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CRITICAL NOTICE

Why a modular approach to reason?

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In their reviews, Chater and Oaksford, Dutilh Novaes, and Sterelny are critical of our modularist approach to reason. In this response, we clarify our claim that reason is one of many cognitive modules that produce intuitive inferences each in its domain; the reason module producing intuitions about reasons. We argue that in-principle objections to the idea of massive modularity based on Fodor's peculiar approach are not effective against other interpretations that have led to insightful uses of the notion in psychology and biology. We explain how the reason module evaluates reasons on the basis of their metacognitive properties. We show how the module fulfils a social function, that of producing reasons to justify oneself and convince others and of evaluating the reasons others produce to convince us.

KEYWORDS
inference, metacognition, metarepresentation, modularity, reasoning

We are very grateful to Nick Chater and Mike Oaksford, Catarina Dutilh Novaes, and Kim Sterelny for their generous and challenging reviews. Together, they made 20 objections and suggestions that we wanted to discuss, but in attempting to do so, we ended up with a draft that was much too long and poorly focused. We decided instead to answer in greater depth the one major question raised in all three reviews: is reason a module?

Dutilh Novaes asks what is the "theoretical pay-off" of "construing reason as a specialized module"? In a nutshell, it is to situate reason in the architecture of the mind in a way that makes cognitive and evolutionary sense (something standard approaches to reason fail to do). Reason, we argued, evolved to overcome problems of trust in coordination and in communication that reduced the ability of early humans to properly benefit from their cognitive and social resources. Coordination is helped when reasons are used to explain and justify oneself. Communication is helped when reasons are used as arguments to convince others. To perform this double justificatory and argumentative function, reason evolved the way most adaptations do: by tweaking pre-existing features—in this case, by putting pre-existing metacognitive and metarepresentational abilities to a novel use, namely, the production and evaluation of reasons.

The much longer answer we gave in the book, we now realise, was not sufficiently crisp and compelling. The reviewers found our interactionist approach to reason appealing. They were, however, unsympathetic to our evolutionary psychology perspective, which they found puzzlingly misguided. Let us try, then, to show how this perspective helps make better sense of reason and its social role.

1 | MASSIVE MODULARITY

We begin with the very idea of massive modularity, which Dutilh Novaes and Sterelny explicitly reject. Among philosophers, the discussion of modularity has been dominated by the contribution of Jerry Fodor (1983, 2001). In computer science, biology, or cognitive science, however, other notions of modularity more relevant to empirical research have been developed before or after Fodor. David Marr, for instance, proposed a "principle of modular design": unless, he argued, a complex process is implemented as an articulation of modules that only interact weakly with one another, "the process as a whole is very difficult to debug or to improve, whether by a human designer or in the course of natural evolution" (Marr, 1982, p. 112). This idea that modularity is a condition for evolvability has been well developed in recent evolutionary biology (e.g., Callebaut & Rasskin-Gutman, 2005; Clune, Mouret & Lipson, 2013; Schlosser & Wagner, 2004).

Tooby and Cosmides (1992) made another evolutionary argument in support of a modularist approach: natural selection favours the emergence of adaptations to specific problems and opportunities. Further work in the evolutionary psychology tradition has underscored the interaction between biological evolution, cognitive development, and cultural inputs in psychological modularity (e.g., Barrett, 2005; Barrett & Kurzban, 2006; Carruthers, 2006; Sperber, 1996, 2001, 2005). Our own work belongs to this tradition of evolutionary psychology.

Sterelny acknowledges that our approach to modularity is not Fodor's but stresses that "the Fodorian conception is not arbitrary." Indeed. According to Fodor, if massive Fodorian modularity were true, it would solve the frame problem (but alas, Fodor adds, it obviously is not true, and the frame problem remains unsolved). We are not aiming to solve "the frame problem" (why not? see Sperber & Wilson, 1996). Our aim is to throw light on the mechanisms of reason. Sterelny, however, sees our modularist approach as quite unhelpful in this and other respects. The architecture we propose, he writes, "does not divide a supposedly unified, domain general, but computationally mysterious capacity into more limited, specialised but less computationally mysterious components. Modules as they appear here are still computationally mysterious." Mysterious? Really? Using Chomsky distinction between problems and mysteries, we suggest that a general capacity to think or draw inferences in all possible domains is computationally mysterious, whereas the procedures used by specialised inferential modules as we describe them are, at worst, problematic—and we discussed the problems involved in some detail.

Sterelny himself gives a fair account of a basic idea that, in our eyes, helps make a modularist approach a source of insights into psychological capacities. Cognition, we argue, exploits domain-specific and local regularities in the world. It does not do so by producing representations of these regularities and using them as premises in domain-general inferences. Rather, cognitive procedures evolved or developed to take advantage of these regularities without representing them. While the deployment of these procedures by specific modules yields conclusions that may be either unconscious or intuitive, the procedures themselves are opaque to consciousness.

Sterelny agrees with the role that local regularities play in inference but suggests that they may be exploited by a domain-general inference system rather than by specialised modules.

> "There is a tradition," he writes "that dates back at least to Carnap on meaning postulates […]. Such postulates give us local predicate-specific inferential rules like "if X is red" → "X is coloured" (Carnap, 1952). Local causal contingences can shape inference without being represented as explicit premises. A domain general cognitive architecture might instead have a single but rich set of inferential strategies; strategies which include local, meaning-postulate-like rules that tune the agent to reasonably stable, reasonably general local regularities, as well as inferential rules that are sensitive only to the general formal structure of a representation."

Actually, Sperber and Wilson developed such an account in the chapter on inference of *Relevance* (1995). They assumed that a great many concept-specific rules of inference, similar to Carnap's meaning postulates, were deployed by a domain-general "deductive device." They also envisaged the possibility of various domain-specific heuristics being directly exploited by this domain-general inference mechanism. They progressively came to the conclusion, however, that too much of inference is probabilistic to be represented by deductive rules modelled on meaning postulates, and too much of probabilistic inference is carried out in domain- or task-specific ways to justify replacing a domain-general "deductive device" with a domain-general Bayesian engine of sorts. Concept-specific rules may well play a role as semantic micro-procedures in a linguistic comprehension module; as such, they may contribute to the comprehension of reasons. Sterelny suggests that such rules could serve as "inferential strategies" for a domain-general cognitive system; we do not see how.

Dutilh Novaes worries that, "[b]y describing reason as a module," we "take a stance against a number of unifying accounts of inference, such as Bayesian, probabilistic models." We do not agree. At the "computational level" (to use Marr's, 1982 distinction of three levels of analysis), a Bayesian approach characterises all cognitive processes as approximating optimal statistical inference (e.g., Oaksford & Chater, 2001; Tenenbaum, Kemp, Griffiths & Goodman, 2011) and is indeed a unifying one. On the other hand, at the algorithmic level where cognitive mechanisms are analysed, a Bayesian approach is compatible with the view that mechanisms performing diverse tasks may use different procedures to approximate optimal statistical inference. At this algorithmic level (and also at the implementation level), a Bayesian approach may be espoused not only by those who see cognitive mechanisms as relatively homogeneous but also by dual-system theorists or by modularists like us. Given this, we agree with Chater & Oaksford when they write, "we take M&S's perspective to be entirely compatible with, for example, Bayesian models of cognition in general […] and reasoning and argumentation in particular."

Logic and Bayesian probabilities are relevant to understanding the very possibility of successful inference, but neither comes near providing a plausible unitary or homogeneous model of the psychological *mechanisms* of inference. The more one pays attention to the kind of inferences humans (and other animals) actually make (as opposed to focusing on an abstract notion of inference or on artificial laboratory experiments), the greater the variety of inferential mechanisms one is led to consider, and the more compelling becomes the idea that all inferential mechanisms are modular "to an interesting degree" (to borrow a phrase from Fodor, 1983, p.73).

2 | METAREPRESENTATIONS

In human intuitive ontology, there are not only things but also representations of things. Whatever they represent, representations have a number of properties and exhibit a number of regularities of their own that afford dedicated inference procedures. Mental representations, for instance, stand in

regular relationships to sensory inputs, to behaviour, and to one another; a mindreading module much studied by developmental psychologists (Baillargeon, Scott & He, 2010; Carruthers, 2013; Leslie, 1992) takes advantage of these psychological regularities. Public representations, such as linguistic utterances ostensively produced to communicate, systematically convey a presumption of their own relevance; Sperber and Wilson (2002) have argued that a dedicated comprehension module takes advantage of this regularity in human communication.

Mental representations of reasons, we argued, are metarepresentations, and reason is a metarepresentational module. Sterelny is sceptical, in part at least because he attributes to us a "non-standard view of metarepresentation" far from the one we hold (see Sperber, 2000). Here is an example he offers as evidence against our account:

> I am asked why I chose a particular café and I respond by saying "it is close and cheap." My reason—that the café is close and cheap—is about the café, it is not about the representation of a café. So when I give a reason, I am not producing a metarepresentation.

We agree with Sterelny, of course, that the proposition expressed by the statement "it is close and cheap" is about the café and not about a representation of a café. Such a proposition, however, is not in and of itself a reason any more than, say, a tree is in and of itself "to the right." Of course, a tree, being located in space, is, when seen from a given location, to the right of many things. But attributing to the tree the property of being "to the right" is relevant and truth-evaluable only in a context such as "the tree, viewed from the south, is to the right of the farm." Similarly, "the fact that the café is close and cheap is a reason" is relevant and truth-evaluable only in a context such as "the fact that that the café is close and cheap is a reason to choose it." This is what Kim means when, being asked why he chose a particular café, he answers, "it is close and cheap." Kim's meaning (conveyed in part explicitly, in part implicitly) is a higher-order representation, or metarepresentation, of the relationship of support between two representations, that of a fact about the café and that of a conclusion about which café to go to.

Sterelny grants us that *evaluating reasons* is clearly metarepresentational, but he adds that "*offering reasons* typically is not." We do not agree. To offer some consideration as a reason for some conclusion is, at least implicitly, to present it as a good reason and to encourage the audience to evaluate it as such, as we will now argue in some detail.

3 | MODULARITY OF REASON

Chater and Oaksford object to our claim that reason is a module:

> (I)f reasoning is a species of intuition, namely reasoning about reasons, then the very idea of a reasoning module of any kind seems difficult to sustain. As we have interpreted M&S's claims above, at least, it seems that reasoning is a process by which we reflect on our intuitions and our justifications for those intuitions, and attempt to fill in gaps and reconcile conflicts. The nature of these processes would seem as varied as thought itself: reasoning about chess, geometry, Sudoku, how to write a computer program, decide whether to take a new job, or how to continue a story, can all involve such processes. It is not clear how strongly M&S really want to hang on to the claim that reasoning is modular—clearly they intend this claim in quite a weak sense. It is not at all clear that they need make it at all.

Is there indeed no problem in our claiming simultaneously (a) that any cognitive module exploits regularities in its domain, (b) that the domain of reason is reasons, and (c) that reasons vary greatly according to the domain to which belongs the conclusion they support? How then could reasons exhibit regularities that a reason module could exploit? Standard approaches to reasoning are based on the assumption that reasons have highly regular formal properties of the kind studied in logic and probability theory. We, however, cannot go in that direction as we deny that reasons necessarily or even generally have such internal formal properties. The relevant properties of reasons, we suggested, are not internal but relational properties. The regularities that the reason module can exploit are to be found not inside reasons themselves but in metacognitive intuitions about reasons and the conclusions they support.

None of the reviews mention, let alone discuss, the role we give to metacognition in our account first of intuitions and then of reasons. Intuitions are a loose category of mental states. They are characterised not by the quite diverse procedures of intuitive inference that produce them but, we argued (drawing on Thompson, 2014), by a metacognitive property: a characteristic sense of confidence in one's capacity to arrive spontaneously at a true judgment or at a good decision. In the general case, this sense of confidence is just a non-propositional attitude described in the literature as a "feeling" that accompanies the intuition. At a dinner party, for instance, you may observe with confidence that your friend Ben is in a bad mood without representing your confidence in this intuition.

Still, this metacognitive sense of confidence can also, on occasion, go beyond a mere feeling and take the form of a judgment. Such a metacognitive judgement, as opposed to a mere feeling, is itself a higher-order, or metarepresentational, intuition. Simple metacognitive metarepresentations take a lower-order intuition such as (1) and embed it in a higher-order intuitive judgement such as (2):

(1) Ben is in a bad mood
(2) It is clear that Ben is in a bad mood

One of the main jobs of reason is to flesh out such metacognitive/metarepresentational intuitions by introducing some considerations that support the lower-order embedded intuition as, for instance, in (3):

(3) *The fact that Ben doesn't participate in the conversation and looks exasperated* makes it clear that he is in a bad mood.

The considerations italicised in (3) provide reasons to accept the embedded conclusion that Ben is in a bad mood.

In most cases, the mere feeling of confidence that accompanies your intuition that Ben is in a bad mood is all you need to interpret Ben's ongoing behaviour and to interact with him accordingly. You do not have to mentally represent, on top of that, the fact that you have confidence in your intuition as in (2), let alone consider reasons for such confidence as in (3). There are, however, situations where doing so is useful. Typically, these situations involve communication.

Say you talk to Rachel, another friend at the party:

You: Ben is in a bad mood tonight, don't you think?
Rachel: Really? I didn't notice.

At this stage, producing reasons for your statement may convince Rachel that you are right, or short of convincing her, it may show her that you had some justifications for your opinion that Ben is in a bad mood:

You: Well, he is much less engaged in the conversation than usual, isn't he? And I have seen him looking exasperated a few times.

How can Rachel evaluate the reasons you invoke for judging that Ben is in a bad mood? Or, rather, how can her reason module provide her with an evaluation? Assume that, now that you have mentioned it, she recognises that Ben has been rather withdrawn. As she herself has not been paying much attention to Ben, she is likely to accept your testimony that he was looking exasperated. This information does not, at this point, go to her reason module—which is not equipped to process such information—but to whatever mechanism she uses to infer people's mood from their behaviour (presumably a mindreading module). This mechanism updates her understanding of Ben's state of mind and may yield the conclusion that Ben is, indeed, in a bad mood or, more weakly, that he may not be in his usual good mood.

What you told Rachel triggered in her several cognitive processes: inferences about Ben on the one hand, inferences about what you said on the other. If, based on your observations of Ben's behaviour, she too concludes with confidence that Ben is in a bad mood, this then provides her reason module with metacognitive evidence that your reasons were good reasons. If, on the other hand, Rachel is not fully convinced but is moved by what you told her to revise her understanding of Ben's mood in the direction you suggested, her reason module will have evidence that you had some justification for what you said. Either way, your putting forward reasons is relevant not only to Rachel for updating her beliefs about Ben but also to both of you for updating your common ground.

To generalise, the evaluation by the addressee A of reasons given by a communicator C in favour of a given conclusion proceeds in the following manner. The information communicated as reasons comes with a specific presumption of relevance: it is intended to achieve relevance by supporting the conclusion that the communicator asserted or implicated, and it is interpreted accordingly (by the relevance-guided modular procedure described in Wilson & Sperber, 2012). Once interpreted, this information is processed by competent cognitive modules according to its tenor (a mindreading module, for instance, to process information about someone's mood). The reason module of A has metacognitive access to the degree to which the reasons offered by C convince A to accept C's conclusion. This degree of conviction is treated as indicative of the strength of the reasons.

We are claiming, in other words, that in the kind of elementary case we are considering, A comes to see the reasons given to her as strong because she was convinced by them or as weak because she was not. This stands in stark contrast with the standard view of reason, according to which epistemic judgement on reasons should precede and determine cognitive effects such as acceptance or rejection of the conclusion.

We evaluate reasons somewhat in the way we evaluate a cognitive artefact such as a pair of glasses. Most of us are not equipped to evaluate glasses on the basis of their optical properties, and we do not need to. What we do is try them on, and if we see well, we conclude that these are good glasses for us, and otherwise, we do not. Similarly, if we are presented with reasons and they convince us, we take them to be good reasons, and otherwise, we do not. It is not irrational provided that our intuitive inferences are generally sound and, hence, that only good reasons are likely to convince us. As our inferences are the output of an evolved cognitive system, the function of which is to provide us with genuine information, this extra assumption is not implausible.

Still, what could be the point of evaluating reasons by backward inference from one's intuitive acceptance or rejection of a conclusion they were intended to support? The point is that reasons are part of our ongoing interaction with others. Reasons that are good enough to convince us should be good enough to convince others, or at least to justify in their eyes our having accepted the conclusion they support. In a discussion, interlocutors inform one another of their evaluation of the reasons they

have been presented with, helping others develop better reasons. Reasons can themselves become the object of higher-order arguments, possibly leading again to better reasons and to a revision of our initial claims. Evaluation of reasons can be both post hoc and highly relevant to social interaction and sometimes to the collaborative pursuit of an epistemic goal.

And what about reasoning on one's own? In anticipating a discussion with others, you may start by considering the conclusion you would like them to accept and test, on yourself, considerations that might convince them. If that conclusion is one of which you yourself had been convinced by others, you may, knowingly or unknowingly, resort to the reasons that had convinced you: good reasons are valuable enough to be recycled; they typically propagate together with the conclusions they support. If you are trying to convince others of a conclusion you reached intuitively on your own, you may, in searching for plausible reasons, retrieve from memory bits of information that had been available to you at the time and that may (but need not) have genuinely contributed to causing your intuition. As we argue in the book (see also Carruthers, 2011), we have no introspective access to what triggered an intuition, but we may have indirect evidence. What matters most, anyhow, is that the considerations we come up with should be convincing to our audience, not that they should be those that swayed us initially.

When we prepare reasons to convince a given audience, we may take into account what we know of their beliefs and dispositions. This may lead sometimes to finding reasons better than those that convinced us or to realise that our best reasons are too weak. We may even realise then that our reasons are weak because our conclusion is dubious (but this is not such a common occurrence).

What about truly solitary thinking not aimed at all at convincing others or at justifying oneself? Most of the time, this is what psychologists study under the name of "problem solving." Problem solving can be complex and creative and may qualify as reasoning in a wider sense of the term. Still, problem solving typically involves imagining and evaluating concrete possibilities rather than representations; unlike the production and evaluation of reasons, it is not intrinsically metarepresentational. Note also that problem solving is not specifically human (see, for instance, Bird & Emery, 2009).

4 | CONCLUSION

Individual reason has been hailed not only as what separates humans from beasts but also as the source of humans' greatest intellectual achievements. If our account is right, not only is the function of reason social, but reason works reliably well only when it fulfils its social function. Most of the uses of reason occur in quotidian interactions, but these trivial uses are much less often mentioned than major intellectual achievements taken to best illustrate the power of reason. These achievements, however, are not the product of great individual minds, making, on their own, intellectual discoveries to be improved or superseded by great minds in the next generation. Rather, in each generation, it is the exchange of reasons among people sharing intellectual or practical goals that leads to such achievements.

Our interactionist approach to reason follows from arguments not just about the functions of reason but also about its mechanisms. The function of *producing* reasons in argumentation is to persuade others of an opinion one already holds when one's authority is not sufficient to do so. The function of *evaluating* reasons is to help decide with some degree of objectivity whether or not to adopt an opinion that one is not disposed to accept just on trust. The mechanism of reason works with different effects for the fulfilment of these two complementary functions.

The backward procedure through which the reason module infers reasons from conclusions that one already accepts is not designed for objective thinking, let alone intellectual discovery. It has an inbuilt confirmation bias or, as we prefer to call it, "myside bias." This bias, as we have stressed in much of our work, is not a weakness when reasons are produced to persuade others. On the contrary, it helps find convincing arguments. On the other hand, the bias stands in the way of objectively evaluating our own opinion (as the experimental literature has richly demonstrated).

When evaluating reasons given by others to convince us, on the other hand, we may approach them with some degree of objectivity. In this case, an opinion is under consideration rather than already accepted. We can evaluate reasons offered to support this opinion by means of the metacognitive/metarepresentational insights that our reason module produces on reasons–conclusion relationships. As we pointed out, the soundness of these insights depends on the cognitive effectiveness of lower-level modules. In an evolutionary perspective, however, the effectiveness of a cognitive module can generally be assumed.

Our reviewers found some parts of our account of reason congenial and others objectionable. In this response, we have tried to make the case that the various parts of our account hang together and are mutually supportive. The whole, we hope, might be more illuminating and no less worthy of discussion than any of its part.

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