HYPERINTENSIONALITY OF DEONTIC MODALS:
AN ARGUMENT FROM ANALOGY[1]

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A plenitude of motivations can and has been be enlisted to speak for the hyper-intensionality of epistemic modals. This fact is well-known and many logical frameworks have been introduced to capture the fine-grained nature of epistemic modals. Recently, hyperintensionality of deontic modals has been brought into the focus. Paradoxes of deontic logic and the failure of substitution of classical equivalents have been enlisted to motivate hyperintensionality in deontic logic. This paper formulates a new argument for hyperintensionality of deontic modals. The argument is based on an over-looked analogy between epistemic logic and deontic logic. This leads us to the question whether any hyperintensional framework apt for epistemic modals would be apt for deontic modals as well. The paper argues that many, but not all would be.

Keywords: Analogy – Belief – Deontic logic – Epistemic logic – Hyperintensionality – Obligation

1. Introduction

Sophie is a modal logician. Despite being clever, valid formulas sometimes surprise her. Think of theorems with dozens of boxes and diamonds in them! She can and does fail to believe in many of them. In fact, it is quite plausible to claim that she fails to believe in infinitely many of them. Related to this restriction, she sometimes believes in a formula of modal logic, but fails to believe in its (much more complex) equivalent. And she may very well have contradictory beliefs, unbeknownst to her. And this is much more likely when these beliefs come from different sources.

Similarly, there are some valid formulas that are not prescribed by Decalogue. Interestingly enough, even a stronger claim can be defended. In particular, it can be

argued that no logically valid sentence is obligatory. This seems to be true of De-ca-logue, and of many other normative systems. This is so, because there is no need to *protect* the truth of a valid sentence by a moral or legal code: prescriptions of this kind would be futile. Moreover, the existence of an empty normative system seems to be at least logically possible (such "state of nature" is thinkable and does not seem to be contradictory; see Hilpinen and McNamara 2013, 60). Also, while Decalogue pre-scribes to honour your father and your mother, it does not prescribe to honour your father and your mother and that *p* implies *p*. Similarly, it does forbid to kill, but does not forbid to kill and to square the circle. Such additions would be irrelevant. And while Decalogue seems to be free of normative conflicts, normative systems may contain hid-den contradictions. And this is much more likely when many different normative sys-tems regulate someone's behaviour.

A plenitude of motivations can be and has been enlisted to speak for the hyperin-tensionality of epistemic modals (expressions such as *(an agent) knows that…*, *(an agent) believes that…*, *(an agent) excludes that…*, and so forth), some of them infor-mally discussed in the first paragraph of this introduction. Of course, this fact is well-known and many logical frameworks were introduced to capture this fine-grained na-ture of epistemic modals.

Recently, hyperintensionality of deontic modals (expressions such as *it is obliga-tory that*, *it is permitted that*, *it is forbidden that*, *(an agent) ought to…*, *(an agent) is allowed to…*, and so forth) has been brought into the focus (cf. Anglberger, Faroldi and Korbmacher 2016, Glavaničová 2015 and 2017, Faroldi 2019a and 2019b). Paradoxes of deontic logic and the failure of substitution of classical equivalents have been en-listed as the main motivation for going hyperintensional in deontic logic.

In this paper, I will formulate a new argument for hyperintensionality of deontic modals. The argument is based on an over-looked analogy between epistemic logic and deontic logic. Hyperintensionality of deontic modals has been construed as a separate problem. My suggestion is that hyperintensionality of deontic modals is analogous to hyperintensionality of epistemic modals.

There is a lack of research related to examining hyperintensional epistemic logics in order to find apt frameworks for hyperintensional deontic logic (as a consequence of overlooking the analogy). As soon as we acknowledge the analogy, we are led to the question whether any hyperintensional framework apt for epistemic modals would be apt for deontic modals as well. The paper argues that many, but not all would be. This in turn motivates new, yet unexplored research topics for deontic logic: exporting and testing different frameworks for hyperintensional epistemic logic; finding out how ex-tensive the analogy is; and finally, considering if any important disanalogies have sur-faced.

2. Hyperintensionality of Epistemic Modals: Motivations

In 1984, H. J. Levesque published an influential paper titled *A Logic of Implicit and Explicit Belief*. Levesque, among others, attempted to overcome the problem of logical omniscience and related worries in epistemic logic (cf. Rantala 1982, Fagin and Halpern 1988). The problem of logical omniscience consists in modelling agents as logically omniscient (i.e. modelling agents as knowing or believing all the consequences of what they know or believe).[2] Levesque claimed that none of the following holds for real people and their beliefs:[3]

(1E) Every valid sentence must be believed.

(2E) If two sentences are logically equivalent, then one must be believed if the other is.

(3E) If a sentence and its negation are both believed, then so must every sentence.

It is hard to disagree with Levesque on this issue. Indeed, people are not theorem provers. We do not believe every valid sentence. It is plausible to say that we believe just a finite number of valid sentences, and fail to believe infinite number of valid sentences. We can be surprised by theorems. We do not believe all equivalents of our beliefs. We may have all the pieces of a puzzle, but still lack the complete picture. And we will be hesitant to infer everything once we found out that our beliefs contain a contradiction.

Also, in the context of epistemic logic there is an interesting complication: the problem of bounded rationality. In a nutshell, this problem consists in modelling agents as rational but not logically omniscient. According to Jago (2014a) and (2014b), rationality requires that we cannot determinately say that an agent has failed to make a trivial inference. Yet every consequence is a result of the chain of trivial inferences. Mark Jago concisely summarizes the problem in the abstract of his (2014b):

> Real-world agents do not know all consequences of what they know. But we are reluctant to say that a rational agent can fail to know some trivial consequence of what she knows. Since every consequence of what she knows can be reached via chains of trivial consequences of what she knows, we have a paradox.

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[2]There are many variants of this problem; see Fagin, Halpern, Moses and Vardi (1995, 335 – 336).
[3] Note that these have their standard names in the literature. For the ease of reference, I will use 1E-3E for the following three problems of epistemic logic and 1D-3D for related issues in deontic logic.

Because of this, it is not easy to capture the bounded rationality of agent. The problem contains complexities which go beyond the (already complex) problem of logical omniscience and related difficulties.

3. Hyperintensionality of Epistemic Modals: A Treatment

Levesque suggested the following treatment: (1E)-(3E) hold only for implicit belief, but not for explicit belief. He thereby preserved the inferentially strong (and interesting) logic but limited the scope of its applicability. Explicit beliefs correspond to an agent's actual beliefs (it is not required that all consequences of an agent's beliefs be explicitly believed, so the problem of logical omniscience is avoided). Yet there is a sense in which beliefs can be treated as closed under logical consequence. Levesque explains this sense in terms of implicit beliefs: what the world would be like if the agent's beliefs were true (Levesque 1984, 198). Implicit beliefs are deductively closed, so considering 1E-3E, it therefore follows that (i) every valid proposition must be implicitly believed, (ii) if two propositions are logically equivalent, then one must be implicitly believed if the other one is and (iii) if a proposition and its negation are implicitly believed, then every proposition must be believed. However, nothing remotely similar can be said about explicit beliefs. Explicit beliefs account for the fact that real agents are not logically omniscient.

Yet it should be noted that Levesque's logic of explicit beliefs is not syntactic. He employs relevance logic for explicit beliefs (from the perspective of proof theory) and models them in terms of impossible world semantics (from the perspective of semantics). Because of this, some inferences can be made even with explicit beliefs. From one point of view this is a virtue, while from another it is a vice. If the account were syntactic, it would be utterly uninteresting from the logical point of view. On the other hand, some questionable inferences pass. For instance, if $\varphi \wedge \psi$ is explicitly believed, $\psi \wedge \varphi$ is explicitly believed and if $\varphi \vee \psi$ is explicitly believed, $\psi \vee \varphi$ is explicitly believed. This may be problematic in the context of epistemic logic (see Fagin, Halpern, Moses and Vardi 1995, 364). An agent may, for instance, be able to derive $\varphi \vee \psi$, but unable to derive $\psi \vee \varphi$ (imagine a program which proceeds to compute the left disjunct first – where φ can be easily computed but a computation of ψ will never terminate).

Also, Jago (2015, 4) criticises such notion of implicit belief: "It is sometimes said that we "implicitly" believe all consequences of what we believe. But unless there is some guarantee that we always avoid inconsistent beliefs, this notion is trivial. We do have non-explicit beliefs, but these do not include all consequences of one's explicit beliefs." It may thus be controversial to hold 3E even for implicit beliefs. Yet it seems to depend heavily on how one interprets implicit beliefs. If we understand implicit beliefs as what will an agent infer, 3E is problematic. Admittedly, no agent would dare to

infer the whole language, even when facing a contradiction. The present interpretation of the implicit belief is different, and can live peacefully with 3E.

Many other solutions to 1E-3E have been proposed, some using the implicit-explicit distinction, others trying to find the right degree of fine-grainedness. An interesting branch of theories that aim to overcome logical omniscience stems directly from Levesque's theory: the logic of awareness, cf. Fagin and Halpern (1988), Fagin, Halpern, Moses and Vardi (1995), Halpern (2001), Schipper (2015). Other approaches, such as Transparent Intensional Logic (TIL) use structured meanings; cf. Tichý (1988), Duží, Jespersen and Materna (2010). Importantly, TIL has been applied to computing inferable knowledge or beliefs of agents in Duží and Menšík (2017). Admittedly, the prevalent branch employs impossible worlds, which are also employed in Levesque's logic, but also in Rantala (1982) and in countless recent papers on hyperintensionality; see for instance Jago (2014a). There are also theories that use primitive hyperintensions; see Pollard (2008) and Faroldi (2016).

All these theories are hyperintensional in the sense that the substitution of classical equivalents fails in the context of epistemic operators (see Jespersen and Duží 2015). Admittedly, discussing strengths and weaknesses of these accounts goes beyond the purpose of the present paper. However, it is important to keep in mind that there are many interesting proposals on how to overcome the above problematic features of standard epistemic systems.

4. From Epistemic Logic to Deontic Logic: The Analogy

My observation is that there are analogous problems in deontic logic. To show the parallelism, it is enough to formulate Levesque's three problematic features of epistemic logic in deontic terms (thereby speaking about obligations instead of beliefs). Let us thus look at 1D-3D, which are deontic analogues of epistemic points 1E-3E:

(1D) Every valid sentence must be obligatory.

(2D) If two sentences are logically equivalent, then one must be obligatory if the other is.

(3D) If a sentence and its negation are both obligatory, then every sentence must be.

Indeed, all of these are problematic. As regards 1D, Von Wright claimed that norms with tautologous content are not genuine (in his 1991, 270 and elsewhere). Moreover, 1D would exclude "the apparent possibility" that nothing is obligatory (cf. Hilpinen and McNamara 2013, 60).

As regards 2D, several deontic paradoxes are rooted in this validity and related validity concerning logical implication rather than logical equivalence: Ross's paradox, Prior's paradoxes, problems related to the Free Choice Permission, the Good Samaritan Paradox, and the Gentle Murderer Paradox, to name some of the most famous ones. Concerning the free choice permission, consider implausible derivations that result from the addition of the free choice principle: $P(\varphi \vee \psi) \rightarrow P\varphi \wedge P\psi$; cf. Sven Ove Hansson (2013, 207 – 217). Five of the implausible derivations discussed by Hansson employ 2D. Hansson claims that the fourth, $P\varphi \rightarrow P(\varphi \wedge \psi)$, suggests that "the free choice postulate may be faulty in itself" (op. cit., 208). Only the free choice postulate and the extensionality principle (our 2D) were employed in the derivation, and the result is "utterly implausible", for it has the following counterintuitive instance: "if you are allowed to ask a stranger for directions to the railway station then you are allowed to ask him for directions to the railway station and then steal his wallet when he answers" (ibid.). Another implausible derivation related to the extensionality principle is the vegetarian's free lunch example, which runs as follows: "You may have a meal with meat or a meal without meat. Therefore, you may either have a meal and pay for it or have a meal and not pay for it" (op. cit., 218). The extensionality principle in deontic logic was criticised by proponents of hyperintensional deontic logic (see for instance, Anglberger, Faroldi and Korbmacher 2016).

3D, which goes under the name "deontic explosion", is certainly very counterintuitive. When some proposition and its negation are both obligatory, we surely do not infer that everything is obligatory. Moreover, since the accessibility relation in the semantics of SDL is serial, we can infer a contradiction from conflicting oughts (it is expected that normative systems are internally consistent). This is even more implausible, so considerable attention has been devoted to developing logics for conflicting oughts (see Goble 2013; Kulicki and Trypuz 2016; 2019).

Three features that Levesque considered problematic in epistemic logic are thus also problematic in deontic logic, what constitutes the base of the present analogy. In other words, if Levesque's way of motivating hyperintensionality suffices in epistemic logic, a parallel motivation should suffice in deontic logic.

5. What Deontic Logic Can Borrow from Epistemic Logic?

Subsequently, the above observation (of the parallelism between epistemic logic and deontic logic) brings up the question whether frameworks parallel to hyperintensional epistemic logics would work for deontic modals. I will defend an affirmative answer to this question. This in turn motivates new, yet unexplored research topics for deontic logic. In the subsequent text, I will focus on three alternatives in this direction: impossible world semantics; awareness structures; and procedural semantics. I will

leave aside truth-maker semantics which has been already explored in the context of deontic logic in the work of Anglberger, Faroldi and Korbmacher. My aim is to informally sketch and motivate the possibilities we have – even though I cannot go into formal details in the present paper.

To begin with, Levesque introduced his logic of implicit and explicit belief to overcome these issues, so it may be promising to adopt a similar strategy in deontic logic. Interestingly enough, this distinction (implicit versus explicit) is already being used in deontic logic, albeit often in a very informal fashion. Both Hansson (2013) and Hansen (2013) employ this distinction informally. Hansen (2013, 168) considers the proposal that "imperatives that are only derived do not exist on quite the same level as explicit imperatives" and that "a difference must be made between explicitly used imperatives, and imperatives that only derive from explicit imperatives". Hansson (2013, 201 – 204) distinguishes between explicit (explicitly formulated), implied (derived from the explicit permissions; implicit in the present terminology), and tacit permissions (derived from the absence of forbiddance). Yet he is aware of the fact that tacit permissions are also derived, and thereby implied. Van der Torre and Tan (1997, 91) employ the implicit-explicit distinction in an analogous way as Levesque (1984) does: "An explicit obligation is an obligation that has been uttered explicitly (an imperative), and an implicit obligation is an obligation that follows from explicit obligations." A distinction between implicit and explicit obligations or permissions thus finds an informal background in theorizing about deontic modals. In addition, this distinction (formalised in a logic of implicit and explicit beliefs with impossible world semantics and relevance logic) was apt to deal with problems related to 1E-3E that have been discussed in this paper.

Given that 1E-3E found their deontic analogies in 1D-3D, formulating a logic of implicit and explicit norms (employing relevance logic and impossible world semantics) is a promising direction for future research, and such logic would be able to deal with 1D-3D. However, it seems that there are no deontic parallels when it comes to the problem of bounded rationality.[4] Because of this, deontic logicians

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[4] I cannot explain this point in full detail in the present paper, but a possible justification for this hypothesis is as follows: In the epistemic context, rational agents can fail to infer even an exceptionally trivial consequence. Because of this, as Jago (2014a) and (2014b) argued, epistemic accessibility has vague boundaries. In the deontic context, several reasons can be enlisted against vague boundaries of deontic accessibility. The contrary would be particularly problematic in the legal domain. Consider, for instance, the legal principle *ignorantia juris non excusat*. An agent may fail to infer even a trivial consequence, but this will not affect what is legally prohibited and what is legally permitted. Another reason is that in the legal context, vague boundaries of deontically admissible, deontically prescribed, and deontically prohibited conduct would be extremely problematic from the practical point of view. Because of this, logic containing vagueness of this kind would not be apt for application in the legal domain.

need not venture into impossible world semantics as complicated as, for instance, the one proposed by Mark Jago (2014a). This is an important disanalogy between epistemic logic and de-ontic logic. A simple impossible world semantics employed by Levesque would suffice for the purpose of analysing deontic modals.

Another interesting alternative is provided by deontic awareness structures. Epistemic awareness structures are based on the idea that explicit or strong belief is defined in terms of implicit belief and awareness (i.e., whenever I have an implicit belief and I am aware of the proposition believed, I have an explicit belief). While the approach is often taken to be "off the table" due to its syntactic flavour, these misgivings are not entirely justified. It is true that the simplest awareness logic is purely syntactic (i.e., awareness has no nontrivial properties and consequently, explicit belief has no nontrivial properties). However, more elaborated awareness logics employ a notion of awareness which has nontrivial properties (see Fagin, Halpern 1988).

Let $\mathcal{A}_a(s)$ be the set of propositions an agent a is aware of at the state s; and let φ and ψ be propositions. For instance, if order of presentation of conjuncts is irrelevant, we could have $\varphi \wedge \psi \in \mathcal{A}_a(s)$ iff $\wedge \varphi \in \mathcal{A}_a(s)$. If an agent is aware of a proposition iff he or she is aware of its negation, we would have that $\varphi \in \mathcal{A}_a(s)$ iff $\neg\varphi \in \mathcal{A}_a(s)$. Moreover, awareness could be closed under subformulas: if $\varphi \in \mathcal{A}_a(s)$ and ψ is a subformula of φ, then $\psi \in \mathcal{A}_a(s)$. Furthermore, only a certain subset of the primitive propositions could be in the awareness set, say Ψ. In this case we could take $\mathcal{A}_a(s)$ to consist of exactly those formulas which only mention primitive propositions that appear in Ψ. There are also many other possible constraints which consider the relation between awareness and other epistemic modals.

Which of the above are relevant in the context of deontic logic? It seems that awareness closed under subformulas is particularly useful in the present context. This is so because this constraint does not allow for deriving irrelevant explicit obligations. Admittedly, the constraint is quite restrictive. However, it still allows us to make simple derivations (e.g., if $O_a^*(\varphi \wedge \psi)$ holds, $O_a^*\varphi$ holds too). The constraint can be captured axiomatically as follows (where $O_b\varphi$ stands for implicit obligation for an agent b and $O_b^*\varphi$ stands for its explicit counterpart):

1. $A_a\neg\varphi \rightarrow A_a\varphi$
2. $A_a(\varphi \wedge \psi) \rightarrow A_a\varphi \wedge A_a\psi$
3. $A_a(A_b\varphi) \rightarrow A_a\varphi$
4. $A_a(O_b\varphi) \rightarrow A_a\varphi$
5. $A_a(O_b^*\varphi) \rightarrow A_a\varphi$

Another promising alternative is that only a certain subset of the primitive propositions could be in the awareness set. This is another way of restricting the possibility of deriving irrelevant explicit obligations. For instance, if a certain chemical compound is not on the "official" list of prohibited chemical compounds, any proposition restricting its usage would be irrelevant from the normative perspective. Note that any notion of awareness which is built on peculiar epistemic notions would not be helpful in the present context.

Yet another option is a procedural semantics of TIL for deontic modals (see Glavaničová 2015 and 2017 for preliminary attempts in this direction). The analysis of epistemic modals in TIL distinguishes between explicit and implicit belief (or knowledge). The core idea is to model explicit obligations in terms procedural semantics of hyperintensions and to model implicit obligations in terms of possible world semantics (intensions). Another attempt to analyse deontic modals in TIL was briefly indicated in Kuchyňka (2012). While Glavaničová employs a propositional deontic logic, the account suggested by Kuchyňka is closer to deontic action logics.

6. Concluding Remarks

The present paper argued that there is an overlooked analogy between epistemic logic and deontic logic: a parallel between certain problems in epistemic logic (various forms of the problem of logical omniscience and related worries) and certain problems in deontic logic (the possibility of an empty normative system, paradoxes of deontic logic, deontic explosion). Levesque and others proposed various hyperintensional frame-works for epistemic logic to deal with problems centring around logical omniscience. The present paper suggested that, keeping in mind the proposed analogy, fine-grained epistemic logics can offer a promising starting point for deontic logicians attempting to develop a fine-grained account of deontic modals.[5] Finally, the paper sketched three alternatives following this direction.

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[5] The present paper attempted to stay as informal as possible. For an example of formal deontic logic following some of the ideas formulated in this paper, see our Glavaničová and Pascucci (2019).

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