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► **To cite this version:**

Franz Dietrich, Antonios Staras. Reasoning in versus about attitudes: forming versus discovering one's mental states. 2020, 12 p. halshs-03023015v1

HAL Id: halshs-03023015

<https://shs.hal.science/halshs-03023015v1>

Submitted on 25 Nov 2020 (v1), last revised 8 Jul 2022 (v3)

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Reasoning In versus About Attitudes: How Attitude Formation is Beyond Logic

September 2020¹

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Abstract

One reasons not just in beliefs, but also in intentions, preferences, and other attitudes. For instance, one forms preferences from preferences, or intentions from beliefs and preferences. Formal logic has proved useful for modelling reasoning in beliefs – the formation of beliefs from beliefs. Can logic also model reasoning in multiple attitudes? We identify principled obstacles. Logic can model reasoning *about* attitudes. But this models the discovery of attitudes of (usually) others, not the formation of one’s own attitudes. Beliefs are special in that reasoning in beliefs can follow logical entailment between belief *contents*. This makes beliefs the privileged target of logic, when applying logic to psychology.

1 Introduction

A growing philosophical literature about rationality and practical reasoning teaches us that one reasons not only in beliefs, but in many other attitudes (e.g., Broome 2006, 2013, Kolodny 2005, 2007, Boghossian 2014). One can form preferences from preferences; such reasoning can increase preference transitivity. One can form the intention to help a child walk from the belief one ought to; such reasoning reduces akrasia. One can form the same intention from the intention to make the child happy and the belief the child’s happiness requires the help; such reasoning increases instrumental rationality.

Attitudes can also change through other processes than reasoning, including processes driven by external causes (music can create desires) and internal psychological processes that are purely automatic and unconscious (desires can destroy intentions). We focus exclusively on *reasoning*, and adopt Broome’s (2013) influential account of reasoning.

¹We are grateful for inspiring feedback from colleagues, notably from Robert Sugden and Frederik van de Putte. Franz Dietrich acknowledges support from the French Research Agency through the grants ANR-17-CE26-0003, ANR-16-FRAL-0010 and ANR-17-EURE-0001.

Not just philosophy, but also logic has a legitimate claim on ‘reasoning’. Linking logicians’ reasoning in beliefs to philosophers’ reasoning in general attitudes is surprisingly problematic. Reasoning in attitudes – which Broome calls reasoning ‘with’ attitudes² – is not reasoning *about* attitudes, by which one discovers attitudes rather than forming them. Reasoning about attitudes is special reasoning in beliefs: reasoning in *beliefs about attitudes*, i.e., theoretical reasoning whose object happens to be attitudes. No doubt, logic has much to say about attitudes, which it represents through modal operators; but it notoriously addresses reasoning *about* attitudes, for instance about preferences (e.g., Liu 2011), about beliefs (e.g., Halpern 2017), or about beliefs, desires and intentions (as in ‘BDI logics’). By contrast, reasoning *in* attitudes is practical reasoning where it creates intentions that cause actions. It is more the topic of artificial-intelligence science than of formal logic, since sophisticated intelligent systems form (artificial) attitudes through (artificial) reasoning, including intentions that give rise to actions.

Reasoning about and in attitudes both matter. Reasoning about attitudes matters where agents reason about one another in interactive settings (such as games), or reason about themselves in an act of reflection or introspection. Reasoning in attitudes matters to attitude formation in practical philosophy, practical reasoning, psychology, and artificial intelligence.

Our question is: can logical entailment model reasoning in attitudes, including practical reasoning? Three natural attempts will fail. This suggests that attitude formation and practical reasoning are phenomena beyond logic.

2 What is reasoning in attitudes?

This section discusses and formalises reasoning in attitudes, as far as needed here. The philosophical account follows Broome (2013), and the formalisation follows Dietrich et al. (2019).

2.1 Attitudes and constitutions

The agent – ‘you’ – holds various attitudes (mental states), such as: believing it snows, desiring to feel warm, intending to dress warm, preferring snow to rain, etc. The set of all possible attitudes is denoted M . Those attitudes you possess form your (*mental*) *constitution*, formally a subset $C \subseteq M$.

Think of attitudes in M as pairs of an attitude-content and an attitude-type. For many philosophers, contents are propositional: they are *single* propositions for monadic attitudes like intention, *pairs* of propositions for dyadic attitudes like preference, etc. One could make this structure of states formally explicit.³

²Our terminology might be better distinguishable from ‘reasoning about attitudes’.

³Let L be a set of *propositions*, and A a set of *attitude-types*, each carrying an *arity* $n \in$

We use the term ‘attitude’ not only for states in M (such as: desiring to be warm), but also for attitude-types (such as: desire).

2.2 Reasoning, informally

Your constitution changes through reasoning. In reasoning, you form a (conclusion-)attitude from existing (premise-)attitudes: you form beliefs from beliefs; intentions from beliefs and desires; preferences from preferences; etc. The process is causal: the premise-attitudes cause the conclusion-attitude. It constitutes a conscious mental act. You bring the premise-attitudes to mind by saying their contents to yourself, normally using internal speech. This lets you construct a new attitude, again using (internal) speech. You might reason:

Paying taxes is legally required. So, I shall pay taxes. (1)

This is reasoning from a single premise (a belief) to an intention. The conclusion-attitude has this content: *I pay taxes*. What you say however involves ‘shall’, a linguistic marker indicating that you entertain the content as an intention. In reasoning, you express to yourself the *marked contents* of your premise- and conclusion-attitudes, not the contents simpliciter. Marked contents are contents marked by how the content is entertained: as a belief, or intention, etc. The English language contains markers for various attitude types, allowing you to reason in those attitudes. Beliefs are special: they need no linguistic marker, as the same sentence – in the example: *Paying taxes is legally required* – expresses the belief’s content and marked content.

Importantly, in reasoning you do not say to yourself *that you hold* the attitudes in question. You do not say:

I believe paying taxes is legally required. So, I intend to pay taxes.

This would be reasoning about your attitudes (cf. Section 3.2).

Reasoning is rule-governed: you draw the conclusion by following a *rule* that you endorse, although this endorsement is not an explicit act and requires no awareness of the rule, indeed of the concept of rules. A rule allows forming some (conclusion-)attitude from some existing (premise-)attitudes. Rules can be individuated differently. In its most specific individuation, the rule you follow in (1) is this: from believing that paying taxes is legally required, come to intend to pay taxes. In a broader individuation, the rule is a schema, such as: from believing

$\{1, 2, \dots\}$, usually 1 (monadic attitudes) or 2 (dyadic attitudes). Plausibly, A contains at least belief *bel* (monadic), desire *des* (monadic), intention *int* (monadic), preference \succ (dyadic), and indifference \sim (dyadic). Finally, define *attitudes* in M as tuples $m = (p_1, \dots, p_n, a)$ where a is an attitude type in A , n is its arity, and p_1, \dots, p_n are propositions in L . So, (p, \textit{bel}) is believing p , (p, \textit{int}) is intending p , (p, q, \succ) is preferring p to q , etc.

that ϕ -ing is legally required, come to intend to ϕ (where ϕ is any act). Many rules promote your rationality. Here are examples of rationality-promoting rules, stated informally:

- (a) *Modus-Ponens Rule*: From believing p and believing *if p then q* , come to believe q . Parameters: propositions p, q .
- (b) *Enkratic Rule*: From believing *obligatorily p* , come to intend p . Parameter: propositions p .
- (c) *Instrumental-Rationality Rule*: From intending p and believing *q is a means implied by p* , come to intend q . Parameters: propositions p, q .
- (d) *Preference-Transitivity Rule*: from preferring p to q and preferring q to r , come to prefer p to r . Parameters: propositions p, q, r .

One could modify these rules, and add others. Exactly which rules you follow or should follow is not our topic.

It is debatable how exactly the English language expresses reasoning with these rules, i.e., which linguistic constructions serve to mark attitude-contents. Reasoning in preferences might at first seem obscure, as preferences are dyadic attitudes. Broome (2006) however points out (citing Jonathan Dancy for this insight) that English has a preference marker, namely a construction with ‘rather’. You can reason in preferences as follows:

Rather bike than walk. Rather walk than drive. So, rather bike than drive.

You initially prefer biking to walking, and walking to driving. You come to prefer biking to driving using the Preference-Transitivity Rule, where p, q and r are *I bike, I walk* and *I drive*, respectively.

2.3 Reasoning, formally

As noted, rules can be individuated specifically or more broadly. Our official definition of ‘rule’ chooses the specific individuation. This choice simplifies the formalism; nothing hinges on it. So we define a **reasoning rule** as any specific combination (P, c) of a set of (premise-)attitudes $P \subseteq M$ and a (conclusion-)attitude $c \in M$. The four rule schemas (a)-(d) in Section 2.3 can now be re-stated:

- $(P, c) = (\{\textit{believing } p, \textit{believing if } p \textit{ then } q\}, \textit{believing } q)$ for propositions p, q ,
- $(P, c) = (\{\textit{believing obligatorily } p\}, \textit{intending } p)$ for propositions p ,
- etc. for (c) and (d).

These re-statements are still semi-informal, but formal statements are possible.⁴

⁴First use the formalism in footnote 3 to respectively write $(P, c) = (\{(p, \textit{bel}), (\textit{if } p \textit{ then } q, \textit{bel})\}, (q, \textit{bel}))$ ($p, q \in L$), $(P, c) = (\{(\textit{obligatorily } p, \textit{bel})\}, (p, \textit{int}))$ ($p \in L$), etc. for (c) and (d). Finally, to give formal meaning to composite propositions, assume that to any propositions p, q is assigned a proposition *if p then q* , to any proposition p is assigned a proposition *obligatorily*

You reason with certain rules – ‘your’ rules. Henceforth, S denotes the set of your rules, your **reasoning system**. If you possess all premise-attitudes of a rule $r = (P, c)$ of yours, i.e., your constitution C includes P , then you can form the attitude c . Your new constitution is $C \cup \{c\}$. Should you already possess attitude c (i.e., $c \in C$), then your reasoning has merely ‘reaffirmed’ or ‘refreshed’ this attitude, and your constitution stays $C (= C \cup \{c\})$.

Starting from your initial constitution C , you can reason consecutively with your rules, thereby gradually forming new attitudes. This process converges to a constitution that is **stable under reasoning**, i.e., cannot change further through reasoning, as it contains the conclusion-attitude of each rule in S whose premise-attitudes it contains. This stable constitution – the endpoint of reasoning – does not depend on the order in which you apply your rules. It is denoted $C|S$ and called the **revision of C through reasoning**. Technically, $C|S$ is defined as the minimal extension of C stable under S .⁵ Concretely, you reason towards $C|S$ by first revising C through any rule $(P_1, c_1) \in S$ that is difference-making, i.e., has $P_1 \subseteq C$ and $c_1 \notin C$; then revising the result $C \cup \{c_1\}$ through another rule $(P_2, c_2) \in S$ that is difference-making, i.e., has $P_2 \subseteq C \cup \{c_1\}$ and $c_2 \notin C \cup \{c_1\}$; and so on until no difference-making rules remain. As long as S is finite, this process converges to $C|S$ after some (finite) number of steps. Our formal definition of $C|S$ also takes care of the case of infinite S .

3 Logic cannot model reasoning in attitudes

It is tempting to try to model reasoning in attitudes through the (semantic or syntactic) entailment relation of a suitable formal logic. Surprisingly, we face principled obstacles. Logic can model reasoning *about* attitudes, a third-personal, meta-level process of attitude discovery, but not reasoning *in* attitudes, an internal, first-personal process of attitude formation. The exception is reasoning in beliefs – theoretical reasoning – which logic can capture to an important extent; we return to this exception in Section 4.

To substantiate this claim, we now go (unsuccessfully) through the three most natural attempts to model reasoning in attitudes logically (Section 3.1–3.3). We shall set aside *dynamic* modal logics. These address attitude formation, but not the way we want.⁶

p , etc. Technically, this defines a binary operator $L \times L \rightarrow L$, a unary operator $L \rightarrow L$, etc. This makes the rules (a)-(d) formally well-defined. One could go further and model propositions in L syntactically (intensionally) as sentences in a formal language, or semantically (extensionally) as subsets of some set of possible worlds. This turns operators into syntactic or semantic operators, respectively (cf. Dietrich et al. 2020).

⁵Provably, this minimal extension exists, is unique, and equals the intersection of all stable extensions $C' \supseteq C$.

⁶They address attitude formation triggered by external events (e.g., public announcements),

3.1 Reasoning as entailment between attitude-contents?

Our first, though naive, attempt must be to model reasoning through entailments between attitude-*contents*. After all, this is what works to an important extent for reasoning in beliefs.

The problem with this attempt is rooted in the nature of logic. In the first place, logic deals with relations between propositions, not reasoning. Still, propositions can form attitude-contents. This opens the door for logicians to address reasoning. When logicians do so, they notoriously choose theoretical reasoning: they interpret propositions as *belief*-contents, which turns logical entailment into a model of belief formation, not desire formation, intention formation, etc. One way to explain this ‘belief bias’ is that logic is representational of an external reality, just like beliefs are representational, while desires or intentions are not. Beliefs normally aim to match reality. Desires and intentions have reversed direction of fit: reality should match you desires and intentions. We return to beliefs in Section 4.

Could logicians instead choose desire (or intention etc.), and take entailments to capture reasoning in desires (or intentions etc.)? For instance, does or should desiring p lead to desiring p or q because p entails p or q ? And does or should a tautology p become desired (or intended, etc.) because it is logically true, i.e., entailed by anything? Probably no. But even if entailment successfully captured reasoning in desires (or in intentions, etc.), we would not have modelled reasoning in *multi*-attitudes. Reasoning in desires (or in intentions, etc.) is still mono-attitude reasoning. Once we mix attitude types, as reasoning routinely does, entailment between attitude-contents fails altogether as a model of reasoning: although p and *if p then q* entail q , you would never reason from desiring p and believing *if p then q* to intending q .

In sum, the attempt to model reasoning through entailments between attitude-contents works for reasoning in beliefs (with qualifications discussed in Section 4), is questionable for reasoning in other fixed attitudes (in desires, in intentions, etc.), and fails altogether for reasoning in multi-attitudes.

For even simpler reasons, entailment between attitude-contents cannot model reasoning in non-monadic attitudes, because their contents are not single propositions. Reasoning in preferences (Broome 2006) is reasoning in attitudes towards proposition *pairs*. There are no entailments between pairs.

not internal reasoning. What is dynamic is not entailments, but (processes expressed by) certain sentences, e.g., ‘after such-and-such, you believe such-and-such’. Yet we aim to model the reasoning process through entailments, not sentences. While standard modal logics model reasoning about attitudes, dynamic modal logics model reasoning about attitude *change*.

3.2 Reasoning as entailment between attitudes – reasoning about attitudes?

Could logical entailments between attitudes (not their contents) model reasoning? This requires a logic of attitudes, with modal operators for attitude-types you reason in: a belief operator, an intention operator, a (dyadic) preference operator, etc. Logics of attitudes exist in abundance. Mono-modal logics address one attitude, e.g., belief in ‘doxastic logics’ (e.g., Halpern 2017) and preferences in ‘preference logics’ (e.g., Liu 2011). Multi-modal logics address more than one attitude, e.g., belief, desire and intention in ‘BDI logics’. Logics of attitudes can do many things. Attitudes are rational, the exact meaning of which depends on the logic and is captured by axioms (e.g., axioms requiring that tautologies are believed).

Why do logics of attitudes not model reasoning in attitudes? We first argue that they provide no *literal* model. Later in Section 3.3 we shall even reject that an indirect reduction works.

Assume you reason as follows:

$$I \text{ ought to pay taxes. So, } I \text{ shall pay taxes.} \quad (2)$$

Here a belief leads to an intention, following an instance of the Enkratic Rule in Section 2. If your reasoning is literally modelled by an attitude-entailment, then the logic contains an entailment $B(p) \vdash I(q)$, where B and I are modal operators for belief and intention, and p and q are sentences representing *I ought to pay taxes* and *I pay taxes*, respectively. But the entailment $B(p) \vdash I(q)$ literally reads:

$$I \text{ believe } I \text{ ought to pay taxes. So, } I \text{ intend to pay taxes.} \quad (3)$$

This is not your reasoning (2). You do not reason about your attitudes; you might not even know you have them. You are not your own observer who discovers a belief in you and deduces you have an intention. Rather, you *form* an intention. Attitude-entailment models attitude discovery, not attitude formation. It models reasoning about attitudes.

Worse, the reasoning (3) would be invalid: its premise can hold without its conclusion. Indeed, before your reasoning (2) you believed p without yet intending q . Why, then, does the logic deem the inference $B(p) \vdash I(q)$ valid? Nothing is wrong with the logic, but we have misapplied it. The logic is designed for rational attitudes, and believing p rationally implies intending q . The entailment $B(p) \vdash I(q)$ is justified as an inference about rational agents. Entailments represent reasoning *about rational* attitudes, not reasoning *in your usually-not-rational* attitudes. Reasoning *about* attitudes does not change these attitudes, but creates beliefs about them (cf. Broome 2014 and Dietrich et al. 2019). Were you already

rational, you would not need to reason in attitudes to become more rational. Ironically, assuming rationality of your attitudes enables reasoning about your attitudes, but removes your need to reason in attitudes in pursuit of rationality.

Who reasons? *You* reason in your attitudes, *an observer* reasons about them. That observer could in principle be you – an assumption needed when attempting to model your reasoning as attitude-entailment. This identification between attitude-observer and attitude-holder is another peculiar move of this modelling attempt.

Our discussion has taken rationality to be the target of your reasoning. But you need not reason towards rationality. Instead of (2), you could reason as in Section 2:

Paying taxes is legally required. So, I shall pay taxes.

Here, the premise-belief entails the conclusion-intention as a matter of legal compliance, not rationality. As Broome might say, you reason towards legality, not rationality. So, in a logic of (merely) rational attitudes, reasoning departs from attitude-entailment for a second reason that is beyond the difference between reasoning in and about attitudes. But this additional problem is an artifact of the choice of logic. We could have used a logic of *permissible* attitudes in a suitably general sense, capturing all normative constraints guiding your reasoning, including rational, legal, or other constraints. *Mutatis mutandis*, our argument generalizes: attitude-entailment in a logic of permissible attitudes captures reasoning about (permissible) attitudes, not in attitudes.

3.3 Could reasoning be reduced formally to entailment between attitudes?

Attitude-entailment does not literally ‘mean’ reasoning in attitudes – but might both be structurally equivalent, so that a reduction works? In our example, could we read ‘ $B(p) \vdash I(q)$ ’ non-literally, as representing an intention-formation rather than -discovery, i.e., as representing your reasoning (2) rather than (3)? If so, the entailment would model your reasoning indirectly.

This modelling strategy however presupposes a *Reduction Hypothesis*, which we now state formally. The object to be modelled is your Broomean reasoning, formally the transformation of constitutions $C \subseteq M$ into revised constitutions $C|S$, where S is your given reasoning system (cf. Section 2). We presuppose a logic of attitudes, which represents each possible attitude $m \in M$ by a sentence m^* , given by $O(\phi)$ where O is the relevant attitude operator and ϕ the relevant sentence (if m is *intending to swim*, O is an intention operator and ϕ reads ‘you swim’).⁷

⁷Presumably, the assignment $m \mapsto m^*$ defines a bijective correspondence between M and the

Reduction Hypothesis (RH): You can reason from your attitudes towards an attitude if and only if your attitudes (represented logically) entail that attitude (represented logically). Formally, for all constitutions $C \subseteq M$ and attitudes $c \in M$, $c \in C|S \Leftrightarrow \{m^* : m \in C\} \vdash c^*$.

To illustrate this hypothesis, consider your reasoning (3). c is *intending to pay taxes*, logically represented as $I(q)$, denoted c^* . Your initial constitution C contains *believing you ought to pay taxes*, logically represented as $B(p)$. RH says: you can reason towards the intention if and only if (in a logical representation) your attitudes entail the intention, formally $c \in C|S \Leftrightarrow \{m^* : m \in C\} \vdash I(q)$. This models reasoning towards c (the left side) as an attitude-entailment (the right side).

The sort of reductive model envisioned by RH is a methodologically more systematic version of what we suggested before, namely to model your reasoning (3) by the entailment $B(p) \vdash I(q)$. The example (3) was simplistic: you reason in just one step with just one premise. RH is general. It is deliberately silent on how many reasoning steps used to form c and which attitudes in C take part in reasoning. The phenomenon modelled (the left side) is not an individual instance of reasoning such as (3), but the general possibility to reason from a constitution to an attitude, using whatever number of steps and whatever premise-attitudes. The entailment serving as model (the right side) starts from all your attitudes (represented logically), not just those relevant (in the example: not just $B(p)$). RH treats reasoning as a black box that generates output attitudes from input constitutions, regardless of the psychological mechanism at work, e.g., the number of reasoning steps. This procedural blindness reflects the reduced ambition of the reductive modelling approach, which aims to capture what reasoning achieves ‘in effect’, regardless of ‘how’ it achieves it – an approach taken reluctantly after the more substantive and mentalistically faithful attempts had failed.

But is RH tenable? We raise three objections, one against sufficiency of entailment for reasoning (direction ‘ \Leftarrow ’), one against necessity (direction ‘ \Rightarrow ’), and one against general plausibility.

Against sufficiency. Sometimes you cannot form an attitude although your attitudes entail it. You might be akratic, and unable to form an intention c which rationally follows from your beliefs about what you ought to do. Here your constitution entails c (formally, $\{m^* : m \in C\} \vdash c^*$), but you cannot reason towards c (formally, $c \notin C|S$). Or you believe that having attitude c makes happy; this belief (we assume) rationally entails forming c , to which you are unable. Or your intend to become wise and believe studying is a necessary means, but you are

set of logical sentences of type $O(\phi)$ for some attitude operator O .

psychologically unable to intend to study, although this intention is (rationally) entailed.

Against necessity. Sometimes you reason towards attitudes that do not follow from your attitudes. You might reason from intending to visit Venice and believing that Venice is reachable only by boat or train towards intending to take a boat. Here your premise-attitudes fail to entail your conclusion-intention, as you could rationally have taken a train. As Broome (2013: 219) says, “[i]f it is correct to reason to some conclusion, that is because rationality permits you to reach that conclusion, not because it requires you to do so.”

Ad-hocness charge: Attitude entailments are entailments between propositions saying that you have some attitude, e.g., desire p . Besides such ‘atomic’ attitude propositions, there are many ‘non-atomic’ ones: that you do *not* desire p , that you desire p *and* believe q , etc. It seems ad-hoc to insist that entailments between atomic attitude propositions correspond to Broomean reasoning, since entailments between other attitude propositions do not. An entailment like $\{B(p) \vee I(q), \neg D(r)\} \vdash \neg D(s)$ (for operators of belief B , intention I , and desire D) has no corresponding Broomean reasoning, as Broomean reasoning cannot start from disjunctions or absences of attitudes, and cannot result in absences of attitudes. You can reason *about* absences or disjunctions, but not *in* them (cf. Dietrich et al. 2019).

4 On the special status of reasoning in beliefs

Where do we stand? Reasoning in attitudes differs fundamentally from reasoning about attitudes. It lets you form rather than discover attitudes. It does not follow entailment. Neither does it follow entailment between attitude-*contents* – which models reasoning in beliefs (with some qualifications mentioned shortly). Nor does it follow entailment between *attitudes* – which models reasoning about your attitudes, typically by someone else.

The categorical difference between reasoning in and about attitudes applies even to reasoning in beliefs, i.e., theoretical reasoning (though the case against a formal reduction might be weaker here). However, theoretical reasoning stands out because beliefs normally track an external truth: they normally aim to match the world, and are thus bound by logic. This is why theoretical reasoning follows entailment between attitude-*contents*.

Does it really? Theoretical reasoning sometimes departs from content entailment. You might derive *more* beliefs, by reasoning inductively. You might derive *fewer* beliefs, because subjectively probable (and believed) propositions sometimes jointly entail subjectively improbable (and disbelieved) propositions, as the Lot-

tery Paradox illustrates. We say ‘might’ because our Broomean account of reasoning might escape at least the second objection, since explicit theoretical reasoning might exclude implicit probabilistic considerations.⁸ Yet a third objection certainly applies: theoretical reasoning can pursue non-epistemic goals. It can notably do so by mistake: the Broomean notion of reasoning permits following incorrect rules, as long as the process *seems right* (Broome’s term) to you. It is debatable whether even correct Broomean reasoning in beliefs can follow non-epistemic goals. Can you correctly reason towards a belief in order to become happier, or because rationality requires forming at least one of certain beliefs? If so, this would further disconnect theoretical reasoning from content entailment. Still, content entailment is a first-order approximation of theoretical reasoning. However reasoning in other attitudes seems to be beyond logic.

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⁸A Broomean reasoner can reason (explicitly) in *partial beliefs* (which of course will not follow entailment between the contents of partial beliefs). But this is not reasoning in (straight) beliefs.