Logic and **L**ogical **P**hilosophy
Volume 21 (2012), 127–163
DOI: 10.12775/LLP.2012.008

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LOGIC OR REASON?

Abstract. This paper explores the question of what logic is not. It argues against the wide spread assumptions that logic is: a model of reason; a model of correct reason; the laws of thought, or indeed is related to reason at all such that the essential nature of the two are crucially or essentially co-illustrative. I note that due to such assumptions, our current understanding of the nature of logic itself is thoroughly entangled with the nature of reason.

I show that most arguments for the presence of any sort of essential relationship between logic and reason face intractable problems and demands, and fall well short of addressing them. These arguments include those for the notion that logic is normative for reason (or that logic and correct reason are in some way the same thing), that logic is some sort of description of correct reason and that logic is an abstracted or idealised version of correct reason.

A strong version of logical realism is put forward as an alternative view, and is briefly explored.

Keywords: reason, logic, thought, mathematics, psychology.

Introduction

This paper explores the question of what logic, itself, is not. Specifically it argues against a wide spread, if largely implicit, assumption that logic is any of the following: a model of reason; a model of correct reason; the laws of thought, or indeed is related to reason at all such that the essential nature of the two are crucially or essentially co-illustrative. By reason here I mean what we humans use when we infer or draw conclusions from premises.

An initial assumption of the paper (there is some supporting argument given, but not much since such argument is not the central aim

Received October 15, 2011; *Revised* November 19, 2011
 ISSN: 1425-3305

of the paper) is that our current understanding of the nature of logic itself is thoroughly entangled with the nature of reason: the way we reason, ought to reason or even can reason. Indeed the idea that logic is somehow essentially linked to reason has become almost platitudinous. Thus I refer to this idea as 'the ubiquitous assumption'.

I show that most arguments for the presence of any sort of essential relationship between logic and reason face intractable problems and demands, and fall well short of addressing them. These arguments include those for the notion that logic is normative for reason (or that logic and correct reason are in some way the same thing), that logic is some sort of description of correct reason and that logic is an abstracted or idealised version of correct reason.

I recommend that the ubiquitous assumption be withdrawn and I briefly explore the consequences of such a withdrawal. One such consequence is a freeing of logic from the intractable problems and ultimately impossible demands such a supposition (rightly) makes of our conception of logic and of the role of logic. A less happy consequence, though, may be that we lose an apparently straightforward explanation of the nature of the relationship between our knowledge of logic (our ability to reason logically, and to understand logical structures) and logic itself.

If logic itself is not, or not essentially, constructible (in the sense of being derivable from or essentially tied to what we use when we reason) then the relationship between how we know and what we know of logic seems, on the face of it, harder to account for. That is, once we admit the possibility that logic is not simply, essentially or ideally tied to reason, we also admit the possibility that logic is something other than the product or tool of our mind or constructive ability. Thus, the problem of accounting both for the nature of logic and for our knowledge of it may be deepened the more our assumption of an essential link between reason and logic is undermined.

I don't think this is a bad thing. The main part of the paper argues that the idea that the ubiquitous assumption provides any such straightforward explanation is an illusion anyhow, insofar as any such explanation is encumbered with a host of intractable problems of its own; and the final parts of the paper briefly explore ways in to an alternative, more promising positive account of the relationship between logic and reason and correlatively of our knowledge of logic and logic itself.

The possibility that the ubiquitous assumption is wrong needs to be taken seriously for a variety of reasons, including that recent empirical

evidence seems to suggest it and, at least to some practitioners in the empirical fields, the evidence is compelling; but, even if the evidence does not compel, the bare possibility that the nature of logic is not essentially or crucially tied to correct reason turns out to be an interesting and fruitful one, promising to enrich our understanding of logic.

In short, I hope to make room for the *possibility* that while it may be correct to identify one application of logic as that which we use when we reason logically, this specific application ought not to be considered canonical, nor essential to our understanding of what logic itself is.

The persistent assumption to the contrary risks introducing what could be thought of as a very broad psychologism to our understanding of logic itself, insofar as the supposition that logic does have some such special relationship to human reason brings along with it the notion that the structure that logic captures is, or depends, in some essential or canonical way, on a structure of the human mind — in this case on our capacity to reason logically.

This broad psychologism, perhaps better dubbed logical constructivism, takes logic to be, in essence, something human, or dependent on human thought or practice. Giving a particular, special status to this one application of logic to correct (logical) reason, then, biases the game from the start toward a view of logic as a human construct, tied essentially to human thought. Thus, from the beginning, other possibilities are sidelined. These include the possibility that logic is the structure, not of thought but of reality, or that the deductive structure is an independent entity, existing apart from the practice and perhaps even the existence of human thought.

The structure of the paper is as follows: section 1 locates the assumption I want to challenge. Section 2 introduces some of the issues arising for this assumption, the following few sections go into more depth on a selection of these: sections 3 and 4 highlight some core problems for the proposal that logic is a model of correct reason; section 5 explores a defence of the notion that logic is an abstracted or idealized version of reason; section 6 outlines some of the empirical evidence telling against the ubiquitous assumption and section 7 explores the ramifications of any attempt in general to defend it.

Finally section 8 proposes that the assumption ought to be withdrawn and offers some final speculations as to what the consequences of this withdrawal might be, and some positive suggestions on the nature of the relationship between logic and reason.

Such a withdrawal need not threaten the relevance of logic to thought nor its application to physical reality. It does not necessitate a withdrawal of the claim that logic can apply to a specific domain of reasoning, or of argument. It means, though, that any claim that there is an essential or canonical relationship between logic and reason needs careful explication and explicit caveats if it is to avoid the problems outlined, and indeed before it is able to make much sense at all.

1. The Ubiquitous Claim

At first glance, logic (traditionally, classical logic) does indeed appear to be especially concerned with reason. This idea is encouraged by typical text book introductions to classical logic, wherein it is not uncommon to read something like the following claims: "logic is the study of the methods and principles used to distinguish good (correct) from bad (incorrect) reasoning ... [and] reasoning is a special kind of thinking" (Copi and Cohen [1990, 3–4]), or "logic attempts to make as precise as possible the conditions under which an argument — from whatever field of study — is acceptable" (Lemmon [1978, 1]), and "[arguments are] encounter[ed] ... in our day-to-day experience. We read them in books and newspapers, hear them on television, and formulate them when communicating with friends and associates" (Hurley [1985, 1]).

Indeed, the claim that "Frege's goal ... was to isolate those aspects of language that are required for *reasoning*" (Heck and May [2006, 29]) would hardly raise a single eyebrow or interpretative question among modern logicians and philosophers of logic. Reason is generally interpreted here as something we do, and correct or completed reason as part of, or an idealization of, the structure of human thought or understanding.

Shapiro [2000] challenges this sort of holistic, internal interpretation and argues that at least some very fundamental logic principles may be external to our web of belief.[1] This gives some degree of support for

[1] "Suppose someone is considering a change in 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

the main alternative notion I put forward here: i.e. that the structure of 'reason' that logic describes is not dependent on, nor canonically linked to, any human capacity per se, or at least should not be assumed to be without further argument.

But the possibility that the relationship of logic to reason may be one of an external structure to an idealization of the internal structure means that the initial interpretation of the term 'reason', used in claims regarding the nature of logic, does in fact need further initial evaluation. 'Reason', used in this context, needs to be read carefully — not automatically as internal, or as dependent on, or idealized over, a human capacity per se; but more neutrally — say as a term for whatever that structure is which logic describes, perhaps in its application as a tool for our internal logical reasoning capacity, but not, at least not initially or by fiat, as essentially bound to that capacity.

As such, I am arguing that we should leave interpretative room for the possibility that the 'reason' that logic describes (especially in slogans attributed to Frege) may be entirely independent of human reason and the human web of belief. Thus Shapiro's arguments support the idea I am putting forward here only in so far as they support the possibility of a quite a strong version of logical realism. It is not clear they go so far. Indeed Shapiro's notion of the externality of the a priori status of logic may be thought of as a Carnapian super-framework from which we view the fundamental assumptions of the web of belief; e.g. "if a proposition is a priori, then it has a warrant that can be broken down into pieces, each of which is infallible because it is a definition or some other immediate or trivial consequence of how language works" Shapiro [2000, 334]. In so far as Shapiro's arguments support this more Carnapian type of a priorism, they do not offer direct support to t he ontological independence of logic that I want to consider here.

To be clear, what is under examination here is a persistent modern interpretation of the idea, in a slogan that "the laws of logic [are] the laws of thought" (paraphrasing Heck and May [2006, 29]). The idea under scrutiny here, then, while it can be characterised as a kind of *broad* psychologism, is not *simple* psychologism. It is not the idea (that Frege went to great pains to reject) that logic explicates or underpins actual instances of human thinking.

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super-logic also just a bunch of nodes in the current web? Regress threatens. Is the super-logic analytic, a priori, or incorrigible?" Shapiro [2000, 338]

Indeed *simple* psychologism is relatively easily avoided. But there remains, I believe, a more subtle, broader version — which is constituted by an over emphasis on the relationship between logic and our own empirical practice and vernacular and which constitutes, as such, a particular interpretation of such Fregean slogans above. At its most benign, this interpretation can be represented by the (relatively weak) claim that there is an essential link between logic, language and 'thought' — a vague presupposition that logic is inherently human: that inference and consequence are somehow co-dependent. At the other extreme, though, the claim that logic and reason are essentially or canonically linked can amount to a central assumption in our understanding of the nature of logic. I want to show that, left undefended, this assumption raises more questions than it may appear at first to answer.

The idea that logic and reason (where 'reason' is read in the usual internal way — including our judgements, inferences and arguments) have an important and instructive relationship is not at issue here. Rather, what is at issue is the idea that this particular relationship is essential or canonical for logic. What we use, and what we ought to use, when we reason or infer, may or may not be logical consequence. Similarly, that we can use the rules and structure of a logical consequence relation to reason correctly does not mean that the structure of logical consequence itself is in any way dependent on, or tied in essence to, human thought. One reason to suspect such ideas is that our ability to reason correctly may not have as much to do with logical validity as is sometimes claimed, and it is still something of an open question whether the rules and axioms of a logical consequence relation are even what we ought to use when we want to reason correctly.

But there are other reasons to question the assumption — not the least of which is the initial obvious burden of proof (more reasonably, of some kind of coherent defence) that such a claim left undefended entails. One further reason is that if logic and the way we reason or ought to reason share a canonical connection, then the gaps between logical laws and proofs and intuitively reasonable principles and arguments needs closing, thorough explaining, or to be comprehensively argued away. This is no small task.

This point is implicitly confirmed with each of the frequent appeals to precisely the need to overcome just such a gap in the logician's use of counter examples and in the frequent appeals to intuitively reasonable principles. So such appeals underscore the correspondingly frequent

presence of the assumption itself. The common thought seems to be that an apparently unreasonable logical axiom requires a lot more defending than an apparently unreasonable principle of physics or mathematics. But the assumption underlying this — that logic and reason share a special relationship — is often neither explicitly stated nor defended. Were it to be so, the problem of exactly how to defend such a claim may by now have prompted its withdrawal.

Returning to the point above, perhaps some of the roots of the ubiquitous assumption (but also, from the alternative interpretation of 'reason' suggested above, some of the ground necessary for rejecting it) are to be found in Frege's very clear link between what it is that we judge and what it is that logic studies.

Thus, while it is not precisely Frege's idea that appears in modern contexts, as in the text books cited above and as the general (albeit largely implicit) belief that the "logical principles of inference [are the] ... laws of rational thought taken most generally" (George and Velleman [2002, 17]), it is nonetheless not hard to see how Frege's initial characterisation of the nature of logic might have informed such modern characterisations.

Frege identified 'facts' (construed as the semantic contents of possible judgements) as the proper subject matter of logic. His aim thereby was to "detach a propositional attitude [including judging and inferring] ... from its target" (Coffa [1991, 91]). That 'thought' for Frege is not everyday instances of 'thinking' is almost a platitude, it is so well repeated. But the modern presence of the ubiquitous assumption suggests that human reason and human thought (or normative or idealization versions of these) have come, almost equally platidudinously, to be conflated with what Frege meant when he referred to reason and to thought.

I do not intend to defend a lengthy explication of Frege's work here. I think it is enough to point out that in his initial characterisation of logic as the laws of thought and as "the precise systemization of the canons of reason" (George and Velleman [2002, 15]) Frege likely used the terms 'thought' and 'reason' in a very particular way. Either intentionally or unintentionally, Frege's characterisation of logic leaves room for the possibility that reason, along with judgements, inferences and thoughts, would be around even were there no humans to reason, judge, infer or think. The modern ubiquitous assumption sidesteps this possibility and reads 'rational thought' and 'reason' as inherent in or in some way dependent on us as thinkers and reasoners.

To reiterate: taking Frege's initial characterisation of logic as a proscription for the way we ought to think if we are to be 'reasonable' thus arguably conflates two quite different conceptions of 'reason'. The ubiquitous assumption takes it that what it is for us, in our spoken or written thoughts, to be 'correctly' reasonable is to adhere to what is encoded in logical law. Likewise, it takes the application of logic to what it is that humans use when they reason correctly to be canonical for logic. But given that even Frege's initial characterisation leaves room for the possibility that 'reason' is an abstract structure much like 'thought'; the idea that the 'reason' and 'thought' that logic applies to are essentially our own, or tied in this way to human practice — albeit an idealized or normative version of that practice — is not something we can assume from the outset without further argument.

In challenging the assumption, I want to identify three initial items in play: everyday reason; correct reason — what is normative for the latter; and logical reason — what we use when we reason logically. The last two may come apart or may sometimes coincide. Regarding the first two, we can note that what is normative for our practice is, likely, in some way dependent on or essentially tied to that practice itself. The point I want to make is that this does not mean that logical reason is similarly tied. The move conflating the latter two is the move I want to avoid.

Thus in its strong form the claim I want to contest says that logic is correct reason, or that logic is the laws of thought. In its weaker form (perhaps also the charitable reading of the strong form) the claim says that there is an essential link between logic and the way we ought to reason or 'correct reason', to which logic must be responsible — i.e. there is a canonical application — and that link illuminates, in essential ways, both the nature of logic and the nature of correct reason.

Recalling the point that the assumption can be detected in more places than just the opening phrases of most introductory text books, I pause here to note some examples of appeals to human thought and to what is 'intuitively reasonable'. Alternative or non-classical logics are often motivated and defended by just such appeals. For example, Edwin Mares' discussion of (one of the) paradoxes of material implication includes the observation that:

> the classical notion of validity does not agree with our pre-logical intuitions about where the division between good arguments and non-sequiters should be ... [they do not] coincide with the intuitions that

> we usually would apply when considering whether a proof is good or bad. (Mares [2002, 609])

In a similar appeal, Bryson Brown notes that paraconsistent logics are often defended by the influential view that:

> consequence relations are models of inference [where] by inference we mean the process of adding new sentences to those we've already accepted by reasoning (rather than by observation). But [according to this defence] it is clear that we would never accept every sentence. So if we ever accept inconsistent premises as a starting point for inference, we must use a paraconsistent logic in our inferences. [On the same theme, Brown also notes] after all, we are finite thinkers who do not always see the consequences of everything we accept. (Brown [2002, 630])

Similarly again, Graham Priest includes a transcendental appeal to thought in his defence of paraconsistent logic and dailethism, noting that: "the contradictions involved in the paradoxes of self-reference are, in a sense, inherent in thought ... [and] being inherent in thought, are *necessarily* true" (Priest [2002, 657]).

Without the assumption that logic and reason are canonically related, such examples lose their impact. Indeed they only make sense in the light of the ubiquitous assumption.

Recall too that alternative logics often employ in their defence the general tactic of an appeal to counter examples, in which a classically valid argument is instantiated with a premise/conclusion set demonstrating that the argument form can be counter-intuitive to our *notion* of validity. But of course, counter examples appeal to our intuition — to what *seems* valid, rather than to what is valid (in the logic being questioned). The standard appealed to in these cases is an internal, intuited one, as opposed to one formalised in any particular logic: so the claim that the 'correct' logic is the one that best captures this internal/intuited standard is inherent in an appeal to counter example, and this, by extension, can be read as an indirect appeal to an implicit assumption that logic is the structure of human reason or rationality.

Further, it is possible to find overt claims that logic and reason are, or should be, essentially linked. These include such examples as Peter Flach's claim that logic "is — or at least, should be perceived as — the science of knowledge" (Flach [2002, 680]).

Among the plethora of questions inspired by the conception of logic as the science of knowledge, Flach identifies the following:

> Which different kinds of unsound reasoning can be meaningfully distinguished? How different is each of them from deduction? Can we draw up a list of necessary and sufficient conditions for any kind of reasoning to be called deductive? [and] Can we remove conditions from this list, and still obtain sensible but unsound forms of reasoning?
>
> (Flach [2002, 682])

Flach bolsters the defence of his positive claim with appeals to van Benthem and Gabbay respectively:

> [the] emphasis [of logic on deductive reasoning] is the result of a historical contradiction of the agenda for the field. Up to the 1930s, many logic textbooks still treated deduction, induction, confirmation, and various other forms of reasoning in a broader sense as part of the logical core curriculum ... but they [these other forms of reasoning] do remain central to a logical understanding of human cognition.
>
> Some members of the traditional logic community ... have not even accepted non-monotonic reasoning systems as logics yet. ... I believe this is fine for mathematical logic, but not for the logic of human reasoning
>
> (Flach [2002, 683], quoting van Benthem [2000] and Gabbay [1994])

In the above quote, Flach anticipates much of the problems for the ubiquitous assumption which will be highlighted in what follows. But for now it is enough to note that this cross section of examples should make it clear that there is a widely held assumption that logic does or ought to have a canonical application to correct reason in general, and that 'reason' in this assumption, is what we, as practitioners of it, use when we correctly infer a conclusion from a set of premises.

In most of what follows, by 'logic' I mean to refer to deductive logic. The discussions refer principally to classical logic (except where specified), but in general the philosophical ramifications of the connections between logic and reason discussed here apply to all deductive logics, including modal, temporal, relevant and intuitionist logics.

2. How Logic and Reason Might be Related

If we grant that there *is* some essential connection between logic and reason, we are beset immediately by a host of initial problems needing an answer, even before any positive exploration of the nature of such a

connection can begin. These include, but are by no means exhausted by, the following.

First: the problem of deciding the *degree* to which the two are essentially related. To see this we can start at the other extreme — i.e. at the realism suggested above: i.e. the interpretation of 'thought' and 'reason', as areas of logical application, but dissociated or independent from human reasoners. This idea, of course, introduces its own set of problems and these include deciding the extent to which what we use when we reason logically (i.e. when we do logic) relates to the way we ought to reason and perhaps too to the way we actually reason, if it does at all. This is something like the usual platonist knowledge problem for the philosophy of mathematics. For logic it reads: how do we know how to reason logically if reasoning logically is not an idealization or abstraction of something we already practice?

Setting the problems for the realist view aside for a minute, note that on the other hand, the assumption that a central application of logic is to the way we ought to reason opts out of the caveat afforded by the 'if at all' option above, and thus has to account, to some degree, for the relationship between logic and human reasoners. That is, there is a burden here to account for the degree to which the full structure of logic is normative for reason, and then too, to what is practiced. One of the most pertinent questions here is whether logic could be applicable to just what is normative for human reason, but not to human reason, as practiced, itself. If so, then what becomes of the very notion of normativity?

If not, how and how much, does the normative structure relate to the practice; and how much of what really is, in practice (for human reasoners) correct or completed reason, does logic capture? All or just part of it? If only part, which part? If not — i.e. if logic *is* applicable to both 'correct' and thereby to actual human reason — we still encounter the problem of degree: to what degree is logic related to human reason as practiced? This is something like the usual constructivist problem of explaining how what we practice reaches the full structure of mathematics itself. The point is that so long as any assumption is made (aside from embracing the 'none at all' option afforded by the caveat above), then these sorts of issues have to be addressed.

The suggestion raised here is that the burden of addressing these issues turns out to be greater than the burden entailed by the aforementioned 'none at all' option. If logic is independent of correct reason, the burden is to explain how we come to use logic for reason at all.

But this burden is one shared by a number of realist philosophies and there are a number of ways to address it — some of which are briefly touched on in the concluding sections of this paper. The position here is that trying to understand the nature of logic in constructivist terms is a fraught endeavour. So fraught that logic is ultimately better understood in broadly realist rather than broadly constructivist terms.

Even supposing this initial problem of degree of involvement is adequately addressed, acknowledging that there *is* a degree (no matter how small or how couched in caveats) to which logic should address the way we actually reason at all (idealized or as practiced or both) leads in turn to the problem of just *how* this ought to be done. The difficulties here can be highlighted by raising just one aspect of this problem: whether the *best* logical capture of good or correct reason is or could also be related in any natural way to the way we successfully reason in general. This is explained in some more detail in what follows.

So the problems created by the ubiquitous assumption (at least, the problems for our understanding of the nature of logic) begin with the common intuition that 'reason' is inescapably linked (in any way) to human cognition or the way we think. Or, put alternatively, the problems begin with the use of the term 'reason', (e.g. by Frege) for what it is that logic studies. The usual interpretation of 'reason' involves such a link, and with this link comes a burden of explanation. This burden is specifically that a genuine study of the former may necessarily involve a study of (at least the reasoning component of) the latter. Or it is the burden of having to defend the assumption or the stipulation that it does not — i.e. the burden of a comprehensive rejection of broad psychologism, while simultaneously retaining the notion that logic canonically applies to correct reason. But just so long as correct reason is tied to human thought, whether in a normative, idealized or g enerally constructive way, the latter burden is ultimately unbearable.

Withdrawing the ubiquitous assumption not only takes the urgency out of the demand to clarify the relationship between reason and logic, but also gives us an alternative account of just that relationship. That is, once our understanding of the nature of logic is not essentially linked to the nature of correct reason, then we have other models we can choose as representing the relationship between us and it, crucially including that between us and mathematics.

Thus arguing or assuming that logic is or is canonically applicable to, reason (no matter how different the two appear) is just one approach

to their relationship, but so too is arguing that logic is in *no sense* reason (as the term is usually interpreted). Of the two, as will become increasingly apparent, it is this latter strategy which turns out to be the most promising insofar as illuminating the relationship between us and logic. There are problems with both strategies, but the main aim of this paper is to highlight the problems with the former. More than this, though, the latter strategy has a better chance to explain logic's place, not just in our conceptual schema, but in relationship to other fields of enquiry as well; and it may even have a better chance to defend the notion that logic and reason are importantly related (though in a non-canonical, far less personal way).

But, as Flach pointed out above, logicians, on the whole apparently disagree that there is much of a problem with the ubiquitous assumption in the first place. This could be a consequence of an implicit faith in the former approach, and perhaps too of the general consensus that formal logic is the study of reasoning in abstracta: reasoning abstracted away from its subject matter. Like a 'get out of goal free' card, perhaps the notion of reason in abstracta has gradually become the piece played in place of a satisfactory explanation of the relationship between logic and reason.

There is a common resistance on the part of practicing logicians to anything 'too empirical'. Where reason apparently ties logic to an empirical subject matter, it may seem that such practice threatens the very notion of a 'pure' logic, which is supposed to apply no matter what the subject matter. Thus logicians seek to remain aloof from empirical concern, while nonetheless retaining the general claim that logic is significantly applicable to reason as it is abstracted from such concern. But reason, even abstracted reason, is, on its usual interpretation, tied to human thought. Human thought is tied to humans. And so the idea that logic canonically applies to reason is in direct opposition to the initial notion that logic remains aloof from empirical concerns. That is, unless the usual interpretation of 'reason' is radically revised.

Sharpening the point, we've suggested that logic is not a model of reason. Putting the suggestion in other words, we could ask: if our notion of 'reason' were indeed to change, say by the weight of evidence accrued by empirical studies (and, as section 6 will show, some modern theorists of reason would claim it should so change), or by the sort of initial interpretative move proposed above, would this mean that logic should change? In fact, the sting in this question remains regardless of

the actual evidence either way. Reason as practiced could, even if just in theory, turn out to be something quite different from what it needs to be to make sense of the notion that logic provides its normative structure. If reason, tied to human thought, were upon investigation, something quite different, then so too would be correct reason, or reason in abstracta, or idealized reason. All of these would, on such a scenario, be something quite different from logic.

The theoretical question needs to be taken seriously regardless of the evidence because it highlights another important burden of proof entailed by the very notion that reason is a canonical application of logic. If this burden is to be avoided, it is critical for logic that it is pre-empted by the preliminary interpretative questions identified above: i.e. whether or not reason is a formal property (e.g. can be dissociated from actual reasoners), is irreducibly empirical, or whether it's a bit of both.

3. Reason

It is not easy to say what an argument is, let alone what a good argument is, and by extension what reason is. But it is precisely this sort of question that the cognitive science of reasoning, the psychology of reasoning and the psychology of deductive reasoning all address.

In this and the following section, current theories from these fields are very briefly canvassed, as are their applications to and ramifications for logic (this question is then explored in more depth in the following section).

Within the field of cognitive psychology there has long been a view that "our understanding of human deductive reasoning will generalize to provide an understanding of everyday, commonsense reasoning, and of human thought in general" (Oaksford and Chater [2002b, 2]). Mike Oaksford and Nick Chater point out that this idea rests on the assumption that real empirical human reasoning is deductive.

But Chater and Oaksford (and others) argue that "almost no commonsense inferences are deductive" and that human behaviour that may seem irrational when measured against the normative principles of logic, in fact "reflects rational, commonsense, reasoning strategies that are appropriate to reasoning about our uncertain world" (Oaksford and Chater [2002b, 2]). If the latter strategies are the best description of reason that we have, then what is it that logic studies?

To see the problem here more clearly, suppose Oaksford and Chater are right and that our commonsense is not logical. Thus the phenomenon operating on an everyday basis called 'commonsense' or 'commonsense reasoning' is one with which logic has nothing, or not much, to do. On this scenario then, whatever it is that logic studies, it is not what we might naturally think of as human reason: our everyday commonsense. Now, if in fact we do think of everyday commonsense as human reason or even as essentially connected to human reason, what becomes of the claim that it is reason (human or not, idealized or not) that logic studies?

We could address this question by seeking to establish which of the two phenomena at hand — everyday reason and whatever it is that logic studies — more naturally expresses or encompasses the very concept 'reason'. Similarly we could try to establish to which of the two phenomena the concept 'argument' more naturally belongs. The problem here (for logic) is that this is a difficult task in itself: prima facie, without further argument the concepts 'reason' and 'argument' do not easily come apart from how we as humans operate day to day — i.e. from 'commonsense reason'.

4. Mental Logic vs. No Logic

Oaksford and Chater note that the claim that human reason involves deduction can be analysed at different levels. These include the computational level and the algorithmic level. The former is where "the performance of the device is characterized as a mapping from one kind of information to another, the abstract properties of this mapping are defined precisely, and its appropriateness and adequacy for the task at hand are demonstrated". A cash register and the theory of arithmetic give an example of computational level analysis, where the latter is the computational level analysis of the former. Such an analysis is justified by "showing that our intuitive constraints on the operation of a cash register map directly onto this mathematical theory." Likewise, at the computational level analysis of human reason, a deductive theory says that in the same way that arithmetic characterizes the operation of a cash register, "logic characterizes the inferences people draw." (All quotes in paragraph, Oaksford and Chater [2002b, 5], quoting Marr [1982, 24].)

This claim, perhaps without the direct reference to 'people', bears a strong resemblance to those given in the introductions to logic texts.

And yet, as Oaksford points out, there is an important sense in which "whether or not this is true is clearly an *empirical* question, just as it is an empirical question whether or not a piece or machinery functions as a cash register" (Oaksford and Chater [2002b, 5]).

Thus we arrive back at the question posed earlier: how important for logic *is* the 'people' part of the claim? Clarifying this, let's say that the question here is whether or not logicians should concern themselves with the truth or falsity of the claim:

(A) logic characterizes the inferences *people* draw.

Before directly addressing this claim, we should note that the algorithmic level of analysis — the level of the computations themselves — describes "how to compute the function specified at the computational level [and also] ... specif[ies] the representations that the algorithm manipulates in computing the function." (Oaksford and Chater [2002b, 5]). Now, utilization of both these levels of analysis enables claims stronger than (A), such as Inhelder and Piaget's that:

(B) "human reasoning is nothing more than the propositional calculus itself" (Oaksford and Chater [2002b, 6]).

Claim (B), at least according to one rendering of the copula and of the phrase 'nothing more than', is an identity claim and so suggests a more potent relevance to logic itself than claim (A). That is, claim (B) might entail claim (C):

(C) the propositional calculus itself is [nothing more than] human reasoning.

This rendering offers a particular interpretation and the beginnings of a possible solution to some of the questions posed in section 2: e.g. a logic whose aim is to capture human reason might look like the propositional calculus. And, at least one capture (namely, the propositional calculus) of good or correct reasoning could also be said to also be a capture of human reason.

The view that logic is both the correct computational analysis and the correct algorithmic analysis of human reasoning is defended by Lance Rips, who proposes the Deduction System Hypothesis — that logical "principles ... are central to cognition because they underlie many other cognitive abilities ... [and] that the mental life of every human embodies

certain deduction principles" (Oaksford and Chater [2002b, 6] quoting Rips [1994, viii]).

If the above claim is true, it has a number of problematic consequences for logic. If a set of deductive rules is demonstrably central to reason, it would seem undeniable that logic ought to include those rules.

But this is not the way logic or logicians work. Empirical evidence that a set of rules are foundational for reason need not and generally do not necessarily dictate that these same rules are foundational for or even included in a given deductive logic. The problem here is that it is hard to see how to defend or explain this apparent neglect, particularly if we took a Rips-style argument as a positive endorsement of logic's role. But, in fact, this same problem applies whenever we propose *any* sort of canonical relationship between logic and 'reason' at all.

5. Strengthening the 'Reason Per Se' Response

Before exploring the 'no logic' option, it remains to examine an alternative possible defence of the notion that logic is an abstraction or idealization of reason, namely the naturalistic argument to the effect that the structure logicians study is an idealisation of human reason — reason idealised in order to study its (formal) deductive properties.

Maddy takes such a line in her [2002]. I suggest that the primary problem for the sort of account she offers is the *degree* of idealization required to reach classical logic from everyday human reason. That is, the difference between the logic eventually arrived at and the reason from which it is supposed to have arisen is too great. Specifically the difference is too great to reasonably sustain the claim that the relationship between the two is one of idealization in the face of the alternative theory that the two are simply different things.

One way of articulating the ideal behind the naturalistic philosophy of logic Maddy puts forward is that of logic as a neat intersection between the internal and the external[2], wherein logical laws are as much a feature

[2] Where 'external;' is read naturalistically — as that which is accessible or inferable from the evidence of our senses and from our best theories. Thus, the 'external' reality to which logic applies on Maddy's reading, is quite a different thing from the external reality of logic itself on my realist alternative.

of an external/objective reality as they are an inherent feature of our own make up.[3]

Thus, logical laws come both from their conceptual necessity and from the general structure of reality itself.[4] So the naturalistic method is (roughly) transcendental insofar as the notion of conceptual necessity corresponds to the notion of the general pre-conditions of conceptual thought itself, and it is empirical insofar as the logical laws are (very generally) empirically veridical.

Maddy proposes a modern version of the set of Kantian categories and forms of judgement, and then examines how these might "underlie the laws of logic" (Maddy [2002, 70]). For example, the first of these categories is that of an object as a member of a class: "objects grouped together by their relational similarities" (Maddy [2002, 70]). From this, Maddy builds "minimal" or pre-formal versions of conjunction and disjunction, as "counterparts of ... intersections and unions" (Maddy [2002, 71]).

One of Maddy's aims is to see whether we could arrive at full classical logic through a series of idealisations from this primitive set. The problems with this approach begin with "extend[ing] the minimal versions [of the fundamental categorical forms] to full [classical] connectives capable of applying to any descriptions" (Maddy [2002, 71]). For example, "does thinking in terms of [the categories] ... also commit us to granting ... that any given object must either have a given property or fail to have it? It seems to me [Maddy] that the answer must be no" (Maddy [2002, 71]). So, classical logic's universal LEM is a significant idealization, "required to cover the distance between the rudimentary logic of our fundamental conceptual machinery and the laws of modern logic" (Maddy [2002, 73]).

The specific problem here is with connecting the LEM with the range of possibilities we allow for truth and falsity, their combination and their (joint or individual) absence:

> we find it quite easy to think, for example, that it's neither true nor false that a given person is bald. Without bivalence, what we have at

[3] Some of this short discussion of Maddy's [2002] is also presented in Brady and Rush [2008], but there it serves a different purpose, largely unrelated to the topic at hand.

[4] This is, of course, a radically strengthened version of the naturalistic aims put forward by Maddy herself. Nonetheless, it suffices to highlight the sort of relationship between reason and logic proposed.

> this stage is atomic sentences that can be true or false or lack truth value. (Maddy [2002, 71])

Thus it seems likely that we reason effectively without any law against truth value gaps. These sorts of problems: i.e. with claiming that the formal LEM is any sort of idealization of an informal counterpart (say, a law of reason), themselves spring from a deeper problem with any similar claim for negation.

According to Maddy (and classical logic) "the negation of a truth should be false, and the negation of a falsehood should be true" (Maddy [2002, 72]). But, as she points out, we are perfectly capable of reasoning with an apparently ad hoc but nonetheless effective rule stipulating that (at least on occasion) the negation of a truth value-less statement is itself capable of being true or false. Thus, "we might be inclined to say [of the example above] 'well, he's not bald, but then, he's not *not* bald either!" (Maddy [2002, 72]).

We could respond to such examples with the observation that there are logics other than classical logic whose 'fit' with ordinary reasoning processes seems more promising.[5] But the problems with negation are particularly potent and they lend weight to the alternative tactic here: a denial of any canonical link between logic and reason whatsoever. Beside Maddy's own observation, there are numerous examples wherein a formal 'negation' claims to be an idealization of 'the' negation we use when we think or reason. Thus the problems Maddy notes are further compounded by the simple fact that there are a *number* of different such formal negations, on top of the (probable) number of different informal negations with which we may reason.

Francesco Berto in his [2006] outlines some of these formal negations, all of which claim to have some kind of essential link to the negation humans use. Negation in da Costa's positive plus systems[6] is one example of these. Berto offers quotes from Richard Routely and Diderik Batens claiming their (respective) belief that this particular formal negation is not and is (in fact one of many), negation(s):

[5] This is, in fact, argued in Brady and Rush [2008].

[6] In such systems, the truth conditions for negation are as follows:

(C1) If "α" is false, then "$\neg\alpha$" is true.
(C2) If "$\neg\neg\alpha$" is true, then "α" is true.

(Berto [2006, 6]). As Berto points out, Contraposition and Double Negation Elimination fail for (most) such systems.

> ... there is little basis for regarding the so-called negations of these systems as genuine negations at all rather than, say, positive modal connectives, e.g. weird truth or necessity connectives.
>
> (Routley [1979, 305] in Berto [2006, 6])

> Routley's intuitions on the matter are wrong ... I have (distinct) intuitions on several kinds of "negation", that I consider it interesting to study some of them, and I presume that some are useful in certain contexts whereas others are useful in other contexts ....
>
> ([Batens [1980, 212] in Berto [2006, 6])

Similar clashes of intuition occur for each formal negation and I would wager, for any formal negation (including Berto's own "NOT", though this is not to say it has not achieved the purpose for which it was designed).

Given that this is the situation, there are a number of possible characterisations we can offer to explain it. First, we could suggest that each of the possible formal negations attempt to idealize the negation we reason with, and that therefore one (or possibly some) of these formal negations meet this goal better than others, and this is to be preferred.

We could also argue, though, that the problem is not which of the hosts of different formal negations capture the most intuitive notion, but that the fact that we can even ask such a question highlights the futility of the question itself. Thus, the question: 'which negation is the one with which we reason?' must remain (at minimum) open, if not entirely *logically* insoluble. This characterization supports the proposal presented here — that, although there may in places be some overlap, logic and the notion (or notions) we reason with are two entirely different things.

Thus the appeal of this characterisation (for negation) feeds directly into the appeal of the thought that deductive logic in general is *no* idealization of reason. That is, the reasons for choosing this (second) characterisation for negation over the first (above) line up with those in support of the claim that logic is no idealization of reason over the claim that it is. And the most obvious of these reasons is that, given the amount of clashes and confusion over competing intuitions and the extent of the mismatches between the formal and the informal, in each case (for negation in particular and for logic in general) we can well imagine how the second characterization could lay claim to being the simpler explanation. Indeed, the mere fact that we can well imagine just such a thing tells strongly against the first characterization.

To recap, I have noted that, at the very least, there is some considerable controversy over how best to capture even the most fundamental of our logical connectives. Not only negation, but even conjunction and disjunction suffer from this confusion.[7] The controversy generalizes to the problem of how well any formal version matches concepts we actually use when we reason. The point here is that the controversy is great enough to suggest that this problem is at the very least an open question.

There is another (subtly different) reason to prefer the proposal here (i.e. that we ought to begin with the assumption that there is no canonical relationship between logic and reason) and that is that such a proposal simply seems more promising *in light of* the confusion outlined above. It certainly seems it will get us into a lot less trouble. After all, such confusion may simply be a result of our having asked too much (or inappropriately) of logic in the first place.

In fact, Maddy's general naturalistic picture of the growth of logical concepts from pre-formal categories highlights the differences between classical logic and human reasoning in quite a number of places. The universal LEM is just one of these:

> This is the first major idealization ... Removing all truth-value gaps and restoring the standard truth-functional negation produces the full store of propositional tautologies involving conjunction disjunction and negation ... a second sort of idealization [is required] ... in the definition of the conditional ... there need be no 'causal connection' (Frege [1879, 14]) between the two components: 'if the sun is shining, then $3 \times 7 = 21$' is true, though the sun's shining has nothing to do with the arithmetical fact. Here we make a clear and deliberate departure from the content of the underlying category. (Maddy [2002, 73])

Given the host of probable disconnects between the pre-formal and the logical, and the extent and degree of the 'departures' from our pre-formal

[7] Berto notes that there is considerable debate over whether "non-truth-functional theories of conjunction and disjunction, such as supervaluationism and non-adjunctive logics, describe [the intuitive concepts] *conjunction* and *disjunction*" (Berto [2006, 2]). He also notes that some authors (Michael Resnik in particular), in accordance with the proposal I put forward here, consider this sort of question unsolvable. There is, though, a big difference between, say, Michael Resnik's resultant non-cognitivism and my proposal. At this stage, I suggest simply that, due (in part) to the fact that such problems are unsolvable, we consider the proposal that logic is not familiarly related to reason, and so logic is so me other thing. This other thing need not be non-cognitive (indeed I do not believe it is).

categories involved in a naturalistic characterization of logic as an idealization of reason, it becomes increasingly apparent that 'idealization' may be too optimistic a term for logic. In short, it seems that when we try to tell a naturalistic story linking human reason with logic, what we in fact encounter is a leap rather than an evolution or idealization from the one to the other. The suggestion here is that the more obvious and simpler explanation is that when we move from one to the other, we are doing precisely that: moving from one thing, to an entirely different thing.[8]

6. No Logic

There are three main methods for assessing whether reason is deductive at the computational level: the collection and analysis of commonsense arguments, laboratory tests of deductive reasoning tasks, and considerations from computer science (Oaksford and Chater [2002b, 9]).

Oaksford and Chater argue that deduction as a computational level theory of reason cannot adequately explain the evidence collected from any of these methods. They claim, for example, that "the problem of whether or not a natural language is deductive cannot be straightforwardly ascertained by purely logical analysis" (Oaksford and Chater [2002b, 9]). To defend this claim, they offer some well known mismatches between logic and natural language, including the following.

Consider the natural language argument:

(NL) Birds fly
Tweety is a bird
Therefore, Tweety flies.

One possible logical translation of this argument might be:

(DL)
$$\frac{\forall x(\mathrm{B}(x) \rightarrow \mathrm{F}(x)) \quad \mathrm{B(a)}}{\mathrm{F(a)}}$$

[8] Of course, I have not given any argument showing exactly where the line is to be drawn such that, once crossed, a purported idealization is more simply understood as an entirely different thing (from that which it claims to idealize). I n the same vein, we could ask which particular features of reason count as essential to any idealization claiming a familial link with the same (the same point could apply to an abstraction, a representation and so on). Such features ought not, one would think, be 'abstracted away' nor absent from any good idealization.

This is a valid deductive form (after universal elimination rules, it's a straightforward substitution instance of MP).

What Oaksford and Chater point out here (beside the usual arguments showing defeasibility, e.g. suppose Tweety is an emu, etc) is that we can only infer the validity of (NL) from (DL) if (DL) is accepted as capturing the logical form of (NL). And, as any logician knows, this is no small leap.[9]

The logical translation in the Tweety example is further compromised by the lack of an explicit quantifier in its natural language counterpart. As Oaksford and Chater point out, "Should [birds fly] be treated as meaning that *all* birds fly? Or is a better interpretation that it means that *most* birds fly, that *normal* birds fly, or perhaps that it is reasonable to assume that a bird flies until there is reason to believe the contrary?" (Oaksford and Chater [2002b, 10])

And so, we might conclude that the theory that reason is deductive can neither be defended by, nor explain the data produced by the collection and analysis of commonsense arguments. Oaksford and Chater also give similar arguments and conclusions against the two other methods — laboratory tests and computer science (Oaksford and Chater [2002b, 9–11]).

To emphasize their point, Oaksford and Chater note that the deductive theory cannot explain the results of Wason's selection task (another well-worn but still illustrative example): "[which is] perhaps", they point out, "the deductive reasoning task that has raised the greatest concerns about human rationality" (Oaksford and Chater [2000, 22]).

Oaksford and Chater explain the task as follows:

> In the selection task, people must asses whether some evidence is relevant to the truth or falsity of a conditional rule of the form if p then q, where by convention "p" stands for the antecedent clause of the conditional and "q" for the consequent clause. In the standard abstract version of the task, the rule concerns cards, which have a number on

[9] Indeed, every logical connective is suspect in this sense. As Kent Bach shows, the logical connective '&' does not seem capable of capturing even basic natural language sentences involving 'and'. Specifically,'&' is commutative, and so cannot capture the difference between:

(A) Carly got married and got pregnant, and
(B) Carly got pregnant and got married

(Bach [2002, 52])

> one side and a letter on the other. The rule is if there is a vowel on one side (p), then there is an even number on the other side (q). Four cards are then placed before the subject, so that just one side is visible; the visible side shows an "A" (p card), a "K" (not-p card), a "2" (q card) and a "7" (not-q card). Subjects then select those cards they must turn over to determine whether the rule is true or false. Typical results were: p and q cards (46%) p card only (33%), p, q and not-q cards (7%), p and not-q cards (4%) (Oaksford and Chater [2000, 23])

In their response to these figures, they argue against the initial assumption that this *is* a deductive task, pointing out that "the assumption that the ... task is deductive ... arises from the fact that psychologists of reasoning have tacitly accepted Popper's hypothetico-deductive philosophy of science [specifically the assumption that] evidence can falsify but not confirm scientific theories" (Oaksford and Chater [2000, 23]).

At this stage it remains an open question whether the inconsistency of psychological tests and models with classical logic is really a problem for the view that logic is (perhaps only in part) a model of normatively appropriate human reasoning. There are some other significant problems with the idea that logic has some sort of normative role; e.g. there seems no way, even in principle, to decide on a representative set of axioms as normative for reason (this is dealt with in some more detail below). Aside from the obvious empirical circularity that such an attempt would induce, choosing which of the different fundamental axioms of different logics is best representative of correct reason is a task doubly fraught. Such a task involves not only justifying the canonical link between logic and reason that is under question here, but also defending logical monism against logical pluralism (presuming that there could only be one normative standard).

The other primary problem for the normative claim is with its apparent commitment to a proscription of irrationality and incorrectness across a large number of examples of everyday reason. This is of a piece with its seeming inability to account for the prevalence and success of such irrationality in the world.

Of course, such considerations need to be weighed against the common, opposing interpretation of such empirical data as highlighting the extent to which our everyday reason goes against a standard which we might, upon reflection, acknowledge as normatively appropriate. But recall that our own sense of what is normatively appropriate is not easily

pinned down, nor is it unproblematic to align such a sense with logic without begging the question to hand.

Oaksford and Chater suggest that an alternative notion of 'correctness' be adopted for interpreting the results of the task, one partly motivated by the resurrection of our faith in human rationality, which has the effect of eliminating a primary role for logic in pursuing this goal. This alternate notion is probabilistic, based on viewing the task itself as a problem of Bayesian optimal data selection (Oaksford and Chater [2000, 24]). The end result is a far better match between theory and empirical data than that offered by the deductive interpretation.[10]

There is an alternative non-logical explanation of performance on the task, namely one which explains the results in terms of levels of insight. In fact, Wason and Johnson-Laird's own idea was that people were capable of reasoning logically but required insight into the fact that logic applied to the task. So, for example, when 'Manchester' and 'car' replace 'p' and 'not-q' cards, and the rule 'if I travel to Manchester, I take the train', people perform better (in conformity to logical correctness). It can be shown that such context changes affect performance in other situations as well. Oaksford and Chater argue that this phenomenon undercuts *any* formal view of reasoning since logical form should be unaffected by content (Oaksford and Chater [2001, 3]).[11] I take this as further evidence of the aforementioned essential separateness of logical reason and correct reason.

Then there's the argument that in such tasks, people are not reasoning at all. In the 'Evan's Negation Paradigm' experiment, the task rules have negations systematically inserted into the antecedent and consequent producing three more rule forms: if p then not-q, if not-p then q, and if not-p then not-q. Evans argued that people could just be matching the items named in the rule rather than reasoning. If this were the case then people should continue to select the p and q cards even for the rules containing negations. He postulates a relevance heuristic wherein

[10] There is some confusion created here, given the connection between mathematical theory and logic, but this particular confusion may be set aside for a time. The interesting idea is that there *may be* a better model for human rationality than that which logic provides.

[11] This seems at least a highly debatable point, though, since the original point was about presence or absence of insight, rather than the presence or absence of logical thinking, but, given it suggests that lo gical thinking is something we can *impose* on ordinary rationality, it is an interesting argument nonetheless.

the topic of a negated constituent is still that constituent (this is the not-heuristic). The overarching goal of such heuristics is to direct attention to the most relevant information. The notion of a 'most' relevant piece of information in turn connects this idea to the probabilistic theories put forward in Oaksford and Chater.

Furthering the whole argument against logic of any sort being (essentially or canonically) any kind of model of reason, Oaksford and Chater also give an example appealing to the notion of artificial intelligence; which boils down to the claim that the sheer size of the machinery needed to capture even the most basic of our commonsense reasoning is prohibitive. That is, no matter which (logical) formal system is chosen, its practical infeasibility (or its huge 'computational expense') simply rules it out (see Oaksford and Chater [2002b, 45], for further detail).

Oaksford and Chater go on to claim that people do not treat even syllogistic reasoning as a deductive task. They argue that if

> people were reasoning logically [when confronted with syllogistic reasoning tasks] they should be able to draw all and only the valid conclusions indicating that nothing necessarily follows from the invalid syllogisms. However, people have graded difficulty with drawing the valid syllogisms. Moreover, they make systematic errors on the invalid syllogisms, offering conclusions where none follow.
>
> (Oaksford and Chater [2000, 28–29])

They again put forward a probabilistic theory which can explain these errors:

> this probabilistic account has the advantage that not only can it explain the data from the 64 syllogisms that use the standard logical quantifiers ... it also extends naturally to the 144 syllogisms that result from combining these with the generalized quantifiers, Most and Few which have no logical interpretation. (Oaksford and Chater [2000, 29])

There is a sharp contrast here to the deductive theory which, it seems, can offer only one explanation for the errors — human incompetence.

So, on the one hand we have some compelling evidence that no part of cognition is deductive, and on the other, arguments (also based on empirical evidence) that almost all of cognition is deductive, or at least based on deduction. But so long as the logician's ubiquitous claim stands, (implicitly or explicitly): that a canonical application of logic is to correct reason, there are significant problems for logic either way.

7. Consequences for Logic

The sorts of arguments presented above have varying degrees of consequences for logic. Perhaps the most obvious of these is the impact on the process by which we decide which logical rules to retain, and which to discard. The logical consequences of rules, their structural utility and the logical results they enable, should become, perhaps, less important than the degree to which they are inherent in thought — or reflect reason.

For example, returning to the Deduction System Hypothesis above, Rips argues that rules which seem incontrovertible (and are established via experiment as such) are essential to capture human rationality and indeed many other forms of thought, from perception through to social understanding and general comprehension (Rips [1990, 321]). In fact, it is a general assumption of many such advocates of mental logics and of mental models that deductive logic provides a computational level account not only of an important class of human reasoning, but also has "at least a partial role in almost every other aspect of cognition" (Oaksford and Chater [2002b, 8]).

Rips specifically singles out 8 rules "producing 97% or greater agreement" (Rips [1990, 331]). These include the disjunctive syllogism and double negation (classical negation).

It is pertinent that the acceptance of these two rules, along with the law of excluded middle, leads to the acceptance of material implication:

> It turns out ... that it is not possible, in general, for logicians to stick with classical negation and have non-classical inferences i.e. it may be that classical negation and classical inference are inseparable. This is borne out by the following relation between classical negation and classical inference. By modifying an argument of Priest in [2001, 14] given classical negation and its two key properties of the Law of Excluded Middle (LEM: $A \vee \sim A$) and Disjunctive Syllogism (DS: $\sim A, A \vee B \Rightarrow B$), material implication can be used to represent inference, provided every rule in the inference is also available in its disjunctive form: If $A \Rightarrow B$ then $C \vee A \Rightarrow C \vee B$. Specifically, if the inference '$A \Rightarrow B$' is assumed then $\sim A \vee B$ holds, and conversely. This is proved as follows:
> L $\rightarrow$ R. Let '$A \Rightarrow B$' and let $\sim A \vee A$. Then, we place '$\sim A \vee$' in front of every step in the inference until $\sim A \vee B$ is established.
> R $\rightarrow$ L. Let $\sim A \vee B$ and let A. Then, by Disjunctive Syllogism, B follows. (A general result of this sort also appears in Brady [1993, 581–584] as a Classical Deduction Theorem.)
>
> (Brady and Rush [2009, 3])

Thus the empirical proscription of well-entrenched rules such as those put forward in Rips [1990] would have a significant impact for a host of alternate logics, particularly those which reject material implication (ironically a primary reason for such rejection is that material implication validates arguments which are intuitively — or as dictated by reason — invalid).

Note too that evidence supporting mental model theories also gives weight to a potential transcendental-style argument of the sort Priest gives (quoted in section 1). In this case, such an argument would look something like: 'the rules of classical deductive logic are inherent in thought, and as such, are necessarily true'. An even stronger Priest-type claim could be constructed if we were to accept that use of the rules is pervasive in cognitive tasks. I pause here to note that some weight can be added to Rips' claims above by noting Johnson-Laird and Byrne's following list of tasks dependent on such rules: plan formulation; action evaluation; the determination of the consequences of assumptions and hypotheses; the interpretation and formulation of instructions; understanding rules and general principles; pursuing arguments and negotiations; weighing evidence; assessing data; deciding between competing theories and problem solving! (Oaksford [2002b, 8]).

Specifically, a Priest-type argument could present the "demonstrably incontrovertible" (Rips [1990, 331]) classical rules as pre-conditions for cognition — or at least for important sections of cognition. If this sort of argument can indeed be supported by the empirical data, then the rejection of such rules becomes an issue somewhat more controversial than that of the technical merits of alternative logics compared to those of classical logic.

If the rules that underpin classical logic also necessarily underpin reason, then (so long as we retain any claim that there is a canonical relationship between logic and reason) the status of any logic that rejects these rules is immediately under suspicion. But this is not the way debates between classical and alternate logics proceed, nor does it seem to represent a proper analysis of the role and importance of logic itself, including the value of such (alternate) logics.

There is a further set of issues surrounding the consequences for logic of empirical studies of reason, and these issues involve the *degree* to which logic is or ought to be tied to reason. At least two logical issues are directly affected by this problem. These are the choice of a consequence

relation, and the question of the degree to which any given logic ought to capture natural language.

In the first case, we might suppose that if logic and reason are connected (canonically) to a *large* degree, then a definition tying logical consequence to rationality would be favoured over one not so tied.

That is, Shapiro's (R) below would be preferred over, say, his (M) or (PW):

> (R) Φ is a logical consequence of Γ if it is irrational to maintain that every member of Γ is true and that Φ is false. The premises Γ alone justify the conclusion Φ.
>
> (M) Φ is a logical consequence of Γ if it is not possible for the members of Γ to be true and Φ false.
>
> (PW) Φ is a logical consequence of Γ if Φ is true in every possible world in which every member of Γ is true. (Shapiro [2002, 233])

Thus, empirical concerns come to play a significant role in determining the correct formal expression of logical consequence: the very heart of formal logic.

In the second case, a heightening of the degree to which logic and rationality are or should be connected should accordingly heighten the degree of concern over the mismatches between natural language and logic. This holds "on the reasonable assumption that what people say is closely related to what they think" (Oaksford [2002b, 9]).

8. An Alternative Suggestion

Suppose that we decide (in the face of empirical evidence, say) that classical or deductive logic in general is after all *not* the best formal theory to describe reason, but that we nonetheless wish to retain the claim that there is some sort of relationship between some formal logic or other and reason. How could this be done? Perhaps we could agree with the Gabbay division between mathematical logic and the logic of human reason (as quoted above in Flach [2002, 683]). We could then pension off the former's obligation to apply to reason, and assign it to the latter.

This move, of course, is not new, but neither is it generally accepted. The idea is to assign deductive logic in general a role akin to whatever role we assign to mathematics, or limit its canonical applications to those

structures to which it has genuine, provable application (including but not limited to mathematics) and excluding the bulk of correct reason. What is new is the idea here that, regardless of how the logic of human reason fares in its task, an important relationship between pure deductive logic (conceived in this way — i.e. as akin to mathematics) and reason can still be identified and accounted for.

The relationship proposed is one of discovery. Mirroring mathematical realism, the logical realism proposed here takes logic to be a free standing independent structure which we can access and the properties of which we can discover. Logic is something we can do — we can infer. But the idea here is that the extent to which a deductive consequence relation captures reasonable inference neither determines nor dictates the extent to which deductive logic is applicable to correct reason. Correct reason (and reasonable inference) is one thing, logical consequence another, in the same way that, according to one variety of mathematical realism, our ability to prove a mathematical theorem is one thing and mathematical proof is another. Note that this idea does not rely on mathematical realism being correct, rather it relies just on its being conceivable.

Shapiro raises an apparent counter to this suggestion in his [2002]. He first outlines a number of notions of logical consequence including (R):

> [Recall]: (R) Φ is a logical consequence of Γ if it is irrational to maintain that every member of Γ is true and that Φ is false. The premises Γ alone justify the conclusion Φ).
>
> [And now note] (Ded) Φ is a logical consequence of Γ if there is a deduction of Φ from Γ by a chain of legitimate, gap-free (self-evident) rules of inference. (Shapiro [2002, 237])

Having defined R and Ded, Shapiro renders Hilbert's thesis thus:

> There is a deduction of a proposition (or natural language sentence) Φ from a set Γ of propositions (or natural language sentences) by a chain of legitimate, gap-free, self-evident rules of language if and only if there is a corresponding argument $\langle \gamma, \varphi \rangle$ in the formal language such that $\langle \gamma, \varphi \rangle$ is deductively valid via S (where S is a deductive system). (Shapiro [2002, 237])

He goes on to make the following claim: "the philosophical interest of formal deductive systems depends on something like Hilbert's thesis. If there is no connection between Ded (or (R)) and formal deductive

validity, then the technical work is a mere academic exercise" (Shapiro [2002, 237]).

The risk outlined here is that of voiding not only deductive logic but mathematics too of anything other than 'academic' interest if we separate these off from the intuitive consequence relation, R. The suggestion above, though, while it does involve the essential separateness of the two, does not preclude the possibility of a connection between R and the formal deductive system of logic. Rather, it suggests a particular rendering of that connection as a relationship between our intuitive conception of rationality and the formal Ded which itself may or may not be intuitive. On the alternative suggestion R may belong to the section of natural language and thought to which logic applies — i.e. logical reason — described from our perspective (with which a small subsection of correct reason may also coincide). Ded belongs to the independent structure of logic itself. Ded and R can coincide and can inform one another, but this does not mean they are the same thing, nor essentially co-illustrative relationships. The coincidence of the items in play is no more or less significant than the coincidence of formal mathematical proof with mathematical reason and to some extent too, with correct reason. It is an interesting and important connection, to be sure, but not canonical, nor essentially co-illustrative. We can understand and investigate the nature of mathematical proof without understanding the workings of mathematical minds when they prove theorems. The relationship between the two, while important, is not *essentially* so. Each is separate and can be understood separately from the other.

This seems to invite the question: how, then, does logic relate to R at all? The answer suggested here is simply 'it does so via the fact that we can reason logically': i.e. in much the same way as mathematics relates to our ability to think mathematically. It does so because thinking mathematically is something we can do, but this does not make what we do when we think mathematically a canonical application of any mathematical structure. So the answer need not be 'because logic is essentially about reason'; it need be no more about reason than it is about any one of its applications. No more than mathematics itself is about the informal process of proof we go through to arrive at our mathematical theorems.

Shapiro's observations highlight a tension in holding both reason and mathematics as two canonical applications for logic. If we decide that deductive logic remains the best formal theory to describe correct rea-

son, then the relationship between R and Ded cannot be developed at the expense of the relationship between Ded and mathematics. Just how to retain both applications is a common predicament for deductive logicians. It need not be, if the application of Ded to R is restricted to our 'logical reason' seen as a separate phenomenon to 'correct reason'.

Conversely, if the mismatch between reason and logic prompts a withdrawal of the claim that deductive logic is the best formal theory to describe correct reason; and it is further acknowledged that reason is the best method by which we think about the everyday, commonly encountered real world, then (as argued above) it seems unreasonable to simply suppose that logic is nonetheless broadly (or unproblematically) applicable to physical reality or indeed to successful abstract descriptions of physical reality. Now, if we want to argue that mathematics is at least to some extent applicable to this everyday commonly encountered real world about which we (non-logically) reason, then to that extent, logic ought *not* to be applicable to mathematics.

At this point, so long as we are operating with one deductive logic with the two applications taken as canonical, it seems we have either to withdraw the original claim: that logic applies to mathematics; or the latter claim: that mathematics is applicable to the 'everyday' real world. Arriving at this point, though, is only one possible scenario (though a likely one for a logician claiming a canonical relationship between logic and reason). There is another way to go.

To see that there is another way to go, recall again that if human reason (or, by logical standards. irrationality) is, by and large, successful in the real world, the following question arises: how can we then claim that logic is similarly successful? We've already noted that the success of (logical) irrationality in the real world suggests that the real world (or at least large parts of it) itself behaves irrationally or unreasonably. Or, put in less anthropocentric terms, the data suggests that the real world may be uncertain and unpredictable, in short, informal. But if this is the case, then logic (which is predictable, formal and certain) ought not to be applicable to at least those parts of or that aspect of physical reality. This in turn may suggest that there is an aspect or a part of physical reality to which our everyday reason (or irrationality) corresponds (or applies) to and a part or an aspect to which our formal deductive reasoning corresponds (or applies to) .

But this need not necessarily be a problem. In fact, the apparent application of logic to everyday reason might be explained best by such

a scenario, namely as the areas in which these two frameworks do in fact coincide or overlap. Conversely, one way of understanding the empirical evidence presented might then be to present a hypothesis that these coincidental areas are, on the whole, rather rare, and that the two, along perhaps, with their *most* successful areas of application, are fundamentally, irreducibly, different things. This is the strategy advocated, and it amounts to the complete withdrawal of any claim of a canonical application of logic to reason.

The beginning of this paper noted that in challenging the ubiquitous assumption, I was identifying three initial items in play: everyday reason; correct reason and logical reason. I have noted how the last two may come apart or may sometimes coincide. This avoids their conflation and allows that their coincidence is not an essential element of the nature of either one.

Note that *prima facie* the withdrawal of the ubiquitous assumption does not force a denial of any commonality or coincidence between logic and reason (e.g. as mentioned earlier, it does not force the withdrawal of the claim that logic is the study of consequence). Rather, it insists that such a claim be couched carefully, and that if the apparent coincidence between consequence and rationality needs to be explained at all, then it must be explained in some way *other* than that logic and reason share a canonical or co-illustrative relationship.

On a lighter note, such a hypothesis may also go some way to explaining the not unusual case of an otherwise apparently rational person seemingly unable to understand logic, or to 'think logically', or those who claim not to have a 'mathematical brain' — such folk do nonetheless tend to be able to make their way through life successfully, and are surely not 'irrational'.

This remains (as yet) speculation. But, in its essence, the proposal is that there are (at least) three items in play (be they frameworks/structures, ways of thinking or what have you) — logic, logical reason and correct reason. The key idea is that the latter two coincide far less than they part ways. We could sum up the situation as the proposal that, while their coincidence may seem compelling, the coincidence itself ought not lead us to relate the two in any of the usual ways discussed in sections 1 and 2, much less to identify them. They remain two entirely different things. Whether they are frameworks, ways of thinking, structures etc. — and whether and how they correspond to areas of reality or to aspects of reality are questions for future work. The

point here is that the three are not the same, and that logic does not have a canonical application to reason.[12]

One place that such work could begin is with the many examples of successful reasoning that are not reducible to logical laws (or, in accordance with the view proposed here, reasoning that does not coincide with logical structures). The obvious place to look is at the pragmatics/semantics divide, and to find our examples among the examples of wholly pragmatic utterances and inferences.[13] Less obviously, we could look to the sort of cases Maddy touches on above, wherein reasoning takes place despite the apparent failure of the relevant logical laws. Of course, alternative logics may provide a better fit for such examples. Nonetheless, for each refinement, there will be counterexamples present in o ur in everyday practical reasoning, even if simply because we could never formally codify all of our 'informal' reasons for believing something (even if we restricted our attention to all of our good ones). It should be noted that the primary point here is that even when the structure of deductive logic *does* coincide with that of correct reason, we should nonetheless not be tempted to conclude that logic captures correct rea-

[12] Whether it does for mathematics is another question for future work.

[13] For a good overview of the divide, and the debates surrounding it, see Szabó [2006]. Perhaps most relevantly to our purpose here, Szabó also includes a good discussion of "the standard view" according to which "the best we can do in characterizing linguistic meaning is to show how it determines, together with context, the truth-conditional content of an expression." He gives a list (from which we could draw our own list, simply by using the exemplar sentences to build a piece of non-truth-functional reasoning or practical inference) of "putative counterexamples to [the standard view] ... These are all simple, meaningful, well-formed declarative sentences, each of which seems to lack truth-conditional content, even within a context of utterance. [some of his examples are]:

(a) ... (a) Igor is tall (compared to what?)
(b) Louise is taller (than whom?)
(c) Kati is ready (for what?)
(d) Hendryk arrived (where?) ...

[Szabó points out that] intuitively, the parenthetical questions must be answered before we can assign truth-conditional content to these sentences and, it is claimed, the answers are usually not provided by the context in which they are uttered. From this, it is concluded that to these sentences (and many others) semantics theory must assign something *less* than truth-conditional content" (Szabó [2006, 381–382]). Szabó also points out that some have argued that "such underdetermination [as is present in 9(a), for example] is present in virtually every declarative sentence" (Szabó [2006, 382, footnote 54, referring to Searle [1978] and Travis [1985]).

son, nor that the two share a canonical link. For one thing, maintaining their separateness has the potential to explain their coincidence far better than does the canonical claim, which carries with it a burden of proof which cannot, I think, be met.

Reduced to its bare essentials, the relationship shared by the two need consist only of the following: that they occasionally coincide;[14] that both are frameworks accessible in some way to thought (note that this does not rule out either also being an objective structure) and that both find application in the real world.

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[14] Again, the nature of this coincidence — e.g. if it amounts to the coincidence of areas of application, or of ways of thinking, or of both, etc. — is a question for future work.

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