not make it collapse into mathematics any more than it does physics. What I am going to argue is that logic is much more like a natural science than like mathematics: that it accounts for an empirical domain using complicated mathematical models[2].

I am convinced that the subject matter of logic is, roughly, human reasoning – not in the sense of an inner, psychological process, but as an ongoing human social activity[3], also known as argumentation. This activity is based on our human language and especially on that its part that can be called “logical". It is the form of this part of language where our argumentative practices have got sedimented. Hence, I am convinced, it is this language and the ways competent speakers use it that is the ultimate subject matter of logic. True, most of the studies of logic are legitimately carried out through various kinds of analyses of mathematical models of natural language and of reasoning, but the results of the analyses are *logical* results (rather than purely *mathematical* ones) to the extent – and only to the extent – to which it is the theory of our actual reasoning.

This is not to conceal that there is the important difference between physics and logic in that the latter, unlike the former, is *normative*. The normativity of logic comes in two varieties. One is that what logic accounts for are *norms* of our language and of our reasoning. This, *prima facie*, provides for a basic difference between logic and physics; but the difference may be smaller than it seems, if we accept that norms are just very complicated, feedback driven behavioral patterns structuring human societies (Peregrin, 2014). A more substantial difference consists in the fact that logic can influence its subject matter – that it may serve as a *norm* of reasoning in the sense that reasoners may take logic as telling them how they *should* reason. This is where the analogy between logic and a natural science like physics reaches its limits.

[2]See Shapiro (2001) for a similar view

[3]This sense of “reasoning" is epitomized by Laden (2012).

2 Logic and reasoning

The general idea that logic is something like a theory of reasoning, in itself, is certainly in no way new or surprising. This plausible sounding claim, however, may easily lure us into oversimplified views of how exactly it accounts for reasoning. So before we go on, we should make it plain that such oversimplified pictures are not what we are aiming at.

The most straightforward understanding of logic as a theory of reasoning is the understanding of laws of logic as direct instructions for how to infer beliefs from beliefs; or, more generally, how to upgrade the set of one's beliefs so that it be maximally feasible. According to such interpretation, the law of the form

(1) $p_1, ..., p_n \vdash p$

would amount to the instruction

(1*) if you hold all of the beliefs p_1, ..., p_n, hold also the belief p!

Thus, for example, the law of *modus ponens*,

(MP) $p, p \rightarrow q \vdash q$

would tell us that if we have the beliefs of the form p and $p \rightarrow q$, we should also have the belief q.

This view of the laws of logic has been shattered most notably by Harman (1986), and it is definitely not something we would like to suggest. The discussion emerging in the wake of Harman's book has indicated that the relation between logic and reasoning is quite complex[4]; and that there is no easy way to modify the above picture to make it feasible.

One reason why it is not reasonable to interpret (1) as (1*) is that the beliefs p_1, ..., p_n as well as the belief p can be odd and we can hold p_1, ..., p_n for various odd reasons; and it would hardly be viable if logic were to tell us to hold another odd belief. From this viewpoint, it might seem that a better interpretation of (1) might be[5]

[4]See, e.g., van Benthem (2008); Milne (2009); Field (2009); Dutilh Novaes (2015); or Steinberger (in press).

[5]Broome (1999) speaks about a "non-detaching relation" here: for in contrast to the previous case, which amounted to *if you believe p, you ought to believe q*, where p was "detachable" in the sense that if you do believe p, you have the obligation to believe q, this case amounts to *you ought to see to it that if you believe p, you believe q*, and given you believe p there is not an unambiguous obligation to adopt the belief q – if q is too weird, you can do justice to your obligation by giving up the belief p. The former case is also often called a *narrow scope* requirement, while the latter is dubbed a *wide scope* requirement (according to the scope taken by the *ought* – see, e.g. Way, 2010).

(1**) if you hold all of the beliefs p_1, ..., p_n, either hold also p, or abandon at least one of p_1, ..., p_n!

But the problem is that even if we hold perfectly reasonable beliefs p_1, ..., p_n, it would still not be reasonable for us to hold every p that follows from them. Any sentence has an unlimited number of trivial consequences (p_1, for example, has the consequences $p_1 \wedge p_1$, $p_1 \wedge p_1 \wedge p_1$, ...) and the obligation to hold all of them would lead to what Harman aptly described as "cluttering one's mind with trivialities" (ibid., p. 12)

Another option we might want to try is:

do not hold all of p_1, ..., p_n together with $\neg p$!

But this already presupposes that we identify negation independently of principles of this kind, which is a problematic presupposition – any feasible definition of negation will already have to contain the clause that p_1, ..., $p_n \vdash \neg p$ renders p incompatible with is p_1, ..., p_n or something equivalent to it. (A proof-theoretic definition will probably contain $p, \neg p \vdash q$, which entails this via cut; a semantic definition will have to include something as $||p|| \cap ||\neg p|| = \emptyset$ which has a similar effect.)

Thus, interpreting the slogan *logic is the theory of reasoning* in some such straightforward way is problematic; and we repeat that this is *not* what we are after. Hence the question that comes into the fore is how exactly to understand it. In which sense is logic a theory of reasoning? Let us look at some recent attempts at an answer to it.

3 Williamson on logic

In a recent paper, Timothy Williamson (2017) expresses a view of logic *prima facie* very similar to that advertised above. He speaks about the "abductive methodology" that should govern our choice of logical theory, as well as governing the choice of any other scientific theory: we should judge logical theories, just as we judge theories in other sciences, "with respect to how well they fit the evidence, of course, but also with respect to virtues such as strength, simplicity, elegance, and unifying power". Hjortland (2017) summarizes this kind of attitude in the slogan "logic is not special": "Its theories are continuous with science; its method continuous with scientific method. Logic isn't a priori, nor are its truths analytic truths. Logical theories are revisable, and if they are revised, they are revised on the same grounds as scientific theories."

This seems to fit very well with the approach sketched above. Yes, logical theories are theories that are to systemize and explain certain bodies of evidence with certain aims, just as physical theories are to systemize the evidence we gain from perceiving, measuring, and experimenting in the physical world with the aim of discovering natural laws and helping us utilize them to foster our goals. But surprisingly, after claiming that the conceptual apparatus of logic should be instrumental to the formulation of "the most fruitful questions and their answers" and that it should be evaluated "with respect to how well they fit the evidence", Williamson does not go on to clearly articulate exactly what kinds of questions logic should answer and what kinds of evidence it is to fit.

What he puts forward is that the crucial theses logic is to accept or reject are universal generalizations of logical laws, such as "for every *p*, *p* or not-*p*". Such theses, Williamson argues, are not "meta-linguistics"; they are not about any language, rather they are about the world. In this way, Williamson comes close to the view of B. Russell (1919), who famously claimed that "logic is concerned with the real world just as truly as zoology, though with its more abstract and general features" (p. 169). (Wittgenstein, 1956, §I.8, ridiculed this construal of logic as the construal of "logic is a kind of ultra-physics, the description of the 'logical structure' of the world, which we perceive through a kind of ultra-experience".)

A crucial question, it would seem to me, is what the "for every *p*" in the above thesis quantifies over. The answer cannot be "everything", for the entities are subjected to logical operations (negation, disjunction), and hence they must something of the kind of sentences or propositions. If they are propositions, we can only access them via (such or another) sentences, so we can – and indeed must – keep using sentences as their proxies. Thus even if logical theses are not directly meta-linguistics, they are bound to be about entities intimately related to language (being subject to negation, disjunction etc.) and accessible only via linguistic entities (unlike other things of the world, which can be pointed at and investigated without the mediation of language).

And indeed, if we see logical laws as thus inherently related to language, we can see that there is no straightforward answer to the question about the domain of quantification of the "*p*" in Williamson's example. Of course, we have artificial languages of logic for which (or for the propositions expressed by their sentences) it holds. But we also have those in which it does not hold; and very probably it does not hold exceptionlessly for any natural language (i.e. for the propositions expressed by its statements). It would seem probable that every natural language contains sentences generally taken, by its speakers, as neither true nor false ... . The principle can also be read as a methodological directive, as saying, roughly: doing logic, restrict your attention only to sentences that have one of the two truth values!

In any case, here it is where the view of logic put forward here differs essentially from Williamson's. Logic, by my lights, is about reasoning and argumentation; and reasoning (in the sense relevant for logic) and argumentation are things we do with (a) language[6]. It is reasoning and argumentation that is the basis for determining which kinds of logical theories are worth pursuing; just like any other theory, logic should be answerable to the relevant evidence and to the aims which guide our efforts to master its subject matter. And the evidence relevant for logic resides in the ways people actually reason and argue.

Hence, though like Williamson I do think there are important parallels between logic and physics (parallels ignored or denied by those who think that logic *is* special, that, e.g., it is a matter of an *a priori* analysis), I disagree with him concerning how exactly they are parallel. Williamson argues that logic should not "tailor its basic theoretical terms to fit whatever pre-theoretic prejudices and stereotypes may happen to be associated with the word 'logic', any more than physics should tailor its basic theoretical terms to fit whatever pre-theoretic prejudices and stereotypes may happen to be associated with the word 'physics'"; and though I certainly agree that logicians should not pay attention to "prejudices and stereotypes", I think this does not mean that they should not pay attention to how people really reason, to which arguments they hold for correct – for these form the *evidence* logic works with.

Why should we pay attention to the actual ways of reasoning of fallible people – should we not be interested only in the ways in which it is *correct* to reason, independently of whether anybody actually does reason in this way? Is what people actually do not irrelevant to what they should do – and is not paying attention to what they do just buying their "prejudices"[7]?

Consider purely practical (in contrast to theoretical or discursive) reasoning. I want to find out what to do to fulfill my needs. Here it might be

[6] As Mercier and Sperber (2017) put it: "Unlike verbal arithmetic, which uses words to pursue its own business according to its own rules, argumentation is not logical business borrowing verbal tools; it fits seamlessly in the fabric of ordinary verbal exchanges. In no way does it depart from usual expressive and interpretive linguistic practices". (p.172)

[7] Nowadays we have access to many studies of the fallacies human reasoners tend to make (from Wason, 1968, or Kahneman & Tversky, 1996, to a host of their more recent followers).

purely the study of the world that is able to show us how to fulfill the needs most effectively, especially what kind of reasoning is most efficient. However, most of our reasoning is theoretical and discursive, and to do this it employs meaningful symbols. And to be able to say what is the best way to operate with certain *symbols* we need to know what they *mean*. And to learn what the symbols mean we need to pay attention to how their users actually use them, including how they reason with them.

We carry out all our theoretical reasoning in terms of concepts, mostly the concepts bestowed on us by our mother languages. (We might have developed some amended versions of the languages with slightly better – clearer, less ambiguous ... – concepts, but the heritage of our normal language is certain to still play a vital role.) Hence, if we are to be given any advice on how to reason, it will have to be an advice concerning how to reason within the framework of our natural language.

Many of the important theses our reasoning focuses on will probably be of the shape *If A then B*. If somebody wants to advise us how to deal with these more proficiently, she or he will have to know what exactly they mean – in particular, what exactly *if ... then ...* means. And to learn this, she or he will have to gather evidence concerning how we actually deal with the expressions – and in this particular case also what kinds of arguments including *if ... then ...* we hold for correct, which for incorrect and which are perhaps indeterminate.

4 G. Russell on the nature of logical laws

Another recent paper treating logic as a theory of reasoning is due to G. G. Russell (2015). Considering the nature of logical laws and rejecting two *prima facie* plausible accounts of logical laws (namely, the account that logical laws are analytic truths which implicitly define the meanings of logical constants and the account that they are simply some very central nodes of our overall web of belief), the author comes to the conclusion that “logic isn’t basic, reasoning is". Russell’s approach then comes closer to the one put forward here than Williamson, however, it does not bring it to its consequences.

Russell describes a four stage pilgrimage of a student of logic into the secrets of the subject. In the first stage, the student enters as a complete layman, her “beliefs about logic are rather inchoate". In the second stage, she discovers classical logic and starts to consider it as *the* logical tool, “she enthusiastically accepts both the general theory of truth-functional logic, and the more specific claim that the law of excluded middle is a logical truth." The third stage is marked with the recognition that some rules of classical logic, especially the rule of excluded middle (hereafter EM), may not be valid after all, and she “eventually comes to agree with [her professor] that classical logic is wrong, and she should adopt the three-valued logic instead." In the fourth stage she is confronted with paraconsistent logic, which subverts still more laws of classical logic, but leads to a logic that is “intolerably weak", so she starts to reconsider her rejection of EM and “she steps back to classical logic, holding ultimately, that its theoretical virtues and power outweigh those of the alternatives" and she “regains her belief that the law of excluded middle is a logical truth".

Thus, the way in which Russell sees reasoning as setting the agenda of logic is that it is the *de facto* reasoning that determines what is logically valid and what is not, and thus it underlies the content of logical laws. This, I think, is very true, but it seems to me that neither Russell’s story, nor the morals she draws from it, are as clear and as explicative as they should be. What are the main lacunas I see in Russell’s exposition?

Firstly, Russell wants to expose the nature of logical laws, but in the end she does *not* tell us, explicitly, what the laws are. Instead she gives us her story, from which she draws certain morals, but surprisingly no explicit moral with respect to the nature of the laws. Her story is instructive and can help us to gain insight into the nature of logic; but an explicit conclusion seems to be lacking.

Secondly, I think that to reach such an explicit conclusion would call for a more careful scrutiny of the nature of the concept of “validity" (or that of “logical truth", which the author seems to use interchangeably with “validity"), which features prominently in the story (indeed it is the “coming-of-age story" in the course of which the hero moves from naive views of what is “valid" to more mature views) and which, I am afraid, harbors certain dangerous ambiguities.

Anyway, the fact that Russell puts the concept of validity in the center of her picture deserves a special attention. On the one hand, it is in no way surprising: that the question which logical principles are valid (or which are – the true? – laws of logic) is central to logic appears to go without saying. On the other hand, however, if we view logic as a theory of the *de facto* enterprise of reasoning, this is no longer so obvious – should not logic, in this case, concentrate on some regularities of this very process?

I think that the solution to this quandary lies in the recognition of the fact that the *de facto* reasoning is an (essentially) *rule-governed* enterprise. We play our "games of giving and asking or reasons" (Brandom, 1994) according to certain rules, just as we play football according to its rules. (And here we should not imagine so much an "official" football all the rules of which are explicitly canonized; but rather a "yard game", with most of the rules relatively clear but not explicitly spelled out.) And central to the account for the game is capturing the rules that constitute its framework. Thus, the way we account for the enterprise of reasoning is that we try to capture its rules, by means of what we call logical validities or the rules of logic.

Hence the picture that looms before us is the following: As a matter of fact, we humans engage in ongoing reasoning, in the never-ending game of "giving and asking for reasons". The rules are part of the game, just like those of football are part of football – though most of them are not necessarily quite explicitly written down, they are implicit in that the players respect them and are prone to ostracize their violators. The most basic aim of a theory of reasoning, hence, is to make the rules fully explicit: to present the model that captures them as adequately as possible and as reasonable. And it captures them in the form of schemata which we tend to call *valid* and which we tend to see as *logical laws*.

Given this understanding of the enterprise of logic, it is, first and foremost, necessary to be quite clear about what *validity* amounts to. The question is whether this concept, as standardly construed within logic, can be taken as the very concept that can play the role of the principal explicandum of logic understood as a theory of *de facto* reasoning.

5 What kind of validity?

Rules of our "giving and asking for reasons" get captured, within a formal language, as certain patterns: schematic arguments or directly as schematic statements. Thus, *modus ponens* gets captured as

(MP) $p, p \rightarrow q \vdash q$,

whereas *excluded middle* gets captured as

(EM) $p \vee \neg p$,

where "p" and "q" are contentless placeholders. Such a schematic argument or a schematic statements is then called valid if all its instances are correct arguments or true statements.

One concept of validity, hence, is straightforward – the concept internal to a logical system. Thus we know, for example, in this sense that EM is valid in classical logic and invalid in intuitionistic logic[8] Can we use this relative concept of validity to arrive at an absolute one? Certainly, it is enough to raise a particular logical system to the rank of *the true* logic. Then the validity within this system becomes validity *simpliciter*. However, it is not clear which decisive arguments could support such a claim of a logical system. Of course, it might be that somebody sees a logical system as embodying some mental operations crucial for logical reasoning; or it might be that one sees it as capturing some logical relationships that "in fact" interconnect Platonic ideas or propositions; but, as any evidence for either the former or the latter view could only be very indirect and susceptible to differing interpretations, it would be hard to see it as indisputably supportive.

Alternatively, we can try to go for an absolute concept of validity from the beginning. We might say that the letter "p" in "$p\vee\neg p$" stand for some "real" sentences or propositions, and hence that the law says that the disjunction of a sentence or a proposition with its own negation is always true. What kind of entity would this formulation refer to? They might be linguistic entities (sentences of a natural language) or entities related to the linguistic ones (propositions expressed by such sentences), but as we have already noted, there is no way of getting hold of the latter directly, without the mediation of the former, and hence it would seem reasonable to focus our attention on the linguistic entities, sentences.

Construed thus, the validity of EM comes down, within our linguistic milieu, to the claim that the disjunction of any English (declarative) sentence with its own negation is (necessarily?) true. This, to be sure, presupposes that we know what the disjunction of two English sentences is, and what the negation of an English sentence is; and while for the former we can say that it is the complex sentence which arises out of connecting the sentences with the connective "or", the latter is more problematic. (For example, is "The

[8] Of course, it is slightly less straightforward to delimit this concept generally. We might try: EM is valid in a logical system iff the formula "$p\vee\neg p$" is a theorem/tautology of the system. However, this would obviously not work, for the specific signs a system employs are arbitrary, and "$\vee$" and "$\neg$" need not express disjunction and negation, respectively. Hence what we need would be: EM is valid in a logical system iff the formula "$p\vee\neg p$" (or, for that matter, "$p\oplus\circledast p$"), where "$\vee$" ("$\oplus$") is a disjunction of the system and "$\neg$" ("$\circledast$") is its negation, is a theorem/tautology of the system. And then we would have to define what it takes to be a $disjunction$ and a $negation$ of a logical system, which, in general, is far from straightforward. (Notice that someone might want to say that the validity of EM is one of the $defining$ features of – "genuine" – negation. Notice that we might have systems where more constants aspire to being a disjunction or a negation, etc.) But let us leave all these difficulties aside and assume that this relative concept of validity is straightforward.

king of France is not bald" the negation of "The king of France is bald"?) Hence in this case the validity of EM is not quite non-negotiable. In the case of many sentences of natural language we have significant leeway over the determination of both where to place the boundary of true sentences and which sentences are to count as instances of "$p \vee \neg p$".

One might try to argue that the problem results from our decision to focus on sentences rather than on propositions. Only some sentences express propositions, the argument might go, and it is perhaps only those not expressing them that constitute the invalid instances of "$p \vee \neg p$". However, there is no simple way to draw a dividing line between those sentences that do, and those that do not express propositions[9]; and as a result, this argument appears to be a sleight of hand: if we dismiss any counterexamples on account of their "not expressing propositions" without being able to formulate any *independent* criterion of when a sentence does express a proposition, we are effectively turning EM into an irrefutable claim which therefore ceases to be interesting.

Now validity within a formal system (which is a matter of the definition of the system) and validity within natural language (which is a matter of a general claim which can be tested empirically) are two very different notions. They can coincide – if we fine-tune the formal system so that its validities capture precisely (or at least approximate reasonably) the validities of the natural language. However, such an absolute coincidence is unlikely – for the replication of all the twists and turns of any natural language would force our logic to be overly complicated and heterogeneous, while logic should be, as any other model, something simple and perspicuous.

Thus, a logical analysis, the subsuming of natural language cases under the umbrellas of formulas of a formal language (which are then considered the "logical forms" of the natural language sentences) usually involves plenty of mutual adaptation. It is not only that logic is formed to comply with the language, but that the language, conversely, must be as if "pressed into a suitable conceptual mold" – and sometimes even directly regimented – to allow for a relatively simple coverage by logical forms. This process is

[9]Proposals to this effect often contend that only sentences that are in some sense *complete* express propositions. (Thus, as Frege, 1918, p. 76, for example, puts it, the sentence "this tree is covered with green leaves" is not complete, because it does not specify the "the time-indication".) However, then the question is whether *any* sentence of natural language is sufficiently complete to express a unique proposition. The sentence "this tree is covered with green leaves" is certainly *not* complete until the tree in question is uniquely specified; but it is also not quite clear what the boundaries are for a tree being "covered" by green leaves (in contrast to merely "having" green leaves) etc.

very similar to the process of reflective equilibrium which is argued to yield ethical rules[10].

Note also that the kind of “harmony" between a natural language and logic which would substantiate us in saying that a logic captures a language, is not something the existence of which could be proved or ascertained once and for all. The relation between a formal language and a natural one is like that between a formal model of an empirical phenomenon and the phenomenon itself: we can carry out various kinds of “measurements" to examine whether the former captures the latter, but no amount of such measurement is able to establish that it is *absolutely* adequate. Moreover, what we call *adequate* is a matter of the purpose for which we do the modeling.

Unfortunately, many freshmen in logic, and also at least some of its veterans, seem to have the intuition not only that the two notions of validity can be calibrated and maintained in the required harmony, but that this harmony is somehow intrinsic. They take it, for example, that the “$\rightarrow$" of classical (or, for that matter, another) logic is *intrinsically* tied to the English “if ... then ...", just because they are two incarnations of a supernatural *implication* (“$\rightarrow$" being definite and perfect, and “if ... then ..." being loose and elusive). Probably nobody would really want to defend this explicitly, as its oddness is readily seen, but nevertheless it seems to lurk in the background of a lot of thoughts about logic. This is documented by the “unbearable lightness" with which many textbooks on logic move back and forth between sentences with “if ... then ..." and corresponding formulas with “$\rightarrow$", as if they were naturally the same.

6 Two kinds of languages

Considerations of the previous paragraph come down to the essential importance of the distinction between two kinds of languages. Every human (perhaps with some negligible exceptions) speaks at least one language – a language she has not invented, but which was passed to her by her elders. The expressions of the language are meaningful, and they are passed from one generation to another as such. (One may take part in a process in which the meanings of some expressions get gradually modified, but the bulk of the meanings are simply not up for grabs for any given individual; they are,

[10]See Peregrin and Svoboda (2016, 2017). In fact though it was Rawls (1971) who coined the term, the idea behind it was exploited already earlied, by Goodman (1983), and it was precisely in connection with logic

as it were, prescribed to her[11].) It is in terms of these meanings that she reasons, thinks and understands her world.

Can one *create* a language? Certainly one can create something that shares enough features with natural languages to be called *language* – be it something like Esperanto or something like the language of Peano arithmetic. But can one create a language with semantics as comparably rich and nuanced as that of natural language? This is much more dubious. In general, we may endow expressions of an artificial language with meanings either by linking them to expressions of a natural language and thus borrowing their meanings (as in the case of Esperanto) or by trying to craft the meanings from scratch. When we go for the former option, the question is whether what we gain is a truly new self-standing language, or rather a mere simulacrum parasitic on an existing one or existing ones; if we go for the latter, the question is whether we are able to create something that will be really usable as a language, or, indeed, be of any use at all.

There is no problem in sitting down and devising a "language" by positing a vocabulary, some grammatical rules and some rules of semantics – be it a kind of "model-theoretic" semantics imitating the relation of designation or rather a "proof-theoretic" one related to the use-theory of meaning. The question is whether such a "language" would be of any use. We know that it may be useful if it is close enough to a part of our natural language that it can be used as its simplified (and/or more precise, more perspicuous ...) "model", or even as its more rigorous "proxy". This, for example, is the case for an artificial language of Peano arithmetic, which is so closely related to our pre-theoretical discourse in natural language that its sentences can be taken as precisely expressing what we had expressed imprecisely before. This may also be the case for various languages of pure logic (which however, are usually not genuine languages but rather mere language forms).

It seems clear that when we ask whether EM holds, we cannot mean whether it holds in an arbitrary artificial language. We know we can easily construct an artificial language (or 'language'?) in which it holds, as well as we can equally easily construct another one in which it does not hold. Moreover, there is no saying which kind of language is a "genuine" language of logic – we know that both languages supporting EM, such as classical logic, and languages rejecting it (such as intuitionistic or three-valued logic) have

[11] And let me stress that this is no mysticism of the kind of "the genuine language is shrouded in mystery". Natural language is simply so complex, and so complexly interwoven with all the things we do, that it is hardly possible to recreate it, in all its complexity, in "laboratory conditions".

firm places in the enterprise of logic. And we have also seem that looking at EM as summarizing truths of natural language heralds many problems.

As a result, we have artificial languages, where logical laws hold (or do not hold) in clear, unambiguous and often provable ways, which, however do not seem to have any universal bindingness for us; and we have natural languages which do bind us (in that they are our universal medium of grasping the world), in which logical laws hold (or do not hold) only fuzzily and usually not exceptionlessly. And as the question about the validity of a law like EM does not seem to fit with the context of either of the kinds of languages, it might seem it must go with something that is "beyond" the languages, to something which is both precise and binding enough to make the question straightforward. It might be a language of thought with which each of us is born, or a system of propositions within a Platonist heaven towards which the minds of each of us work their way. But the trouble with ideas like these is that they are just *ad hoc* stipulations fashioned to make our philosophical life easier. There is no way to investigate such an absolute" language in an independent and intersubjective way.

Instead of this, I think that the *locus* of validity of logical laws can be seen as the interaction of the natural and the artificial languages. A rule of a formal language becomes a logical law insofar as the formal language becomes our standard "prism" through which we see our natural language. Of course, the choice of such a prism is far from arbitrary – far from every artificial language is usefully employable as such a prism. However, there is still leeway: as we know, there are logical accounts of our linguistic intercourse, of our reasoning and of our cognitive life based on classical logic as well as those based on non-classical logic which rejects EM.

7 Logic as a science

It is time to return to the elucidation of the claim that logic, in some, important aspects, is like a natural science. The picture we have sketched up to now is that the formal languages that have been ubiquitous in logic during the last hundred-odd years are like the mathematical models that have become ubiquitous in physics or other natural sciences.

Thus, we can agree that logic – in this sense – is not special, as Hjortland stresses, and that it follows the kind of abductive methodology urged by Williamson. Logic tries to cope with the evidence and yield theories that are able to systematize it in the simplest, most effective and most usable way.

However, as most of the reasoning that is its subject matter rides the vehicle of language, it is basically about language and about rules that govern some of our language games. (Also, it may sometimes suggest how to improve on them, or how to play them using some artificially created linguistic items instead of those offered by ordinary language. However, such improvements and gadgets are usually only local and do not wholly disentangle us from the framework of our ordinary language.) I am not sure whether this means that logic is, in Williamson's term, "meta-linguistic", but it does mean that it is largely concerned with language[12]. (Though insofar as language is part of the real world, logic *is* concerned with the world, albeit merely with a part of it.)

The situation in physics is such that there are some data, data which usually result from measuring some parameters of some natural objects, events of phenomena, and these data are used to build the model. The advantages of the model are that it is simpler than the phenomenon itself, it is explicitly and exactly delimited, and it is susceptible to mathematical treatment. (Of course it is crucial that it is simpler in just the right way, that it disregards those features of the phenomenon which are not important from the current viewpoint and retains those that are.) Then we can use mathematical methods to learn something new about the model, and project these results back on the phenomenon which it was a model of.

The thesis now is that the formal languages of logic can be seen precisely as models in this sense, as models of "natural" reasoning or argumentation and of its "natural" vehicles, natural languages. What remains to be clarified is what exactly counts as the data which are both the point of departure of building the models and its checkpoints.

Priest (2016, p. 355) writes: "In the criterion of adequacy to the data, what counts as the data? It is clear enough what provides the data in the case of an empirical science: observation and experiment. What plays this role in logic? The answer, I take it, is our intuitions about the validity or otherwise of vernacular inferences." This is almost precisely what I want to propose.

[12]Quine (1960, p. 273) stresses that this does not render logic as a matter of linguistic in any deep sense: "Most truths of elementary logic contain extralogical terms; thus 'If all Greeks are men and all men are mortal ... '. The main truths of physics, in contrast, contain terms of physics only. Thus whereas we can expound physics in its full generality without semantic ascent, we can expound logic in a general way only by talking of forms of sentences. The generality wanted in physics can be got by quantifying over non-linguistic objects, while the dimension of generality wanted for logic runs crosswise to what can be got by such quantification. It is a difference in shape of field and not in content; the above syllogism about the Greeks need owe its truth no more peculiarly to language than other sentences do."

I say *almost*, because I do not think it is good to use the term “intuition". I would say that what counts as data is “the validity or otherwise of vernacular inferences", i. e., which inferences in natural languages are taken and treated as correct. This can be researched empiricially, and indeed it can be researched by “observation and experiment" (which reemphasizes the proximity of logical research and the research in natural sciences). We can observe which inferences are used and accepted in real arguments and we can set up experiments to find out which such inferences would be accepted or considered correct.

Let me repeat that this rapprochement of logic and natural sciences does not do away with the pending *dis*similarities between logic and natural sciences mentioned above: especially with the fact that unlike theories in natural sciences, logical theories do not only *capture* its subject matter, but rather *interact* with it. They can be used to *correct* human reasoners thereby having the feedback on their subject matter. This does render the whole enterprise different from that of natural sciences. Hence in contrast to the “non-exceptionalist" program I maintain that there *is* a discontinuity between the method of logic and those of the sciences; though I agree that the extent to which they are continuous is important and interesting.

8 The nature of logical laws

If we take natural language at face value, then almost none of the laws articulated by common logical systems, were we to apply them as strictly as possible, would hold for it. (We have seen this for the case of the EM, but counterexamples have been reported with respect to almost any logical law, including MP.) The reason for this is that the inferential properties of “logical" expressions of natural language are generally far more complex (and also less determinate) than those of the logical constants that we normally use to regiment them.

What does this show us regarding the nature of logical laws? Put briefly, I think that what we take to be a logical law is a rule of a formal language that we find indispensable for systematizing certain basic rules of natural language. Thus MP is a logical law as it is hard to imagine a formal language capable of usefully formalizing the whole of natural language which would lack an implication governed by this law. It follows that a logical law is a law not so much in the sense of a natural law, i.e. of a discovered natural regularity, but rather in the sense of a linguistic rule, which is first present, in a tentative form, in our natural language, and then fortified and raised to a true law when canonized by our logical theory.

There is one more misconception we should avoid when taking the laws of logic as rules of reasoning. We have already rejected the view that the rule tell us directly which beliefs to hold. However, here we must reject even the more general view that the laws are any kind strategic instructions telling us how to manage the system of our beliefs to keep it in good shape. From the viewpoint advocated here, this is not true, for the laws are not strategic, but rather *constitutive* rules, rules constitutive of (the meanings of) logical constants. Hence, rather than telling us how to think or how to manage our beliefs, they produce, as it were, “material" with which to think, of which to compose some complex beliefs.

Take MP: It is properly so called only insofar as $\rightarrow$ is an *implication.* (Note that were it a conjunction, the rule would still be valid – but *such* a rule is certainly not what we call MP.) But it is hard to imagine how to characterize implication, as contrasted with other kinds of operators, without including MP. (Someone might object that we can find a logical system in which implication does not obey MP, or does not obey it unexceptionally. The reply is that if there is an implication not obeying MP and if it is still to be a specific kind of operator distinguishable from other operators, then there must be some *other* rules – or at least features of its logical behavior – that characterize it. And I do not see anything that might be generally acceptable; so I think that it is necessary to stick to MP and to conclude that if an operator is called implication and does not obey MP, then it is so called only by courtesy[13].)

Here we may instructively refer to the well worn comparison of the laws of logic with the rules of chess. Laws like MP or EM are much more similar to the rules constitutive of chess (the rules delimiting the permitted kinds of moves) than to the rules that would instruct us how to play chess so as to improve our chance of winning. And just as we can see the constitutive rules of chess as “producing" individual pieces, like pawns, rooks, bishops etc., which are what we can then rally to lace into the opponent, so we can see the laws of logic as “producing" logical constants, like negations, conjunction, implication, etc., which we can then use to engage in our human kind of “logical", “propositional" or “rational" thinking, especially reasoning.

[13] In natural language, on the other hand, we can assume only an approximate match – we cannot assume that natural language expressions will exactly fit with the artificial categories.

9 Conclusion

I think that logic is secondary to reasoning: with a certain oversimplification we can say that logic is to reasoning as physics is to the swarming of the natural world. Logic offers theories of reasoning, analogously to physics offering theories of behavior of spatiotemporal things. And just as physics also does, logic accounts for its subject matter in terms of idealized models, with the consequence that the laws it formulates apply immediately and unexceptionally to the models, but only in a mediated way to the original subject matter.

And once we distinguish between the natural languages, which are the natural vehicles of our reasoning, and artificial languages, which act as the models, we can depict the parallel even much more concretely. The role of the data (which, in case of physical theories result from various kinds of measurements of the world) is played by the fact concerning the inferences that are taken and treated for correct by the speakers of the natural languages (which, again, can be measured, though in this case by methods of sociology, which are less exact and reliable than those used by physics).

There are, of course, important differences between logic and physics. A crucial one is that what logic accounts for are rules, which can be themselves influenced by logical theories. Thus – like in ethics and unlike in physics – there is a feedback in which the theories may make us not only recategorize the data, but modulate – be it only slightly – the stream of the data, by changing the behavior of the subjects who produce them. In this sense the reflective equilibrium yielding our logical laws not only homes in on the most effective conceptual framework for our accounts, but also plays an active role in what is to be accounted for.

Also like in ethics and unlike in physics, the laws of logic advise us what to do, in particular how to reason. And here we must be careful not to mistake logical laws, which mostly delimit the space in which reasoning may take place, and which constitute the equipment needed to do so, for rules that advise us how to reason effectively and fruitfully. From this viewpoint, the laws of logic can mostly be seen as constitutive of the meanings of logical constants – *viz.* as analytic truths implicitly defining them.

It is, however, necessary to keep in mind that what is in play are always *two* kinds of languages: there is the messy, but conceptually binding natural language and there are the exact, but unbinding formal languages. It is only when we achieve the required harmony between them, making one of the latter ones a prism through which we see the former one (the fine-tuning of the harmony being achieved in the process of the reflective equilibrium), that the two very different entities interconnect to yield something that is both exact and binding – and what we tend to call logical laws.

References

Brandom, R. (1994). *Making it explicit: Reasoning, representing, and discursive commitment*. Cambridge (Mass.): Harvard University Press.

Broome, J. (1999). Normative requirements. *Ratio*, *12*(4), 398-419.

Dutilh Novaes, C. (2015). A dialogical, multi-agent account of the normativity of logic. *Dialectica*, *69*(4), 587-609.

Field, H. (2009). What is the normative role of logic? , *83*(1), 251-268.

Frege, G. (1918). Der gedanke. *Beiträge zur Philosophie des deutschen Idealismus*, *2*, 58-77. (English translation: The Thought, *Mind, 65*(259), 1956, 289-311.)

Goodman, N. (1983). *Fact, fiction, and forecast*. Cambridge (Mass.): Harvard University Press.

Harman, G. (1986). *Change in View (Principles of Reasoning)*. Cambridge (Mass.): MIT Press.

Hjortland, O. T. (2017). Anti-exceptionalism about logic. *Philosophical Studies*, *174*(3), 631-658.

Kahneman, D., & Tversky, A. (1996). On the reality of cognitive illusions. *Psychological Review*, *103*(3), 582-591.

Laden, A. S. (2012). *Reasoning: A social picture*. Oxford: Oxford University Press.

Mercier, H., & Sperber, D. (2017). *The enigma of reason*. Cambridge (Mass.): Harvard University Press.

Milne, P. (2009). What is the normative role of logic? *Proceedings of the Aristotelian Society, Supplementary Volume*, *83*, 269-298.

Peregrin, J. (2014). Rules as the impetus of cultural evolution. *Topoi*, *33*(2), 531-545.

Peregrin, J., & Svoboda, V. (2016). Logical formalization and the formation of logic(s). *Logique et Analyse*, *59*(233), 55-80.

Peregrin, J., & Svoboda, V. (2017). *Reflective Equilibrium and the Principles of Logical Analysis: Understanding the Laws of Logic*. New York: Routledge.

Priest, G. (2016). Logical disputes and the apriori. *Logique et Analyse*, *59*(236), 347-366.

Quine, W. V. O. (1960). *Word and object*. Cambridge (Mass.): MIT Press.

Rawls, J. (1971). *A theory of justice*. Cambridge (Mass.): Harvard University Press.

Russell, B. (1919). *Introduction to Mathematical Philosophy*. London: Allen & Unwin.

Russell, G. (2015). The justification of the basic laws of logic. *Journal of Philosophical Logic*, *44*, 793-803.

Shapiro, S. (2001). Modeling and normativity, how much revisionism can we tolerate? *Agora*, *20*(1), 159-173.

Steinberger, F. (in press). Consequence and normative guidance. *Philosophy and Phenomenological Research*.

van Benthem, J. (2008). Logic and reasoning: Do the facts matter? *Studia Logica*, *88*(1), 67-84.

Wason, P. C. (1968). Reasoning about a rule. *The Quarterly journal of experimental psychology*, *20*(3), 273-281.

Way, J. (2010). Defending the wide-scope approach to instrumental reason. *Philosophical Studies*, *147*(2), 213.

Williamson, T. (2017). Semantic paradoxes and abductive methodology. In B. Armour-Garb (Ed.), *Reflections on the Liar* (p. 325-346). Oxford: Oxford University Press.

Wittgenstein, L. (1956). *Bemerkungen über die Grundlagen der Mathematik*. Oxford: Blackwell. (English translation: *Remarks on the Foundations of Mathematics*, Blackwell, Oxford, 1956.)

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