

Evidence in Logic*

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Abstract

The historical consensus is that logical evidence is special. Whereas empirical evidence is used to support theories within both the natural and social sciences, logic answers solely to *a priori* evidence. Further, unlike other areas of research that rely upon *a priori* evidence, such as mathematics, logical evidence is *basic*. While we can assume the validity of certain inferences in order to establish truths within mathematics and test scientific theories, logicians cannot use results from mathematics or the empirical sciences without seemingly begging the question. Appeals to rational intuition and analyticity in order to account for logical knowledge are symptomatic of these commitments to the apriority and basicness of logical evidence. This chapter argues that these historically prevalent accounts of logical evidence are mistaken, and that if we take logical practice seriously we find that logical evidence is rather unexceptional, sharing many similarities to the types of evidence appealed to within other research areas.

1 Introduction: What's Special about Logic?

The historical consensus is that logical evidence is special. Unlike within the natural sciences, logical beliefs cannot be supported by appealing to empirical observations. After all, no physical state of affairs directly demonstrates that a rule of inference is valid, and even if we attempted to *infer* the truth of a logical claim from empirical evidence, this would itself require us to *use logic* in order to infer the consequences of such evidence. Thus, rather than empirical evidence providing support for our logical beliefs, we would inadvertently be presupposing the truth of logical claims in order to use such empirical evidence (Shapiro 2000). Logical evidence then must be *a priori*. However, logical evidence is also dissimilar from other traditional *a priori* areas of enquiry, such as mathematics. For whereas in mathematics we can presume the validity of logical inferences in order to establish mathematical results,¹ this possibility is

*Non-citable pre-print. Forthcoming in *The Routledge Handbook of the Philosophy of Evidence*, M. Lasonen-Aarnio & C. Littlejohn (eds.). Routledge.

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¹Though note this does not mean we always need to presume the same logical inferences as being valid within mathematics. Different results from different mathematical research

not open to us when establishing truths in logic without begging the question. Logical evidence then is basic in a way that other evidence is not, for much of our other evidence presumes logical knowledge, without the inverse being true. We require logic to establish mathematical truths, test our scientific theories, and engage in rational debate. Thus, it's unclear how any of this knowledge from other domains could be relied upon as evidence to either support or undermine our logical beliefs (Russell 2014). The views that logical evidence is *a priori* and epistemologically basic are two of the traditional tenets of *logical exceptionalism*, the thesis that logic is exceptional as a science (Martin & Hjortland 2022),² and are widely found in the historical and contemporary literature (Kant 1998; Frege 1950; Dummett 1978b; Boghossian 2000).

It seems then that logical evidence requires its own treatment. Nor is determining the epistemology of logic purely of academic interest. There is now a very practical need to establish how we come to know logical claims, with a plethora of competing logics at our disposal that disagree over which rules of inference are valid. Further, these rules of inference under dispute often play an important role within mathematical and scientific reasoning. For example, advocates of classical and glutty paraconsistent logics disagree over whether inconsistent premises entail any arbitrary proposition (Priest, Tanaka and Weber 2018), with members of the latter family of logics often invalidating important rules of inference such as *modus ponens* and the disjunctive syllogism. Given that both rules of inference play an important role within scientific practice, sanctioning predictions and establishing consequences for empirical findings, it is of paramount importance we establish whether we are justified in using these rules of inferences. Yet, in order to make a principled decision over which rules of inference we ought to license, we must choose between the competing logics we have available to us based upon sound criteria, which subsequently requires an understanding of what constitutes logical evidence. It is the complications that arise from providing just such an account of logical evidence which is the subject of this entry. In what follows, through consideration of the traditional

programmes can presuppose the validity of divergent logical inferences (see Shapiro 2014, Ch. 3).

²These are by no means the only tenets of logical exceptionalism, however. For example, there is the purported special feature of logic that it is *formal*, whatever exactly that entails (see MacFarlane 2000). Kant, for example, tells us that “the boundaries of logic, however, are determined quite precisely by the fact that logic is the science that exhaustively presents and strictly proves nothing but the formal rules of all thinking...it is thereby justified in abstracting—is indeed obliged to abstract—from all objects of cognition and all the distinctions between them” (1998, Bviii-ix). Related is the famous claim, made by both Kant (1998, A52/B76; 1992, 12) and Frege (1950, §14; 1965, xv), that logic is *general* in that its rules provide prescriptions for all thoughts, not just thought related to a particular domain. It is in this sense that the logical laws, unlike other scientific laws, are *laws of thought*, “boundary stones set in an eternal foundation, which our thought can overflow, but never displace” (Frege 1965, xvi. Cf. MacFarlane 2002 for more on the relationship between the *formality* and *generality* of logic). However, given that these further tenets of logical exceptionalism are not strictly putative properties of logical *evidence*, they are not of particular interest for this chapter. For a detailed discussion of these traditional properties of logic, see Martin & Hjortland 2022.

accounts of logical epistemology, we propose that logical evidence is in fact not exceptional. Instead, logical practice suggests the reasons advanced to support logical claims share many similarities to reasons proposed within other research areas, supporting *anti-exceptionalism about logic* (Hjortland 2017a). Logical evidence isn't so special after all.

2 Two Traditional Exceptionalist Accounts of Logical Evidence

Two *exceptionalist* accounts of logical evidence have dominated the philosophical landscape (Martin 2021b; Martin & Hjortland 2022). The first, popular with rationalists, is that we come to recognise the truths of logic, just like other necessary truths, unmediated though a distinctive form of mental insight (Bonjour 1998). Having the intuition *that p* is sufficient (if defeasible) evidence for *p*. The second account, popular with many empiricists and made famous by the logical positivists, is that logical sentences are true purely in virtue of their meaning (Carnap 1937), and consequently that understanding the meaning of a logical sentence constitutes sufficient evidence for its truth or falsity (Ayer 1936). Both of these epistemologies of logic then emphasise the *apriority* and basicness of logical knowledge. Neither allows for sensory data to justify any of our logical beliefs, and neither proposes that logical knowledge presupposes evidence from other research areas. The disagreement between the two is over the source of this *a priori* basic knowledge, whether it is to be found in some quasi-perceptual intellectual faculty or linguistic proficiency.

According to *logical rationalism*, we can account for the *apriority* and basicness of logical evidence in terms of an immediate awareness of truth or validity through introspection; we simply *see* that the relevant propositions must be true, and the inferences valid. This view can be traced back to at least Descartes, who emphasised that logical inferences are “continuous and uninterrupted movement of thought in which each individual proposition is clearly intuited” (Descartes 1985, 15), however a clear statement that we come to know logical *propositions* through mental insight does not come until later.³ A clear case can be found in

³A significant complication that arises when discussing *logical justification* and *evidence*, which historical authors such as Descartes were seemingly unaware of, is the need to distinguish between two types of logical justification: justification for *holding certain logical beliefs*, i.e. having good reason for believing certain logical propositions are true, and justification for *inferring according to certain rules of inference*. The distinction is necessitated by, among other reasons, the *Lewis Carroll problem* (Carroll 1895) which shows that the warrant we have for inferring according to a law of inference cannot simply be explained in terms of an acceptance of a proposition expressing the inference's validity, on pain of an infinite regress. Consequently, there are two distinct, but connected, projects within logical epistemology: establishing what justifies our logical beliefs, and what justifies our inferring according to certain fundamental logical rules of inference, such as *modus ponens*. (For more on this distinction, see Boghossian 2000.) The present discussion is primarily concerned with the

Gödel's (1964, 271) discussion of the continuum hypothesis in set theory:

[D]espite their [sets'] remoteness from sense experience, we do have something like a perception also of the objects of set theory, as is seen from the fact that the axioms force themselves upon us as true. I don't see any reason why we should have less confidence in this kind of perception, i.e., in mathematical intuition, than in sense perception.

While some advocates of intuition, most famously Lewis (1983, x), have been keen to think of them as merely beliefs, most conceive of intuitions as conscious, occurrent cognitive states with a unique phenomenology, suggestive of a quasi-perceptual sense (Koksvik 2017), as hinted at in the Gödel quote above. (For reasons to think of intuition as a quasi-perceptual source of evidence, rather than simply beliefs or dispositions to believe, see Chudnoff 2011.) According to rationalists, in being phenomenologically similar to perceptual states, intuitions are able to represent states of affairs, providing us with evidence for the truth or falsity of their contents, including logical propositions:

When you have an intuition that A , it *seems* to you that A ... [understood as a] genuine kind of conscious episode. For example, when you first consider one of de Morgan's laws, often it neither seems true nor seems false; after a moment's reflection, however, something happens: it now just seems true. (Bealer 1998, 207)

Again, we simply *see* (or, it *seems to us*) that the relevant proposition is true, or inference valid. To this extent, the epistemology of logic is similar to that of other basic conceptual truths, such as that no object can be both red and green all over (BonJour 1998, §4.2), and geometrical truths, such as that every diameter of a circle determines a line of symmetry for it (Chudnoff 2011, 636).

In comparison to the *logical rationalists*, who hypothesise a whole new cognitive faculty to accommodate logical (and other fundamental items of) knowledge, *logical semanticists* offer a deflationary account of logical knowledge and evidence: we can gain evidence for the truth or falsity of a logical sentence simply by understanding the meaning of its constituent parts. With its genesis in Hume's (1975, Sec. 4, Pt. I) distinction between "Relations of Ideas, and Matters of fact", logical semanticism can be seen historically as a consequence of an attempt to explain the necessary truth (and falsity) of logical and mathematical propositions without needing to hypothesise any metaphysically dubious notion of necessity. If some truths are necessary, this is because of a necessity borne out of language, rather than reality. It is for this reason that, for the logical positivists, logical propositions lack any factual content, for they can be neither

former project, and thus with what constitutes evidence for endorsing logical propositions, and consequently endorsing one logic over another. While the conclusions highlighted here will have impact upon the latter project, unfortunately discussion of such points would take us beyond the scope of the present chapter.

empirically verified nor falsified (Ayer 1936, 73). Logical semanticism was seen to be a suitable middle-ground for the empiricist, between the unwanted appeals to pure reason by the rationalist and the radical empiricism of J. S. Mill (on which, see section 4 below). Appeal to definitions allowed the empiricist to maintain the *apriority* and necessity of logic without the rationalist baggage of intuitions (Carnap 1963, 46).

As logical semanticism was originally born out of a thesis regarding how logical propositions came to be true and false, tied up within the logical positivist account of logical epistemology was an account of the genesis of logical truth. Consequently, logical positivists were committed to two distinct claims about the analytic status of logical claims, although not well recognised at the time – one *metaphysical* and the other *epistemological* (Boghossian 1996):

Metaphysical Analyticity: Logical propositions are true (or false) solely in virtue of the meaning of their constituent parts.

Epistemological Analyticity: Evidence for the truth (or falsity) of logical propositions consists solely in understanding the meanings of the constituent parts of the propositions.

Traditionally, the epistemological analyticity of logical propositions flowed directly from their metaphysical analyticity. Once we admit that the proposition’s truth (or falsity) is dictated solely by the meaning of the terms contained within it, all we must do then to recognise its truth (or falsity) is grasp its meaning. This is perhaps clearest in Ayer’s discussion of logic, in which he first defines analytic propositions as those whose “validity depends solely on the definitions of the symbols it contains,” and then proposes that in order to know such claims, all one must do is understand the meaning of the terms included:

If one knows what is the function of the words ‘either’, ‘or’, and ‘not’, then one can see that any proposition of the form ‘Either p is true or p is not true’ is valid. (Ayer 1936, 79)

For the modern advocate of *logical semanticism*, however, it is not necessary to endorse both versions of analyticity. While epistemological analyticity follows neatly from metaphysical analyticity, the inverse is not true. One can consistently propose the possibility of inferring the truth of the proposition ‘All Germans are Europeans’ solely from the meaning of its constituent parts without admitting that the proposition’s truth is due solely to its meaning, rather than to facts about Germans and Europe (see Boghossian 1996; Williamson 2007, Ch. 3). Indeed, all that the logical semanticist requires in order to accommodate the *apriority* of logic, while evading the need to posit a special rational faculty such as intuition, is to endorse epistemological analyticity.⁴ This is particularly welcoming for the logical semanticist as, by not committing herself to

⁴Of course, without accepting metaphysical analyticity, it is not so easy for the modern empiricist to explain the putative *necessity* of logical and mathematical truths without ad-

metaphysical analyticity, she can then avoid Quine's (1935 & 1960) early devastating criticisms of Carnap's attempt to provide an account of logical necessity via linguistic conventions, and thus metaphysical analyticity.

By divorcing epistemological analyticity from metaphysical analyticity, the logical semanticist no longer need to suppose that logical propositions are true solely in virtue of the meaning of the constituent terms, and consequently that the proposition's truth is due to an act of stipulation and convention. Instead, she can be solely committed to the claim that once we fully understand the constituent parts of a logical proposition, we will be able to reliably ascertain its truth or falsity.

While *logical rationalism* and *semanticism* offer the two main theories of logical evidence for the logical exceptionalist,⁵ it is not always clear which of the two theories exceptionalists endorse. A famous case in point here is Frege. While a staunch logical exceptionalist, Frege never provides a detailed enough account of logical epistemology to be able to fit his theory of logical evidence into one of the two camps. Frege is undoubtedly more preoccupied with accounting for the epistemology of arithmetic, given that many propositions of arithmetic are not self-evident and "every assertion that is not completely self-evident should have a real proof" (Frege 1952, 164). In comparison, the primitive logical laws are self-evident (Frege 1965, xvii) and thus do not require a proof, yet it's unclear exactly how we should understand the epistemic notion of *self-evidence* here given that it's consistent with both a rationalist and semanticist interpretation.⁶ The propositions could be self-evident in that they immediately *strike*

mitting some notion of metaphysical necessity. However, such a commitment seems to be less of a concern for modern empiricists.

⁵There is a third exceptionalist theory of logical evidence found in the contemporary literature, similar to *logical semanticism*, which puts stress on the *grasping of conceptual content* rather than the understanding of meaning (see Giaquinto 1996 and Peacocke 1993 & 1998). This *logical conceptualism*, which proposes that fully grasping logical *concepts* is evidence enough for establishing the truth (or falsity) of logical propositions, did indeed seem to be a distinct position to *logical semanticism* when the latter position included claims regarding the conventional status of truths of logic. After all, the contents of concepts are not matters of convention in the same way that the meanings of sentences are. However, now that *logical semanticism* has rid itself of this metaphysical baggage, while there may be slight differences between how meanings and conceptual contents are individuated, it is quite clear that most of the concerns over *logical semanticism* will hold also for *logical conceptualism* (Williamson 2007, Ch. 3). This will hold as equally true of the concerns we raise over *logical semanticism* in the following section.

⁶Interestingly, in establishing how the truths of arithmetic can be justified, Frege attempts to demonstrate that arithmetical truths are analytic. Yet, by "analytic", Frege does not mean the same as either *metaphysical* or *epistemological* analyticity. Rather, according to Frege, a proposition is analytic if in attempting to prove the proposition "we come only on general logical laws and on definitions" (Frege 1950, §3). Now, of course, these general logical laws would themselves, due to reflexivity, be analytic in a trivial sense. However, given that Frege's whole notion of analyticity is meant to demonstrate that other propositions can be justified in virtue of the general logical laws, the analyticity of these laws does not tell us anything whatsoever about how we should come to recognise these primitive logical truths in the first place. Indeed, we are told that "the question why and with what right we acknowledge a law

us as true (rationalism), or because once we understand the proposition it is *obvious by its meaning* that it is true (semanticism).

While it would be neat and tidy to be able to place each logical exceptionalist's view of logical evidence into one of the camps, that won't be necessary here. We will leave historical exergeses to elsewhere. For present purposes, it will suffice to recognise that *logical rationalism* and *semanticism* are the two live options for an exceptionalist theory of logical evidence.

3 Weaknesses of Logical Rationalism and Semanticism

Both *logical rationalism* and *semanticism* suffer from their own particular weaknesses, many due to the general features of the type of evidence they postulate. Logical rationalism, in its appeal to a new quasi-perceptual source of knowledge, leaves itself open to the accusation that this supposed ability is rather mysterious, and that it is unreasonable within a naturalistic worldview to suppose that we could have direct access to the world (whether it be concrete or abstract), purely through our mind (Devitt 1998). Further, as proponents of rational intuition have consistently failed to provide details of what intuition is, and how this mental insight provides us with access to the world, there is the continued concern that 'intuition' is simply the "name for the mystery we are addressing [in accounting for *a priori* knowledge], rather than a solution to it," (Boghossian 2000, 231. Cf. Boghossian 2001). Some have even gone so far as to suggest that, contrary to philosophical tradition, there is no special type of evidence picked out by talk of 'intuition' (Cappelen 2012), and that consequently philosophers would be "better off not using the word 'intuition' and its cognates" (Williamson 2007, 220). Additionally, even if we admit that there is a special intellectual faculty, intuition, we might be sceptical of its reliability, and thus ability to furnish us with knowledge of the world. (Recent findings from experimental philosophy put stress on exactly this point. See, for example, Swain, Alexander & Weinberg (2008).) Indeed, it is one thing for a source of justification to be fallible, and a whole other to be wholly unreliable. If intuitions fall under the latter category then they will constitute little to no evidence at all, whether for the truth (or falsity) of logical or any other type of claim.

Advocates of epistemological analyticity face their own problems, ranging from classic Quinean (1951) concerns over whether any significance can be placed on the notion of 'synonyms', and thus whether any reasonable line can be drawn

of logic to be true, logic can answer only by reducing it to another law of logic. Where that is not possible logic can give no answer," (Frege 1965, xvii). For more on the complications that arise in interpreting Frege's epistemology of logic and arithmetic, see Burge (1992), Kitcher (1979), Ricketts (1997), and Weiner (2009).

between analytic and synthetic propositions, to more moderate concerns over the indeterminacy of meaning, based on lexical complexities, ensuring that in non-technical circumstances instances of epistemology analyticity are minimal (Giaquinto 2008). Further, it has recently been argued by Williamson (2007, Ch. 4) that linguistic competence is not sufficient to ensure acceptance of a proposition, for the shared understanding of terms can always be compensated by divergent theoretical commitments, ensuring disagreement over the truth of the proposition. Take, for example, the proposition ‘Some foxes are foxes’. This is a paradigm example of a proposition that one can be justified in believing to be true simply via understanding the meaning of the constituent terms. Yet, there are good theoretical reasons one could have for not accepting the proposition, even if one was a highly competent English speaker. For example, imagine someone who accepted a pragmatic theory of truth, so that truth should be understood in terms of warranted assertibility. Imagine also that they take a very strict interpretation of Grice’s (1975) conversational maxims, so that one should not assert any claim which could be misleading. It would be reasonable for this individual, while accepting that indeed every fox is a fox, to deny that we are warranted in asserting that *some* foxes are foxes, given that we are fully aware that *every* fox is a fox. This would not be a failure on their part to understand the meaning of the word ‘some’. They may even acknowledge in a logic class that some members of one class A being members of another class B does not preclude that every member of A is also a member of B, and thus that one can be warranted in asserting that ‘Some foxes are foxes’ and later that ‘All foxes are foxes’ without contradicting oneself. However, once we are aware that, in fact, *every* fox is a fox, it would be highly misleading to assert that ‘*some* foxes are foxes’, given that in this case we would be withholding pertinent information we possess. Subsequently, so they reason, we are not warranted in asserting the latter proposition, and thus it shouldn’t be recognised as true. Here, then, is a case in which an individual understands perfectly well the proposition, but fails to acknowledge it as true given theoretical commitments.

There may be reasonable responses to these concerns raised against logical rationalism and semanticism. Yet, this is not the place to fully evaluate the existence, and general reliability, of either rational intuition or epistemological analyticity.⁷ Instead, we are interested in the applicability of both forms of evidence to logic. Even if some propositions can be known through intuition or meaning alone, can these forms of evidence account for logical knowledge? Our answer is a resounding no. The best evidence we can provide for this claim is the inability of both to explain actual logical disagreements. If neither logical rationalism nor logical semanticism can account for the types of evidence that logicians actually use in logical arguments, then this must count against the theories of evidence rather than logical practice itself (Martin 2021b; 2022).

⁷For recent detailed accounts and defences of rational intuition see Bengson (2014), Chudnoff (2013; 2017) and Climenhaga (2017), and for a recent well-formed defence of epistemological analyticity see Boghossian (1996 & 2011).

According to *logical rationalism*, the *apriority* of logical knowledge is explained in terms of an internal awareness of the relevant proposition’s truth or falsity. We simply *see* that the propositions must be true, and the inferences valid. This means that if our interlocutor fails to share our intuitions on these fundamental matters, there is little we can do. They are simply not looking hard enough. In comparison, logical semanticists appeal to a grasping of the meaning of the constituent parts of the logical proposition to explain our coming to recognise its truth or falsity. Consequently, if our interlocutor fails to assent to the proposition we recognise as a truth, this is simply because she has misunderstood it. All we can do in this case is point out its meaning even more explicitly.

This ensures that, if *logical rationalism* or *semanticism* are correct, we ought to expect actual logical debates to be almost exclusively full of direct appeals to intuition (in the case of logical rationalism), or to the meaning of the propositions under dispute (in the case of logical semanticism). But this is not the case. In advocating a logic, most parties will provide a far more varied evidence base than simply intuitions or definitions. Indeed, as in other areas of research, the fruitfulness of one’s definitions often need to be *argued for*, such as when relevantist logicians offer the advantages of their non-classical notion of ‘logically follows from’ (Anderson & Belnap 1975), and while accommodating intuitions can sometimes play a role in logical theory-choice, the ability to solve theoretical problems are as important for logics. In important areas of dissent, like theories of truth or vagueness, philosophers of logic often agree on many of the problems to be solved, but disagree on which theory best solves the theoretical problems.⁸ But if logical rationalism and semanticism are not corroborated by actual debates about logic, where do we turn for an account of evidence in logic?

4 Logical Anti-Exceptionalism

One possibility is that logical rationalists and semanticists exaggerate the extent to which logical evidence differs from that in other fields. According to logical anti-exceptionalists, evidence for logical theories is not wholly *a priori*, and thus, just as in other scientific fields, empirical evidence *can* play a role in logical theory-choice. Logical knowledge, therefore, fails to have the privileged and foundational role envisaged by the logical rationalists and semanticists. Logical evidence isn’t special.

By rejecting logical apriorism, the anti-exceptionalist owes us answers to two questions: i) What exactly counts as evidence—and *a posteriori* evidence—for a logical theory? ii) How can empirical evidence provide support for logical propositions? Several different versions of anti-exceptionalism, attempting to

⁸For more on the forms of evidence given within prominent logical debates and their deviation from rationalism and semanticism, see Martin (2021b; 2021c; 2022), Martin & Hjortland (2021), and Williamson (2007).

answer these questions, have been proposed. Firstly, early anti-exceptionalists, such as Mill, endorsed inductivism about logic, proposing that logical theories are supported directly by inductive inferences from experience, while later anti-exceptionalists such as Quine were motivated by naturalism, so that logical theories were evidenced more indirectly by findings from the natural sciences. In contrast, contemporary anti-exceptionalists construe logical evidence more broadly to include data about vagueness, semantic paradoxes and set theory, in addition to empirical findings.

An early attempt to provide a non-apriori account of logical evidence is found in John Stuart Mill’s (1963) *The System of Logic*. While Mill holds that syllogistic inferences are *verbal*, in the sense that the conclusion is already contained in the premises, he insists that logic also contains *real* inferences.⁹ Whereas verbal inferences only provide information about the meaning of expressions, real inferences provide information about the world. Crucially, these latter inferences also rest on an inductive justification, based upon our everyday experiences. Examples of such inductive generalizations include fundamental logical laws, such as the laws of non-contradiction and excluded middle. These principles outstrip what we can know simply in virtue of the meanings of the involved expressions, and serve to explain how reasoning in, say, arithmetic can lead to genuinely informative conclusions.

Mill’s inductivism ultimately failed to garner much support, as a result of Frege’s (1950, §§7-10) devastating criticisms of his philosophy of mathematics and psychologism in the *Grundlagen*.¹⁰ As Mill required that knowledge of every arithmetical truth be explained by direct empirical observation, Frege rightly complained that this would require a confirming observation for each distinct sum—an unreasonable requirement, given the paucity of ordinary objects in our everyday environments and the large numerals we encounter in even simple sums (Frege 1950, §7). After this, it was clear that if empirical evidence were ever to inform logic, it could not simply be through inductive generalizations.

It is only with the advance of philosophical naturalism and Quine’s writings that anti-exceptionalism received serious consideration in the philosophy of logic. Quine’s brand of anti-exceptionalism was a product of the naturalism and confirmation holism presented in his *Two Dogmas of Empiricism* (Quine 1951). While Quine’s naturalism requires that empirical evidence be the ultimate arbiter of a theory, his holism denies that individual claims are directly confirmed or falsified by experience. Instead, it is entire theories—or, at least chunks of theories—that receive (dis)confirmation together.

By accepting naturalism, Quine rejects exceptional apriori forms of evidence,

⁹See Skorupski (1998) and Godden (2017) for details on Mill’s account.

¹⁰See Godden (2017) for more on the psychologistic underpinnings of Mill’s inductivism.

and thus requires an alternative account of how formal theories of logic and mathematics are justified. Yet, while Quine’s naturalism requires that the evidence in support of logical propositions must ultimately derive from experience, he fails to draw the same conclusion as Mill, that logical propositions are supported directly by observational data or inductive generalisations. Instead, in order to accommodate logical and mathematical evidence, Quine appeals to confirmational holism and the principle of conservatism. The truth of logical propositions are confirmed as part of a larger cluster of propositions, including non-logical propositions from the other sciences, which have been found to be predictively successful together. Thus, there is no difference in the kind of evidence which justifies logical and non-logical propositions:

Mathematics and logic are supported by observation only in the indirect way that those aspects of natural science are supported by observation; namely, as participating in an organized whole which, way up at its empirical edges, squares with observation. I am concerned to urge the empirical character of logic and mathematics no more than the unempirical character of theoretical physics; it is rather their kinship that I am urging, and a doctrine of gradualism. (Quine 1986, 100)

As a result, ordinary empirical evidence for scientific hypotheses provide evidence for logical theories, anchoring the laws of logic and mathematical axioms in the scientific theories they contribute to. Logical theory choice is just considered to be part of the wider game of scientific theory choice.¹¹

But, if logical and non-logical theories face the tribunal of empirical evidence together, as a cluster of theories, what explains our reluctance to reject logical laws, rather than those from the natural sciences? It is here that Quine appeals to methodological conservatism. While logical laws are ultimately supported by empirical evidence, just like all other laws, these logical laws do hold a distinguished position within the ‘web of belief’ (Quine 1951). But, a distinguished *position* in the web does not entail the propositions are justified by a distinguished form of *evidence*! Since giving up a logical law will have wide-reaching consequences for our entire system of beliefs, logical laws have a central position within our theoretical commitments. In combination with Quine’s advice that we ought to make the minimal changes necessary to our web of commitments in order to accommodate empirical findings, the centrality of logic entails such theories are rarely revised. However, even if revision of logical laws is unlikely, Quine insists that it is in principle possible. Indeed, Quine holds that absolutely all theoretical commitments—be they from physics or logic—can be subject to rational revision.¹²

¹¹Quine (1969, 324) says, “I am concerned to demarcate the class of logical or mathematical truths, as I might the class of chemical truths; not to show how or why the evidence for truths in the class differs from the evidence for other truths.”

¹²Both Dummett (1978a, 270) and Haack (1978, 237) have argued that Quine later changed

Conversely, by the same token, no statement is immune to revision. Revision even of the logical law of the excluded middle has been proposed as a means of simplifying quantum mechanics; and what difference is there in principle between such a shift and the shift whereby Kepler superseded Ptolemy, or Einstein Newton, or Darwin Aristotle? (Quine 1951, 40)

Quine is here referring to the proposed revision of classical logic in favour of quantum logic (cf. Putnam 1969). The claim is that quantum mechanics points towards a rejection of the law of distributivity, and therefore a revision away from classical logic. Unlike Putnam, Quine actually rejects the argument in favour of quantum logic, but he nonetheless thinks that the example supports the possibility of a revision of logical laws that is a result of evidence from natural science. If Quine is right that such revisions are possible, and potentially rational, he has given an account of theory choice in logic that is not only non-apriorist, but naturalist.

The claim that logic is revisable was certainly not unique to Quine among his contemporaries. Intuitionists, relevantists, and other nonclassical logicians also offered revisionary arguments. What set Quine's revisionism apart from his contemporaries', however, was his insistence that such revisions ought to be justified solely by evidence from the natural sciences. In contrast, nonclassical logicians often appeal to evidence from outside the natural sciences: intuitionism has been motivated by a constructivist philosophy of mathematics (Heyting 1956) and a number of meaning-theoretic arguments (Dummett 1977; 1991); relevant logics have been motivated by data about the English language indicative conditional (Anderson & Belnap 1975); and an array of paracomplete and paraconsistent logics have been motivated by the semantic paradoxes (Field 2008, Priest 2006b). These examples of logical argumentation have led to a new, contemporary, breed of anti-exceptionalism which is far more liberal in its interpretation of logical evidence. While these contemporary anti-exceptionalists do not (generally) rule out evidence from the natural sciences justifying a revision of logic, the above cases lead them to think that we should also include other forms of evidence. Two significant examples of these are paradoxes and linguistic data.

The Liar paradox, the sorites paradox, and Russell's paradox figure prominently in debates about logic. There is general acceptance within the logical literature that these paradoxes constitute data which logics must accommodate, and that these data can pose problems for certain logics. For example, that classical logic, when combined with a transparent truth predicate and standard arithmetic, trivializes. Consequently, proponents of these logics must recognise these potential troublesome cases by either altering their overall theory in order to

his mind about the revisability of logic, with the introduction of his so-called meaning-variance thesis: a change of logic is a change of subject (Quine 1986). However, see Priest (2006a) for some compelling reasons to think that Quine still subscribes to revisionism in his later work. See also Arnold & Shapiro (2007).

accommodate the paradoxes, or explaining away their apparent deviancy (such as by deeming the troublesome sentences meaningless). In other words, these paradoxical sentences cannot simply be ignored, even if they are recognised and bracketed off for a future occasion. The recognition and acceptance of the role that the logico-semantic paradoxes play within modern logical theory choice is probably the major point of difference between contemporary anti-exceptionalists (e.g. Hjortland (2017a; 2017b), Martin (2021b), Martin & Hjortland (2021), Russell (2014; 2015; 2018), Priest (2006a; 2014; 2016), Williamson (2017)) and Quinean anti-exceptionalists.

Another recognised significant source of evidence within logical theory choice is data about language use (Priest 2014, Russell 2015, Shapiro 2014). Logicians who seek to formalize natural language expressions, such as ‘if...then...’ and ‘not’, rely on competent speakers’ linguistic judgments as empirical evidence. For example, the claim that the English language indicative conditional should be formalized by the material implication has been criticized because indicative claims would come out as true if the antecedent were false or the consequent true. Hence, seemingly false claims like ‘If there are no planets anywhere, the solar system has at least eight planets’, would turn out true.¹³ These counterintuitive features of the material implication are known as the positive and negative paradoxes, and have been used to motivate the conditionals of relevant logics. In fact, most accounts of the logical connectives have been met with criticism at some point, as they are seen to idealize away important natural language features (cf. Strawson 1950, Edgington 2006).

While there is significant agreement between practicing logicians over many of the types of data that logics must accommodate, this of course does not ensure that the parties agree over which theory best accommodates the data. Not only can the parties disagree over which data ought to be prioritised, but what it is to *best fit* the data. Debate over the Liar paradox is a case in point: classical, para-complete, and paraconsistent logicians all respect the Liar paradox as a datum, but have different strategies for how to make their theories of truth align with the evidence. In order to bolster their respective approaches, they offer other corroborating pieces of evidence, such as linguistic intuitions, but also appeal to other selection criteria for theories, such as simplicity, unification, deductive strength or conservativeness. This similarity between logic’s methodology and theory choice in other research areas is emphasised by Priest:

Given any theory, in science, metaphysics, ethics, logic, or anything else, we choose the theory which best meets those criteria which determine a good theory. Principal amongst these is adequacy to the data for which the theory is meant to account. In the present case, these are those particular inferences that strike us as correct or incorrect. This does not mean that a theory which is good in other respects cannot overturn aberrant data. As is well recognised in the

¹³The example is from Bennett (2003).

philosophy of science, all things are fallible: both theory and data. Adequacy to the data is only one criterion, however. Others that are frequently invoked are: simplicity, non-(ad hocness), unifying power, fruitfulness. (Priest 2014, 217)

Logical theories, then, are chosen on the basis of abductive arguments, with theories scored against a number of selection criteria, among them fit with the data, and theory-choice determined by the (implicit) aggregate score of the theories.¹⁴ Combined with the fact that the data theories must accommodate is not wholly a priori, such a methodology ensures that evidence for logical theories is not somehow different in kind to evidence in the other sciences.¹⁵

5 Ways Forward: Potential problems

While a better fit to actual logical practice than logical rationalism and semanticism, Quinean and contemporary anti-exceptionalist accounts of logical evidence are not without their own problems. These problems concern both the particular sources of evidence which various anti-exceptionalists appeal to, and the general abductivist (or, predictivist) methodology proposed for logical theory-choice.

Examples of this former type of concern include pessimism over philosophical naturalism, and using linguistic judgments as data. Using linguistic judgments as a source of evidence for logical theories presupposes that what logical theories are attempting to capture is how logical expressions are actually used, and which logical laws actually govern propositions containing them. Yet, this view is undoubtedly controversial. Other logicians have explicitly based their theory choice not on the basis of which logical expressions we currently use in our vernacular, but which we *ought* to have. For example, intuitionists have objected to classical logic not on the grounds that it misrepresents natural language, but rather that it makes metaphysical or epistemological assumptions with regards to decidability (Dummett 1991). Others have also understood logical theories as offering replacements for natural language expressions, in order to increase expressive precision or power (Eklund 2002; 2017, Scharp 2013). For those who view logical theories as not simply reconstructing the implications of logical expressions within the vernacular, but instead adapting and improving upon them, the use of linguistic evidence to directly motivate a theory is ill-conceived.

The general abductivist approach of the contemporary anti-exceptionalists also faces challenges. While they can more readily account for the sort of data logical

¹⁴For an alternative, but equally anti-exceptionalist account of logical theory choice, according to which logics are assessed by their *predictive success*, rather than simply *fitting* or *accommodating* the current data, see Martin & Hjortland (2021).

¹⁵See also Williamson (2017, 14).

theorizing typically answer too, there is little consensus about the finer details of the methodology. Although anti-exceptionalists, such as Williamson and Priest, seem to agree on a number of the selection criteria for logical theories, they do not agree on which theories best satisfy the conditions. Williamson favours classical logic, while Priest argues that the abductivist method points towards paraconsistency. Underlying the disagreement is a difference in articulation and weighting of the selection criteria. Currently, there is little agreement on which theoretical virtues apply to logical theories and how they ought to be weighted. For example, classicists like Williamson tend to cite deductive strength as a major advantage of classical logic, but recent work has argued that it is far from clear how significant this virtue is (cf. Hjortland 2017a, Martin & Hjortland 2021, Russell 2018).

However, neither the problem of what exactly ought to constitute evidence for a logical theory, nor how we ought to select and weight theoretical virtues within a theory-choice, are particular to logic's epistemology. While both questions are worthy of discussion, the disagreements that inevitably flow from asking them are no more an indication of a fatal flaw with the anti-exceptionalist account of logic than abductivist methodologies within other research areas. These are issues not specific to logic, but concerns raised over theory-choice more generally. In facing these problems then, logical methodology is again not exceptional.

This brings us to a more fundamental worry, and one particular to logical theory-choice—a problem which originally motivated the position that logical evidence was foundational. By denying that logical evidence is constituted wholly of an immediate *a priori* justification for propositions, whether this be an intuition or the grasping of meaning, the anti-exceptionalist must explain how arguments, and thus logical inferences, can justifiably be used to motivate logical theory choice. The concern is that any arguments required to motivate a logical theory-choice cannot themselves be justified without presupposing the validity of certain arguments, and thus prematurely taking a stand on the logical debate at hand. If the objection is left unanswered, it appears to blunt the anti-exceptionalist's attempt at providing an account of how we come to know basic logical laws, for every time we attempt to produce an argument for the law, we end up already presupposing it. This is the very problem that the logical exceptionalist was trying to solve by introducing a special sort of evidence for logical theories. Shapiro (2000, 338) formulates the objection for a Quinean anti-exceptionalist:

Suppose someone is considering a change of logic, because less drastic measures are not working. Presumably the troubled theorist would follow the model for any change in the web. He would replace the old logic with the new one and see how it comes out. That is, the theorist would examine the consequences of the change in logic for the proposed new web of belief. Consequences? Which logic do we use to assess the consequences of different logics? Is there a correct

logic for that, and is this super-logic also just a bunch of nodes in the current web? Regress threatens. Is the super-logic analytic, a priori, or incorrigible?¹⁶

At base, any argument for a logical theory-choice will presuppose the validity of certain logical inferences. Yet, once the argument has motivated a particular theory choice, the resulting logic will either sanction or prohibit the inferences contained within the argument. If the recommended logic validates the argument, then the argument begs the question against those logics which don't recognise the inferences as valid, and if the recommended logic finds the argument invalid, it undermines its own supporting evidence. Either way, we find ourselves having to take a stand on matters of logical validity in order to provide evidence for a theory of logical validity. This is a feature of logical theory choice that separates it from other research areas. Theories within chemistry, economics, or physics can be evidenced without running into worries of justificatory circularity. This is often known as either the *background logic* or *centrality* problem (Martin 2021a; Wright 1986).

Can the anti-exceptionalist answer this concern? There are, it seems, two live options. The first is to insist that, just as with the natural sciences, one uses and works within the framework that one already accepts. This would mean, when considering the available evidence, allowing only the use of those logical inferences marked as valid by the already accepted logical theory. Call this the *intra-framework approach*. Priest (2014) is an advocate of such an approach. According to him, we have to accept that we cannot start the process of theory-choice without presupposing some logical laws, even if the initial choice is unjustified. The best we can do is to revise the theory we have in light of new evidence, and the resulting theory will be a result of the evidence and the initial theory.

The second option is to allow the use of those rules of inference which are not under dispute by the relevant parties. In other words, to take those members within the intersection of the disputed parties' set of valid rules of inference as the common ground. Call this the *inter-framework approach*.

Both options are not without their problems. The *intra-framework approach* would seem to permit two research programmes to use the same evidence to further confirm their own theory, leading to no convergence on the correct logical theory. This result would contravene a basic principle of rationality, that given a complete account of the evidence, all parties ought to converge on the truth, regardless of their starting point.¹⁷ Additionally, if the preliminary work in Woods (2017) on the debate between Tennant and Burgess over the validity

¹⁶Similar objections against Quine's epistemology of logic can be found in Arnold & Shapiro (2007), Boghossian (2000), Field (1996), and Wright (1986).

¹⁷Convergence theorems within Bayesian probability theory are just one explicit recognition of this principle.

of Cut can be generalised, proponents of the *intra-framework approach* cannot preclude the possibility of an agent constantly flip-flopping between various logical theories L_1 and L_2 given the same data set Γ . For while Γ could support advocating logic L_1 while using L_2 as a background logic, once the agent switches to logic L_1 , and thus uses logic L_1 as their background logic, it is possible this combination of Γ and L_1 advocates switching back to L_2 . This would be an uncomfortable result, although further methodological principles might offer comfort, such as Woods' (2017) own *Logical Partisanship* principle, which proposes we ought to only switch logical theories if all of the theories under consideration advocate the same result.

In comparison, the *inter-framework approach* faces the challenge of demonstrating the tenability of its proposal. It would need to be shown that in any given sensical disagreement between logical theories, there are some shared logical rules that could be used to hinge the debate upon. As has been argued by Priest (2006a, Ch. 12), this challenge becomes unmanageable once we allow the disagreement to be between all available logical theories simultaneously, for there are no universally endorsed rules of inference or principles across the logics. The advocate of the *inter-framework approach* then is under the additional burden of showing how we should conceive of these shared grounds between logical theories, given that multiple disputes between logics can occur simultaneously.¹⁸

If successful, the *background logic problem* promises to undermine the tenability of the whole anti-exceptionalist proposal. Given the seeming inability of other accounts of logical evidence, such as logical rationalism and semanticism, to appropriately accommodate logical practice, determining a suitable answer to this problem is one of the most important challenges facing contemporary epistemologists of logic.

¹⁸For an account of what constitute these shared grounds, facilitating such logical debates, see Martin (2021c).

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