Individuating beliefs: DP objects of attitude verbs and their domains of quantification[1]

Nina HASLINGER — *Georg-August-Universität Göttingen*

Abstract. Attitude predicates can take DP arguments that seem to quantify over propositions. But letting the DPs range over *arbitrary* propositions predicts incorrect truth conditions when combined with a standard possible-worlds semantics for attitude verbs. Here, I develop a new descriptive generalization characterizing the relevant propositions: Each set *S* of propositions the determiner combines with is restricted to those propositions that partially answer a question in a certain set, and are 'minimal' within *S* among the partial answers to that question. The set of questions is derived from the Hamblin sets of questions raised in the context. While this paper does not provide a full analysis, I argue that the effects of this generalization are not limited to attitude predicates, suggesting that it reflects a more general property of DP quantification.

Keywords: propositional attitudes, monotonicity, DP quantification, context-dependency.

1. Introduction

A property of attitude predicates that has received relatively little attention in linguistic semantics (but see e.g. Moltmann 2008, 2013; Elliott 2017) is their ability to combine with DP arguments, especially quantificational DPs like *something* in (1a) and *the same thing* in (1b).

(1) a. *John believes something Mary (also) believes.*
    b. *John and Mary believe the same thing.*

Since such DPs appear to quantify over potential attitude contents, they have attracted the attention of philosophers interested in the question whether the ontology underlying natural language semantics must include abstract objects encoding attitude contents, like propositions (e.g. Quine 1960; cf. also Geach 1972). Quine (1960: §44) ultimately dismisses the relevance of such examples because of "how uncertain one feels about sufficient conditions for identity of objects of the propositional attitudes". The goal of this paper is to investigate the linguistic phenomenon behind this uncertainty – the contribution of context to the truth conditions of sentences like (1). Examples will mostly come from German, which is not to say that German is special in this respect; to my knowledge, there is no cross-linguistic study of this topic.

The focus will be on two classes of examples, which I call **restricted higher-order existentials** (exemplified by (1a) and (2a)) and **higher-order identity statements** (exemplified by (1b) and (2b)). In the former, an indefinite DP in an opaque argument position contains a relative clause with a gap in another opaque argument position – the object position of *glauben* 'believe' in (2a). The latter are sentences in which *the same thing(s)/dasselbe* in an opaque argument position has what Beck (2000) calls an 'NP-dependent reading' relative to a plural expression.

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(2) a. *Der Peter glaubt etwas, das auch die Maria glaubt.*
the Peter believes something REL also the Maria believes
'Peter believes something Maria also believes.'

b. *Der Peter und die Maria glauben dasselbe.*
the Peter and the Maria believe the.same
'Peter and Maria believe the same thing(s).'

As the term 'higher-order' suggests, my starting point is a somewhat naive approach to the ontological issue just mentioned: I follow Hintikka (1969) in taking attitude verbs to combine with propositions, which are modeled as functions from possible worlds to truth values. Within this framework, Elliott (2017) argues that sentences like (1) and (2) involve quantification over genuine propositions rather than individuals or events associated with propositional content (see also Section 6). Following him, I take (1) and (2) to involve DPs that denote or quantify over propositions, which I call **higher-order DPs (hDPs)**.[2] This general picture raises two questions: Which propositions do the hDPs in (2a,b) quantify over? And are there constraints on these propositions that go beyond the usual contextual variability of the domains of natural language quantifiers? In this paper, I will concentrate on establishing two descriptive claims: I) The reason the truth conditions of (2a,b) are so elusive is that they are context-dependent. The set of propositions quantified over systematically depends on a contextual parameter whose value is a question meaning; more specifically, it only contains propositions that partially answer that question. II) Not all partial answers to that question have the same status: Certain answers are 'too weak' to be in the domain of the hDP, a phenomenon first discussed in Zimmermann's (2006) work on intensional transitive verbs that I call the **non-monotonicity effect**.

The paper is structured as follows. After showing that the non-monotonicity effect extends to attitude predicates in Section 2, I motivate the claim that hDPs depend on a question parameter, using higher-order identity statements (Section 3). In Sections 4 and 5, I show that this context-dependency is not enough to account for the truth conditions of restricted higher-order existentials, and develop a descriptive generalization about the conditions under which the monotonicity effect arises in restricted higher-order existentials with *believe*. Finally, in Section 6, I argue that the non-monotonicity effect is not specific to hDPs and propose a second descriptive generalization about the class of predicates that give rise to it. In Section 7, I conclude and mention various unresolved questions.

2. The non-monotonicity effect

My starting point will be Hintikka's (1969) analysis of attitude verbs like *believe* as universal quantifiers over possible worlds (3).[3]

(3) a. $[\![believe]\!] = [\![glauben]\!] = \lambda w.\lambda p_{\langle s,t\rangle}.\lambda x_e.\forall w'[w' \in \text{DOX}(w)(x) \rightarrow p(w')]$

b. $\text{DOX}(w)(x) = \{w' \mid w' \text{ is compatible with } x\text{'s beliefs in } w\}$

[2]This class of expressions is called 'propositional DPs' by Elliott (2017) and 'special quantifiers/special pronouns' by Moltmann (2008, 2013).

[3]I assume an interpretation function $[\![\cdot]\!]^{g,\mathfrak{c}}$ that is relativized to a context $\mathfrak{c}$ and an assignment g and maps each expression of type a to its intension w.r.t. g and $\mathfrak{c}$, an element of $D_{\langle s,a\rangle}$. I omit $\mathfrak{c}$ and g if they are irrelevant. The domains of variable assignments are sets of indices, where an index is a pair (i,τ) of a natural number i and a semantic type τ. A variable assignment is a partial function g from indices to denotations such that, for every $(i,\tau) \in \text{dom}(g)$, $g(i,\tau) \in D_\tau$. Following Heim and Kratzer (1998), I assume that at LF, the index of a moved constituent is adjoined immediately below it.

This analysis has a serious problem with sentences like (1a). Consider a 'naive' semantics for (1a) based on my present assumptions. The indefinite hDP denotes an existential quantifier over propositions. For simplicity, I will decompose *something* into an existential determiner and a noun *-thing* with no lexical semantic content, both of which have meanings given by cross-categorial schemata (4a,b). The relative clause then involves a trace of type $\langle s,t\rangle$ in the object position of *believe*. This gives us the LF in (4c), which denotes the proposition in (4d).

(4) a. For any type a: $[\![\exists_a]\!] = \lambda w.\lambda \mathscr{P}_{\langle a,t\rangle}.\lambda \mathscr{Q}_{\langle a,t\rangle}.\exists x_a[\mathscr{P}(x) \wedge \mathscr{Q}(x)]$
b. For any type a: $[\![\textit{-thing}_{\langle a,t\rangle}]\!] = [\![\textit{-was}_{\langle a,t\rangle}]\!] = \lambda w.\lambda x_a.1$
c. $[[\exists_{\langle s,t\rangle}$ [*-thing*$_{\langle\langle s,t\rangle,t\rangle}$ $[(2,\langle s,t\rangle)$ [*Mary* [*believes* $\mathrm{t}_{(2,\langle s,t\rangle)}$]]]]] $[(1,\langle s,t\rangle)$ [*John* [*believes* $\mathrm{t}_{(1,\langle s,t\rangle)}$]]]]
d. $\lambda w.\exists p_{\langle s,t\rangle}[\forall w'[w' \in \mathrm{DOX}(w)(\textbf{mary}) \rightarrow p(w')] \wedge \forall w'[w' \in \mathrm{DOX}(w)(\textbf{john}) \rightarrow p(w')]]$

The problem is that (4d) is trivially true. This is because the verb meaning in (3a) is **upward-monotonic** with respect to its propositional argument: For any individual x, world w and propositions p and q, if $[\![\textit{believe}]\!](w)(p)(x)$ and p entails q ($p \sqsubseteq q$), then we also have $[\![\textit{believe}]\!](w)(q)(x)$. This property has some linguistic motivation – for instance, (5) is odd, if not contradictory.

(5) *#John believes it is raining heavily, but he does not believe it is raining.*

Let us now take an arbitrary proposition p such that $[\![\textit{believe}]\!](w_0)(p)(\textbf{mary})$ holds and an arbitrary proposition q such that $[\![\textit{believe}]\!](w_0)(q)(\textbf{john})$ holds. (Given the semantics in (3a), such propositions can always be found since any individual x 'believes' $\mathrm{DOX}(w_0)(x)$ in w_0.) Since p entails the disjunction $p \vee q$, we have $[\![\textit{believe}]\!](w_0)(p \vee q)(\textbf{john})$ due to upward-monotonicity. Along the same lines, $[\![\textit{believe}]\!](w_0)(p \vee q)(\textbf{mary})$. So there is at least one proposition – $p \vee q$ – that satisfies the existential statement in (4d), regardless of whether John's and Mary's epistemic states intuitively have anything in common. The actual truth conditions of restricted higher-order existentials involving *believe* and its German counterpart *glauben* therefore do not seem to reflect the monotonicity properties these predicates intuitively have, a phenomenon I call the **non-monotonicity effect**.

The first detailed study of this effect, Zimmermann (2006), concentrated on intensional transitive predicates like *look for* which, if analyzed as in Montague (1974) or Zimmermann (1993), are also upward-monotonic with respect to their opaque argument position. Zimmermann notes that an upward-monotonic predicate meaning, when combined with a semantics for the DP that involves unrestricted quantification over the type of the opaque complement, predicts (6) to be true whenever John is engaged in a search and Mary is engaged in another search, even if the goals of their searches are completely unrelated.

(6) *John is looking for something that Mary is looking for (too).*

Since the intuitive truth conditions of (6) are stronger than that and (1a) appears to be non-trivial, there must be something wrong with the DP semantics in (4) or with our standard assumptions about monotonicity properties of opaque predicates. For (6), Zimmermann (2006) proposes to reject the assumption that *look for* is lexically upward-monotonic. While his approach to *look for* can be extended to attitude verbs, this would require an analysis of ordinary complement clauses as quantifiers over propositions to account for the effect of upward-monotonicity in examples like (5). As discussed in Haslinger (2019: ch. 6), this requires a radical revision of the LF syntax and semantics of attitude complements.[4] In this paper, I therefore want to explore a different possibility, namely that the effect is due to DP semantics and connected to an empirical property of examples like (1a) that I have ignored so far: the contextual variability of their domains of quantification. Let us model this by giving the determiner an additional argument position which is filled by a variable of the same type as its restrictor and its nuclear scope – in the case of (1a), a set of propositions. (1a) would then have the LF in (7b) with the interpretation in (7c).

(7) a. For any type a: $[\![\exists^c_a]\!] = \lambda w.\lambda \mathscr{C}_{\langle a,t\rangle}.\lambda \mathscr{P}_{\langle a,t\rangle}.\lambda \mathscr{Q}_{\langle a,t\rangle}.\exists x_a[\mathscr{C}(x) \wedge \mathscr{P}(x) \wedge \mathscr{Q}(x)]$

b. $[[[\exists^c_{\langle s,t\rangle}\ C_{(3,\langle\langle s,t\rangle,t\rangle)}]$ [-*thing*$_{\langle\langle s,t\rangle,t\rangle}$ $[(2,\langle s,t\rangle)$ [*Mary* [*believes* $\mathrm{t}_{(2,\langle s,t\rangle)}$]]]]] $[(1,\langle s,t\rangle)$ [*John* [*believes* $\mathrm{t}_{(1,\langle s,t\rangle)}$]]]]

c. $[\![(7\mathrm{b})]\!]^g = \lambda w.\exists p_{\langle s,t\rangle}[p \in g(3,\langle\langle s,t\rangle,t\rangle) \wedge \forall w'[w' \in \mathrm{DOX}(w)(\mathbf{mary}) \rightarrow p(w')]$ $\wedge \forall w'[w' \in \mathrm{DOX}(w)(\mathbf{john}) \rightarrow p(w')]]$

Crucially, if $g(3,\langle\langle s,t\rangle,t\rangle)$ happens to be a set of propositions that is not closed under disjunction, (7c) comes out as non-trivial in spite of the upward-monotonic verb semantics. The question, then, is i) whether there is independent support for this context-dependency and ii) if so, whether this is all we need to derive the non-monotonicity effect. I will argue for a positive answer to question i) in Section 3 and for a negative answer to ii) in Section 4.[5]

3. Domain restriction via contextually provided questions

To bring out the contribution of context to the interpretation of hDPs, let us first focus on a seemingly analogous puzzle about higher-order identity statements like (2b). Since the NP-dependent reading of *same/dasselbe* gives rise to a compositionality problem beyond the scope of this paper, I will simply give a denotation for the VP *dasselbe glauben* 'believe the same thing' that lets it take a plural individual as its subject (8). Given (8), (2b) is predicted to be true iff the set of propositions Peter believes is the same as the set of propositions Maria believes. This is to say that their epistemic states are identical, which is clearly too strong.

(8) $[\![\textit{dasselbe glauben}]\!] = \lambda w.\lambda x_e.\exists S_{\langle\langle s,t\rangle,t\rangle}.\forall y_e[y \leq_a x \rightarrow \{p_{\langle s,t\rangle} \mid [\![\textit{glauben}]\!](w)(p)(y)\} = S]$
where $\leq_a$ is the atomic-part relation on individuals (cf. Link 1983)

As before, we could address this problem by assuming that *dasselbe* actually compares only those of Peter's and Maria's beliefs that are in a contextually given set of propositions. Like the indefinite in (7b), *dasselbe* could introduce a domain-restriction variable that is mapped to a set of propositions by the variable assignment:

(9) $[\![[\textit{dasselbe}\ C_{(i,\langle\langle s,t\rangle,t\rangle)}]\ \textit{glauben}]\!]^g =$
$\lambda w.\lambda x_e.\exists S_{\langle\langle s,t\rangle,t\rangle}.\forall y_e[y \leq_a x \rightarrow \{p_{\langle s,t\rangle} \mid p \in g(i,\langle\langle s,t\rangle,t\rangle) \wedge [\![\textit{glauben}]\!](w)(p)(y)\} = S]$

If so, we should be able to see clear effects of contextual domain restriction once the broader discourse context provides a value for $C_{(i,\langle\langle s,t\rangle,t\rangle)}$. As an illustration, consider the dialogue in

[4]According to Ede Zimmermann (p.c.), the observation that this puzzle extends to attitude predicates was independently made by Maribel Romero.

[5]Whether the idea that restricted higher-order existentials are non-trivial due to contextual domain restriction can be extended to Zimmermann's (2006) original examples, like (6), is not obvious. While these are context-dependent too (see Haslinger 2019: 93ff.), this context-dependency is harder to study systematically, since unspecific complements of *look for* arguably denote properties or quantifiers. While a set of propositions can be made salient by asking a question, the linguistic means of making sets of *properties* salient are less well understood.

(11) – where speaker A is clearly asking for beliefs relevant to the question who will make it to the final – in scenarios (10a) and (10b).

(10) SCENARIOS: Peter and Maria are German soccer 'experts' who were just interviewed on TV about the upcoming World Cup final.
a. Peter believes Germany will play Brazil in the final and Germany will win. Maria believes Germany will play Brazil and Brazil will win.
b. Peter believes Germany will play Brazil in the final. Maria believes France will play Brazil.

(11) a. [A: *The big question is who will make it to the final. What do our experts think?*]
b. B: *Peter und Maria glauben dasselbe …*
Peter and Maria believe the.same
'Peter and Maria believe the same thing.' **true** in (10a), **false** in (10b)

The fact that (11b) can be judged true in scenario (10a) shows that it does not involve quantification over arbitrary propositions: Even if Peter and Maria disagree on the question who will win the final, what matters is that their answers to the question posed in (11a) are the same. In contrast, (11b) is most naturally judged false in scenario (10b), which suggests that it is not enough if Peter and Maria agree on *some* partial answer to that question (the contrast becomes more clear-cut with *genau dasselbe* 'exactly the same thing(s)'). At this point, a plausible generalization is that in a context like (11a), which explicitly asks for beliefs 'about' a certain question Q, the quantificational domain is restricted to propositions that partially answer Q:

(12) **hDP Generalization 1 (to be revised)**
hDPs that quantify over propositions involve a contextual parameter whose value is a question extension Q. Their domain is restricted to the set of partial answers to Q.

The relevant notion of partial answerhood can be defined as follows. I take question extensions to be sets of propositions along the lines of Hamblin (1973), e.g. $[\![\textit{who will be in the final}]\!](w_0) = \{[\![\textit{Brazil will be in the final}]\!], [\![\textit{Germany will be in the final}]\!], \ldots\}$. Against this background, we can define a **strongly exhaustive answer** to a question extension Q as a proposition that specifies for each element of Q's Hamblin set whether or not it is true and does not provide any other information (13). A **partial answer** is then a non-trivial disjunction of strongly exhaustive answers (14). Note that unlike the notion of 'weakly exhaustive answer', (14) permits arbitrary Boolean combinations of the elements of the Hamblin set, including their negations.

(13) The set $\textsc{sea}(Q)$ of strongly exhaustive answers to a question extension Q is defined as $\{(\lambda w.\forall p \in S.p(w) \wedge \forall p \in Q \setminus S.\neg p(w)) \mid S \subseteq Q\}$.

(14) The set $\textsc{pa}(Q)$ of **partial answers** to a question extension Q is defined as $\{\bigvee R \mid R \subset \textsc{sea}(Q) \wedge R \neq \emptyset\}$.

That hDPs are not just sensitive to strongly exhaustive answers is shown by the contrast in (15), where neither scenario involves a subject who believes a strongly exhaustive answer.

(15) a. SCENARIO: Peter and Maria both believe that Germany will be in the final, but they have no opinion about the second finalist. (11b) **true**
b. SCENARIO: Peter believes Germany will be in the final. Maria believes Brazil will make it. Neither of them has an opinion about the second finalist. (11b) **false**

Adverbials like *was die Frage Q betrifft* 'concerning the question *Q*' or *zur Frage Q* 'as for the question *Q*' allow us to explicitly shift the question parameter of a hDP. For instance, the modifier in (16) seems to have the same effect as the context in (10) and (11a). From now on, I will concentrate on examples with such modifiers. However, the parameter explicitly shifted in (16) is implicitly present in sentences without the modifiers as well. Arguably, this is why the truth value of such sentences is hard to judge when they are presented with little or no context.

(16) *Zur Frage, wer ins Finale kommt, glauben Peter und Maria dasselbe.*
to.the question who into.the final comes believe Peter and Maria the.same
'Concerning the question who will make it to the final, Peter and Maria believe the same thing.' **true** in (10a), **false** in (10b)

According to (12), a hDP restricted by a question *Q* quantifies over the actual partial answers, but not over other propositions that are relevant to *Q* in the sense that they entail a partial answer. This is confirmed by examples like (17b), where propositions like ⟦*John owns a red car*⟧ cannot be in the domain of *dasselbe* (if they were, (17b) would be false in scenario (17a)).

(17) a. SCENARIO: Anna and Brit are organizing a car parade in their village. They need to find out who owns a car and what colors the cars are. The local authorities have now given them an exhaustive list of all car owners. But the authorities have no data about the colors of the cars. Brit has now found out the colors of most cars, but she has not told Anna yet. Anna does not know the color of any car.
b. *Zur Frage, wer hier ein Auto besitzt, wissen Anna und Brit dasselbe.*
to.the question who here a car owns know Anna and Brit the.same
'As for the question who owns a car here, Anna and Brit know the same thing(s).' **true** in (17a)

In sum, at least for *glauben*[6], generalization (12) is a good approximation of the truth conditions of higher-order identity statements. We will now see that restricted higher-order existentials are subject to non-trivial additional restrictions that do not follow from (12).

4. The non-monotonicity effect revisited: Domain restriction is not enough

(12) makes a clear prediction about our motivating example (2a): It should be true relative to a question *Q* iff there is at least one partial answer to *Q* that Peter and Maria both believe. But once a broader range of scenarios is considered, we find a more complex pattern, illustrated in (19). This section will focus on the contrast between what I will call the '$a \vee b/a \vee b$ scenario' (19a) and the 'a/b scenario' (19b); scenario (19c) will be considered in Section 5.

[6] With attitude predicates like *wissen* 'know' (but, at least in my judgment, not for *glauben* 'believe'), hDPs appear to have a reading on which they do not range over partial answers at all, but rather over 'pieces of evidence' that might be relevant to answering the question. This is illustrated by (ib), which would be false in scenario (ia) if the hDP *fast alles* 'almost everything' quantified over partial answers. I think that a broader study of the linguistic differences between knowledge and belief attributions is needed to understand this reading.

(i) a. SCENARIO: Anna is studying the question which MPs will keep their seats after the next election. She is familiar with almost all of the available information, including polls and interviews with the MPs and their staff, but she still cannot make reliable predictions about most of the seats.
b. *Zur Frage, wer wiedergewählt wird, weiß die Anna fast alles.*
to.the question who reelected AUX knows the Anna almost everything
'As for the question who will be reelected, Anna knows almost everything.' can be **true** in (ia)

(18) *Zur Frage, wer heute zum Abendessen kommt, glaubt der Peter etwas,*
to.the question who today to.the dinner comes believes the Peter something
das auch die Maria glaubt.
REL also the Maria believes
'Concerning the question who will come to dinner tonight, Peter believes something Maria also believes.'

(19) a. $a \vee b / a \vee b$ SCENARIO: Three people were invited: Ada, Brit and Carl. Peter believes at least one of Ada and Brit will come. Maria also believes at least one of Ada and Brit will come. They have no other relevant beliefs. (18) **true**
b. a/b SCENARIO: Three people were invited: Ada, Brit and Carl. Peter believes Ada will come and has no other relevant beliefs. Maria believes Brit will come and has no other relevant beliefs. (18) **false**
c. $a \wedge b / b \wedge c$ SCENARIO: Three people were invited: Ada, Brit and Carl. Peter believes Ada and Brit will come. Maria believes Brit and Carl will come. They have no other relevant beliefs. (18) **true**

Let a, b and c be the propositions $[\![$*Ada will come*$]\!]$, $[\![$*Brit will come*$]\!]$ and $[\![$*Carl will come*$]\!]$, respectively. If the domain of the *wh*-phrase in (18) is restricted to Ada, Brit and Carl, the embedded question has the Hamblin set $Q = \{a, b, c\}$. The disjunction $a \vee b$ is then a partial answer to Q. Generalization (12) therefore correctly predicts (18) to be true in the $a \vee b / a \vee b$ scenario (19a).[7] In the a/b scenario, however, (18) is most naturally judged false even though we have $[\![$*believe*$]\!](w_0)(a \vee b)(\textbf{peter})$ and $[\![$*believe*$]\!](w_0)(a \vee b)(\textbf{maria})$ due to upward-monotonicity. Why does the partial answer $a \vee b$ count in one scenario, but not the other?

This example suggests that the non-monotonicity effect persists even if we control for context-dependency by explicitly providing a question that restricts the hDP's domain. Thus, while generalization (12) correctly predicts (18) to be non-trivial, it still fails to derive the non-monotonicity effect. At this point, one could claim that the domain of a hDP restricted by a question contains just the elements of the Hamblin set and possibly their negations, while the other partial answers are disregarded. Since $a \vee b$ is not a Hamblin answer in (18), this would account for the effect in the a/b scenario.[8] At first sight, this hypothesis seems like a non-starter since it predicts (18) to be false in the $a \vee b / a \vee b$ scenario as well. But the following variant is worth taking seriously:

(20) **hDP Generalization 2 (to be revised)**
hDPs of type $\langle\langle s,t\rangle,t\rangle$ contain a domain-restriction variable whose value is the Hamblin set of a question Q. Their domain is restricted to propositions that are either in Q or in the Hamblin set of a contextually salient subquestion of Q.

(21) For current purposes, a question Q is a **subquestion** of another question Q' iff any

[7] Daniel Büring (p.c.) notes that (18) sounds a bit odd in scenario (19a). I think this judgment reflects a Quantity implicature: In (19a), Peter and Maria believe the same relevant propositions, so a stronger alternative involving *dasselbe* 'the same' could have been uttered. (30) below, which is otherwise analogous, avoids this issue.

[8] The assumption that $a \vee b$ does not count as a Hamblin answer is also required for the generalization I ultimately propose in Section 5. It is worth noting that there are good arguments for the existence of a 'higher-order reading' of *wh*-questions which, if analyzed in Hamblin's (1973) framework, would give rise to a Hamblin set closed under disjunction unless the question contains other scope-taking operators (see e.g. Spector 2007). This raises the open question how the phenomena motivating this reading interact with the interpretation of hDPs.

strongly exhaustive answer to Q' entails a strongly exhaustive answer to Q given general world knowledge.[9]

The intuition behind (20) is that the non-monotonicity effect can be obviated by making certain subquestions salient, as shown in (22). Context (22a) establishes the subquestion which continents the teams in the final will come from. Since (22b) is true in the scenario, the proposition ⟦*a European team will be in the final*⟧ seems to be in the domain of the indefinite hDP. This is surprising since, given general world knowledge, this proposition is equivalent to a disjunction of several Hamblin answers to the question ⟦*who will be in the final*⟧. If the question introduced by the modifier were all that mattered, we would therefore expect a non-monotonicity effect in both (22a) and (19b), for the same reason. But since (22a) introduces a subquestion that has ⟦*a European team will be in the final*⟧ in its Hamblin set, the effect does not arise.

(22) a. SCENARIO: Peter and Maria are discussing the upcoming World Cup with their friend Fritz. They have a long-standing disagreement about the question which continent(s) the teams in the final will come from. Peter believes that France will make the final and Maria believes that Germany will make it. But Fritz believes that both finalists will be South American teams like Brazil or Uruguay.

b. *Zur Frage, wer ins WM-Finale kommt, glaubt der Peter*
to.the question who into.the World.Cup-final comes believes the Peter
etwas, das auch die Maria glaubt.
something REL also the Maria believes
'As for the question who will make it to the World Cup final, Peter believes something Maria also believes.' **true**

This observation suggests the following explanation of the contrast in (19): In the $a \vee b/a \vee b$ scenario, the proposition $a \vee b$ is explicitly mentioned, which makes the subquestion $Q' =$ ⟦*whether at least one of Ada and Brit will come*⟧ salient. The Hamblin set of this subquestion clearly contains $a \vee b$. In contrast, nothing in the a/b scenario (19b) makes Q' salient.

One argument against the approach in (20) involves 'asymmetrical' scenarios in which one of the two attitude subjects believes a disjunction, while the other believes one of the disjuncts. An example is given in (23). If the judgment in the $a \vee b/a \vee b$ scenario were due to the fact that a disjunctive partial answer is mentioned, we would expect an equally clear-cut judgment for the $a \vee b/a$ scenario. However, this is not borne out: While restricted higher-order existentials are sometimes accepted in scenarios like (23), judgments vary a lot and some speakers I consulted report being unsure about the judgment. Further work on examples like (23) is needed to determine the source of the variation.

(23) $a \vee b/a$ SCENARIO: Three people were invited: Ada, Brit and Carl. Peter believes at least one of Ada and Brit will come. Maria believes that Ada will definitely come. They have no other relevant beliefs. (18) %**not true**

Instead of pursuing an explanation based on the contextual salience of a disjunction, I will therefore try to describe the contrast in (19) in semantic terms. On a semantic approach, the

[9]The relativization to general world knowledge, which is not included in some otherwise similar definitions in the literature (e.g. Groenendijk and Stokhof 1984: 220, (7)), is arguably needed to account for the World Cup example (22) since, say, ⟦*France will be in the final*⟧ does not *logically* entail ⟦*a European country will be in the final*⟧.

a/b scenario shows us that the restrictor and the nuclear scope of the hDP are each narrowed down by a mechanism that is sensitive to logical strength. That is, if Peter has a belief p that partially answers the question provided by the modifier – or one of its salient subquestions – then his logically weaker beliefs that answer the same question are disregarded. A first precise statement of this generalization is given in (24): (24a) defines an operator $\text{MINPA}_{\sqsubseteq}$ ('minimal partial answers with respect to logical strength') that applies to a set $\mathscr{Q}$ of questions and a predicate P of propositions and returns a predicate true of only those propositions satisfying P that i) partially answer a question Q in $\mathscr{Q}$ and ii) are minimal w.r.t. $\sqsubseteq$ among the propositions in P that partially answer Q. (24b) then says that both arguments of the indefinite determiner are obligatorily restricted by $\text{MINPA}_{\sqsubseteq}$. The relevant set $\mathscr{S}_{w,\mathfrak{c}}$ of questions includes the contextually provided question plus any subquestions that were explicitly raised in the preceding discourse.

(24) **hDP Generalization 3 (to be revised)**

a. For $P \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ and $\mathscr{Q} \in D_{\langle\langle\langle s,t\rangle,t\rangle,t\rangle}$:
$\text{MINPA}_{\sqsubseteq}(\mathscr{Q})(P) = \lambda w.\lambda p.P(w)(p) \wedge \exists Q \in \mathscr{Q}[p \in \text{PA}(Q) \wedge \neg\exists p'[p' \sqsubseteq p \wedge p \neq p' \wedge P(w)(p') \wedge p' \in \text{PA}(Q)]]$

b. With respect to a contect $\mathfrak{c}$ and assignment g, a restricted higher-order existential with the determiner $\exists_{\langle s,t\rangle}$, the restrictor predicate P, the nuclear scope P' and the domain-restricting question C is interpreted as
$\lambda w.[\![\exists_{\langle s,t\rangle}]\!](w)(\text{MINPA}_{\sqsubseteq}(\mathscr{S}_{g,w,\mathfrak{c}})([\![P]\!]^{g,\mathfrak{c}})(w))(\text{MINPA}_{\sqsubseteq}(\mathscr{S}_{g,w,\mathfrak{c}})([\![P']\!]^{g,\mathfrak{c}})(w))$,
where $\mathscr{S}_{g,w,\mathfrak{c}}$ is the set containing $[\![C]\!]^{g,\mathfrak{c}}(w)$ and those of its subquestions that were raised in the preceding discourse in $\mathfrak{c}$.

How does this account for the data pattern? Let Q be the Hamblin set $\{a,b,c\}$ as above and let $\mathfrak{c}$ be a context in which no subquestions were raised. According to (24), (18) is true in the $a \vee b/a \vee b$ scenario w.r.t. $\mathfrak{c}$ iff the sets in (25a-i) and (25a-ii) have a nonempty intersection. Since $a \vee b$ is both Peter's and Maria's strongest partial answer to Q in the scenario, this condition is satisfied. In contrast, in the a/b scenario, $a \vee b$ is eliminated both from the restrictor and from the nuclear scope by $\text{MINPA}_{\sqsubseteq}$ since Peter and Maria each believe a logically stronger partial answer. (18) is then predicted to be false.

(25) a. $a \vee b/a \vee b$ SCENARIO:

(i) $\text{MINPA}_{\sqsubseteq}(\{Q\})([\![[(1,\langle s,t\rangle)\ [\textit{Peter}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{\mathfrak{c}})(w_0) = \{a \vee b\}$

(ii) $\text{MINPA}_{\sqsubseteq}(\{Q\})([\![[(1,\langle s,t\rangle)\ [\textit{Maria}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{\mathfrak{c}})(w_0) = \{a \vee b\}$

b. a/b SCENARIO:

(i) $\text{MINPA}_{\sqsubseteq}(\{Q\})([\![[(1,\langle s,t\rangle)\ [\textit{Peter}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{\mathfrak{c}})(w_0) = \{a\}$

(ii) $\text{MINPA}_{\sqsubseteq}(\{Q\})([\![[(1,\langle s,t\rangle)\ [\textit{Maria}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{\mathfrak{c}})(w_0) = \{b\}$

In the World Cup scenario (22), the two questions $Q = [\![\textit{which teams will be in the final}]\!]$ and $Q' = [\![\textit{which continent(s) the teams in the final come from}]\!]$ are both relevant. Let us say that the proposition that there will be a European team in the final partially answers Q'. Note that $\text{MINPA}_{\sqsubseteq}(\mathscr{Q})(P)$ is the property of being a proposition that, for *some* question in $\mathscr{Q}$, is $\sqsubseteq$-minimal among the propositions in P that partially answer $\mathscr{Q}$. Thus, after $\text{MINPA}_{\sqsubseteq}$ applies, the restricted set of Peter's beliefs and the restricted set of Maria's beliefs will still both contain the proposition $[\![\textit{there will be a European team in the final}]\!]$ because neither of the two has a stronger partial answer to Q', although their partial answers to Q are stronger.

(26) a. $\text{MINPA}_{\sqsubseteq}(\{Q,Q'\})([\![[(1,\langle s,t\rangle)\ [\textit{Peter}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{\mathfrak{c}})(w_0)$

$= \{[\![\textit{France will be in the final}]\!], [\![\textit{a European team will be in the final}]\!]\}$

b. $\textsc{MinPA}_{\sqsubseteq}(\{Q, Q'\})([\![[(1, \langle s,t\rangle)\ [\textit{Maria}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{c})(w_0)$
$= \{[\![\textit{Germany will be in the final}]\!], [\![\textit{a European team will be in the final}]\!]\}$

Finally, what about the $a \vee b/a$ scenario (23)? Here the predictions of (24) seem a bit too clear-cut: If the adverbial contributes the question $Q = [\![\textit{who will come to dinner}]\!]$ with the restricted Hamblin set $\{a,b,c\}$ and no other subquestions of Q are fed to $\textsc{MinPA}_{\sqsubseteq}$, we end up with two singleton sets containing Peter's and Maria's strongest answers to Q – $\{a \vee b\}$ for Peter and $\{a\}$ for Maria. Since these sets are disjoint, (18) comes out as false in the scenario. One potential way of making sense of the unclear judgments might be that, since $a \vee b$ is explicitly mentioned in the scenario, a hearer could, but does not have to, accommodate a context in which the polar question whether $a \vee b$ was raised. In such a context, $\textsc{MinPA}_{\sqsubseteq}$ will return the set $\{a, a \vee b\}$ when applied to Maria's beliefs, so the two sets intersected by $\exists_{\langle s,t\rangle}$ are no longer disjoint.

Let me summarize the results of the last two sections. We started with the observation that higher-order identity statements are evaluated relative to a restricted domain of propositions that depends on a contextually provided question. This seems to solve our initial puzzle – why restricted higher-order existentials have non-trivial truth conditions – but on closer inspection, it is not enough to derive the non-monotonicity effect. I therefore proposed that each of the sets of propositions intersected by the indefinite determiner should first be narrowed down to those of its elements that are the subject's strongest answer to a subquestion in a certain set. This set contains the contextually given question as well as any subquestions explicitly raised in the context. In the next section, I will discuss two further refinements of this generalization.

5. Refining the descriptive generalization

5.1. Canonical subquestions

In the $a \wedge b/b \wedge c$ scenario (19c), our running example (18) is judged true, intuitively because both attitude subjects believe $b = [\![\textit{Brit will come}]\!]$. But as in the a/b scenario, Peter's strongest answer to the pertinent question, $a \wedge b$, and Maria's strongest answer, $b \wedge c$, are logically independent. The sets of propositions returned by $\textsc{MinPA}_{\sqsubseteq}$ are therefore disjoint (28) and our current generalization (24) predicts (18) to be false despite the shared belief.

(27) $a \wedge b/b \wedge c$ SCENARIO
a. $\textsc{MinPA}_{\sqsubseteq}(\{Q\})([\![[(1, \langle s,t\rangle)\ [\textit{Peter}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{c})(w_0) = \{a \wedge b\}$
b. $\textsc{MinPA}_{\sqsubseteq}(\{Q\})([\![[(1, \langle s,t\rangle)\ [\textit{Maria}\ [t_{(1,\langle s,t\rangle)}\ \textit{glaubt}]]]]\!]^{c})(w_0) = \{b \wedge c\}$

Since the logical relations between Peter's and Maria's shared beliefs and their strongest relevant beliefs are the same in the a/b and $a \wedge b/b \wedge c$ scenarios, we need to go beyond such relations to account for the lack of a non-monotonicity effect in the $a \wedge b/b \wedge c$ scenario. I submit that, while the basic idea of comparing the attitude subjects' strongest answers to certain subquestions of a *wh*-question Q is correct, we should consider a larger set of subquestions that includes at least all those subquestions derivable by restricting the domains of the *wh*-phrases in Q. Given a Hamblin semantics, this is easy to define:

(28) The **canonical subquestions** of a question extension Q are the non-empty subsets of the Hamblin set of Q.

The set of subquestions passed to the $\textsc{MinPA}_{\sqsubseteq}$ operator will contain the question Q contributed

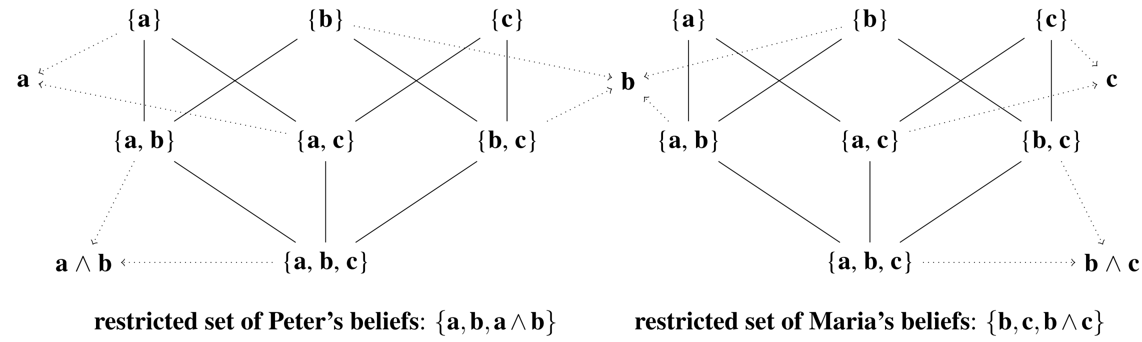

Figure 1: Restricted sets of propositions for the $a \wedge b/b \wedge c$ scenario (19c)

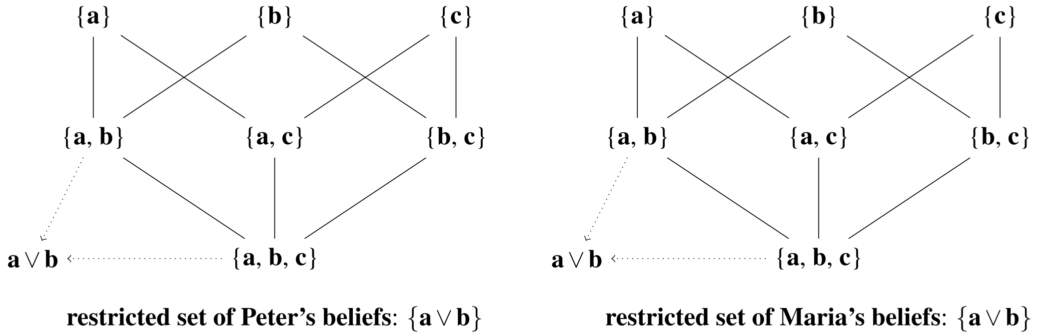

Figure 2: Restricted sets of propositions for the $a \vee b/a \vee b$ scenario (19a)

by the modifier and those subquestions explicitly raised in the discourse, but in addition, it will be closed under canonical subquestions. Thus, if the question $\{a,b,c\}$ ('Who among Ada, Brit and Carl will come?') is in this set, so are $\{a,b\}$ ('Who among Ada and Brit will come?') and $\{a\}$. I take the latter set to correspond to the polar question 'Will Ada come?', *contra* Hamblin's (1973) assumption that the extension of a polar question also contains the negative answer.[10] The restricted set that we get by applying $\text{MINPA}_{\sqsubseteq}$ to a given subject's beliefs will then also contain those propositions that are the subject's strongest partial answer to at least one canonical subquestion. This principle is summarized in (29):

(29) Given a question Q and a world w, each argument P of the indefinite determiner in a hDP restricted by Q, when evaluated in w, is narrowed down to $\text{MINPA}_{\sqsubseteq}(\mathscr{S}_{Q,w,\mathfrak{c}})(P)(w)$, where $\mathscr{S}_{Q,w,\mathfrak{c}}$ is the smallest set that contains $Q(w)$ and the subquestions of $Q(w)$ raised in the preceding discourse context in $\mathfrak{c}$ and is closed under canonical subquestions.

How does this account for the $a \vee b/a \vee b$ and $a \wedge b/b \wedge c$ scenarios? The predictions are summarized in Figures 1 and 2. For each attitude subject x, every canonical subquestion Q that x can partially answer is connected by dotted arrows to the strongest proposition x believes that partially answers Q – i.e. the answer that will remain after $\text{MINPA}_{\sqsubseteq}$ has applied. For the $a \wedge b/b \wedge c$ scenario, since $\{b\}$ is a canonical subquestion and b is both Peter's and Maria's

[10]To my knowledge, the main empirical reason to include negative answers in the Hamblin sets of polar questions is that polar questions embedded under predicates like *know* lack the 'weakly exhaustive' reading observed for *wh*-questions, which is insensitive to the subject's epistemic state w.r.t. negative answers. However, since the existence of this reading is disputed anyway (see e.g. Cremers and Chemla 2016), I am not fully convinced by this argument.

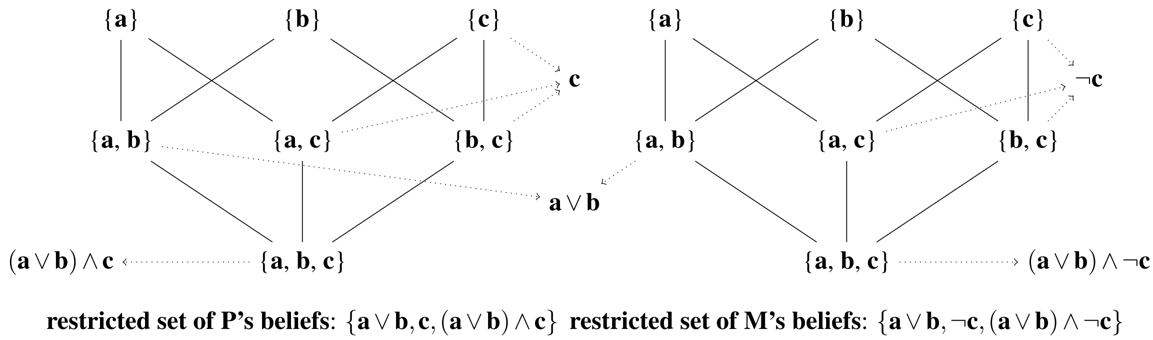

Figure 3: Restricted sets of propositions for the $(a \vee b) \wedge c/(a \vee b) \wedge \neg c$ scenario (30)

strongest partial answer to that question, b will still be contained in both arguments of the indefinite determiner after we apply $\textsc{MinPA}_{\sqsubseteq}$. Why is the a/b scenario different? Since $\{a \vee b\}$ is not a canonical subquestion of $\{a,b,c\}$, there is no canonical subquestion that $a \vee b$ is Peter's strongest partial answer to: While Peter believes an answer to the question $\{a\}$ ('Will Ada come?') that entails $a \vee b$, $a \vee b$ is not itself a partial answer to that question. The canonical subquestion $\{a,b\}$ *is* partially answered by $a \vee b$, but in this case $a \vee b$ is excluded by $\textsc{MinPA}_{\sqsubseteq}$ since Peter also believes the stronger answer a.

The proposal also accounts for scenarios like (30) that involve both disjunctive and non-disjunctive beliefs. Since $a \vee b$ is both subjects' strongest answer to the canonical subquestion $\{a,b\}$, the restricted sets of beliefs will have a non-empty intersection even though they believe incompatible answers to the canonical subquestion $\{c\}$, which also makes their respective strongest answers to $\{a,b,c\}$ incompatible (see Figure 3).

(30) $(a \vee b) \wedge c/(a \vee b) \wedge \neg c$ SCENARIO: Three people were invited: Ada, Brit and Carl. Peter believes at least one of Ada and Brit will come and Carl won't come. Maria believes at least one of Ada and Brit will come and Carl will come. They have no other relevant beliefs. (18) **true**

In sum, we have seen that sentences involving hDPs are sensitive to the internal structure of question denotations.[11] Note that compared to hDP generalization 2, which also made crucial reference to the Hamblin set, the present approach is more permissive: On our current generalization, the output of the $\textsc{MinPA}_{\sqsubseteq}$ operator is a property that may still be true of disjunctive answers, in case there is some canonical subquestion Q such that the disjunction is the subject's strongest belief that partially answers Q.

5.2. Downward-monotonic predicates

We now have a better understanding of the effects of context on restricted higher-order existentials with *believe*. But does this approach generalize to other attitude predicates? Recall

[11]Sometimes, we need a more fine-grained notion of 'canonical subquestion' that is not based on standard Hamblin sets. For instance, ⟦*who owns the books*⟧ should arguably have ⟦*whether Anna owns book 1*⟧, ⟦*whether Brit owns book 2*⟧ etc. among its canonical subquestions. The relevance of plurals for the part-whole structure of questions is independently motivated by Beck and Sharvit (2002), who show that a more permissive notion of subquestion is needed to account for certain cases of quantificational variability effects.

that for *believe*, we predict that a proposition may be 'disregarded' if the subject also believes a logically stronger proposition that partially answers the same relevant subquestions. This reference to logical strength might become problematic when we consider downward-monotonic predicates. A relatively clear case of a downward-monotonic attitude verb in German is *ausschließen* 'rule out', which can also appear in restricted higher-order existentials (32). I will assume the simple possible-worlds semantics in (31) for this verb.

(31) $[\![ausschließen]\!] = \lambda w.\lambda p_{\langle s,t\rangle}.\lambda x_e.\forall w'[w' \in \text{DOX}(w)(x) \rightarrow p(w') = 0]$

(32) *Zur Frage, wer am Tatort war, schließt der Peter etwas aus, das*
to.the question who at.the crime.scene was rules the Peter something out REL
die Maria auch ausschließt.
the Maria also out-rules
'Peter rules something out that Maria also rules out.'

The fact that (32) can be judged false in an a/b scenario like (33)[12] exemplifies the non-monotonicity effect: If Peter rules out the possibility that A was at the crime scene and Maria rules out the possibility that B was there, then presumably a scenario in which A and B were both at the crime scene is ruled out by both of them. If the quantification over propositions in (32) were unrestricted, we would therefore predict (32) to be true in the scenario.

(33) SCENARIO: Peter and Maria are investigating a crime with suspects A, B and C. Peter has come to the conclusion that A cannot have been at the crime scene. Maria thinks B cannot have been there. These are their only findings so far. (32) %**false**

Our current generalization does not predict a non-monotonicity effect here. The *wh*-question in (32) has a canonical subquestion $\{a,b\}$, where $a = [\![A\ was\ at\ the\ crime\ scene]\!]$ and $b = [\![B\ was\ at\ the\ crime\ scene]\!]$. Given the semantics in (31), the partial answers to $\{a,b\}$ that Peter rules out in scenario (33) include $a, a \wedge b$ and $a \wedge \neg b$. The partial answers Maria rules out include $b, a \wedge b$ and $\neg a \wedge b$. Clearly, the strongest partial answer ruled out by both of them is $a \wedge b$. But since generalization (24) is sensitive to logical strength, rather than the monotonicity properties of the predicates involved, 'strong' partial answers like $a \wedge b$ are never disregarded. If we assume the judgment in (33) and take it as indicative of a non-monotonicity effect (but see Footnote 12), we want a generalization that removes such 'strong' partial answers if the predicate is downward-monotonic: If you believe a, then $a \vee b$ should be disregarded because believing a entails believing $a \vee b$. But if you rule out a, then $a \wedge b$ should be disregarded because ruling out a entails ruling out $a \wedge b$. This is implemented by the operator MINPA in (34), a revised version of $\text{MINPA}_{\sqsubseteq}$. Instead of directly comparing the different partial answers to a given subquestion with respect to logical strength, MINPA compares the propositions obtained by applying the predicate P to them. If P is downward-monotonic, the resulting property will be true of those propositions that are the *weakest* partial answer to some relevant subquestion that

[12]This judgment is not universally shared (Magdalena Kaufmann and Clemens Steiner-Mayr, p.c.), while the judgment reported for analogous a/b scenarios with *believe*, like (19b), is shared by all speakers I have asked. However, the varying judgments for (32) are still problematic for generalization (24) above, which predicts it to be unequivocally true in (33). Since we observed in Section 3 that such judgments generally depend on which subquestions are accommodated, the variation might show that subquestions asking whether a given conjunction of Hamblin answers is true are easier to accommodate than the analogous subquestions involving disjunction. In any case, further work is needed to test my empirical claim in the text.

satisfies P. If P is upward-monotonic, the predictions of our earlier definition do not change.

(34) For $P \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ and $\mathscr{Q} \in D_{\langle\langle\langle s,t\rangle,t\rangle,t\rangle}$:
$\textsc{MinPA}(\mathscr{Q})(P) = \lambda w.\lambda p.P(w)(p) \wedge \exists Q \in \mathscr{Q}[p \in \textsc{pa}(Q) \wedge \neg\exists p'[P(w)(p') \wedge p' \in \textsc{pa}(Q) \wedge p \neq p' \wedge (\lambda w'.P(w')(p')) \sqsubseteq (\lambda w'.P(w')(p))]]$

The final version of our descriptive generalization, which uses MINPA and includes canonical subquestions in addition to the subquestions mentioned in the discourse, is given in (35).

(35) **hDP Generalization 4**
With respect to a contect $\mathfrak{c}$ and assignment g, a restricted higher-order existential with the determiner $\exists_{\langle s,t\rangle}$, the restrictor predicate P, the nuclear scope P' and the domain-restricting question C is interpreted as
$\lambda w.[\![\exists_{\langle s,t\rangle}]\!](w)(\textsc{MinPA}(\mathscr{S}_{w,g,\mathfrak{c}})([\![P]\!]^{g,\mathfrak{c}})(w))(\textsc{MinPA}(\mathscr{S}_{w,g,\mathfrak{c}})([\![P']\!]^{g,\mathfrak{c}})(w))$.
$\mathscr{S}_{w,g,\mathfrak{c}}$ is the smallest set that contains $[\![C]\!]^{g,\mathfrak{c}}(w)$ and those of its subquestions that were raised in the preceding discourse in $\mathfrak{c}$ and is closed under canonical subquestions.

At this point one might wonder whether the MINPA operator is also at work in higher-order identity statements like (16) above. For the cases discussed in this paper, an analysis along the lines of (36), which requires the output of MINPA to be the same for each of the sets of propositions that are being compared, would give the same results as our original semantics.

(36) $[\![[dasselbe\ C_{(i,\langle\langle s,t\rangle,t\rangle)}]\ glauben]\!]^{g,\mathfrak{c}} = \lambda w.\lambda x_e.\exists S_{\langle\langle s,t\rangle,t\rangle}.\forall y_e[y \leq_a x$
$\rightarrow \textsc{MinPA}(\mathscr{S}_{w,g,\mathfrak{c}})(\lambda w.\lambda p_{\langle s,t\rangle}.[\![glauben]\!](w)(p)(y))(w) = S]$
where $\mathscr{S}_{w,g,\mathfrak{c}}$ is the smallest set that contains $[\![C_{(i,\langle\langle s,t\rangle,t\rangle)}]\!]^{g}(w)$ and those of its subquestions that were raised in the preceding discourse context in $\mathfrak{c}$ and is closed under canonical subquestions.

The data from Section 2 is therefore compatible with the idea that all cases of DP quantification over propositions involve MINPA. But to turn this into a testable hypothesis that also makes predictions about other determiners, one would have to specify the role of the MINPA operator in semantic composition. While this is beyond the scope of the present paper, the next section briefly discusses one issue that further constrains the analytical options available.

6. Conditions on the non-monotonicity effect

We now have a descriptive generalization that predicts under which conditions a given restricted higher-order existential gives rise to a non-monotonicity effect. But one question we have not addressed so far is whether this effect is specific to hDPs or whether it reflects a more general constraint on DP quantification. Here, I will first provide an argument for the latter option and then discuss a possible formulation of the constraint.

6.1. Informational object nouns and the non-monotonicity effect

So far, one might think that the non-monotonicity effect is limited to DPs that quantify over entities of type $\langle s,t\rangle$ or other functional types (as I suggested in earlier work; Haslinger 2019). But on closer inspection, it is not obvious that semantic type predicts when we find the effect. One counterargument comes from the 'informational object nouns' studied by Sutton and Filip (2019), which arguably do not express predicates of propositions. An example with the German noun *Information* is given in (37). The predicate *Information haben* 'have information' appears to be upward-monotonic with respect to the content of the information: If you have the information that it is raining heavily, you also have the information that it is raining. However, if Maria just learned that Ada will come to dinner and Peter knows that Bea will come, (37) is not necessarily true – an instance of the non-monotonicity effect.[13]

(37) *Zur Frage, wer heute kommt, hat die Maria (etwas) Information, die der Peter auch hat.*
to.the question who today comes has the Maria a.little information REL the Peter also has
'As for the question who will come today, Maria has some information Peter also has.'

Yet, a test due to Elliott (2017) (see also Haslinger 2019: ch. 2) shows that the DP in (37) does not directly range over propositions: Certain attitude verbs, such as *denken* 'think' (in the sense of 'believe'), can combine with clausal complements and with hDPs, but not with DPs ranging over individuals. Since such predicates do not generally disallow DP objects, the contrast must be semantic and plausibly reflects a type distinction. Crucially, DPs with head nouns like *Information* behave like ordinary DPs ranging over individuals: they are odd in the object position of predicates like *denken*. This suggests that such DPs quantify over individuals or states associated with propositional content (but see Sutton and Filip 2019 for a more nuanced view).

6.2. A general constraint on DP quantification?

What does this mean for the analysis of the non-monotonicity effect? First, it raises a problem for any approach assuming a special meaning of the indefinite determiner for hDPs, as I did in Haslinger (2019) and my SuB presentation. The idea there was that the determiner meaning applies MINPA, or some similar operation, to both of the predicates of propositions it combines with; the resulting predicates are intersected. This entails giving up the assumption that the semantics of determiners is given by a uniform cross-categorial schema. It is also counterintuitive in light of the fact that all determiners found in German hDPs can also be used to quantify over individuals: If there was a determiner meaning specific to hDPs, this formal correspondence would have the status of a coincidence. Examples like (37) strengthen this point: Given Elliott's diagnostic, *Information* is naturally analyzed as a predicate of abstract entities that have propositional content, but are not themselves propositions. It would then be unclear why the 'ordinary' indefinite determiner, which does not give rise to the non-monotonicity effect, cannot apply to informational object nouns.

An obvious alternative would be to build MINPA into a separate functional element that shows up with predicates of propositions (or other entities with propositional content), but is semantically incompatible with predicates of concrete individuals since concrete individuals do not relate to questions in the required way. The plausibility of this kind of approach depends on the cross-linguistic situation – we would expect some languages to have overt functional elements (e.g. a classifier) whose presence correlates with the non-monotonicity effect. In the absence of

[13] The noun *Information* has a count and a mass reading. The fact that (37) involves *etwas* 'some/a little', which requires a mass NP, shows that the non-monotonicity effect is not due to the individuation mechanism Sutton and Filip (2019) propose for *count* DPs involving informational object nouns.

cross-linguistic data on the effect, I want to merely discuss a general issue raised by analyses of this kind.

For concreteness, consider the operator RESTRICT_i in (38), which modifies a predicate of propositions by applying MINPA to this predicate and a set of questions determined by its index. (RESTRICT_i could be defined cross-categorially so that it also applies to 'pieces of information'; I omit this for reasons of space.) If insertion of RESTRICT_i is optional, which predictions do we make?

(38) $[\![\text{RESTRICT}_i]\!]^{g,\mathfrak{c}} = \lambda w.\lambda P_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}.\text{MINPA}(\mathscr{S}_{g(i,\langle\langle s,t\rangle,t\rangle),\mathfrak{c}})(P)$
where $\mathscr{S}_{Q,\mathfrak{c}}$ is the smallest set that contains Q and all the subquestions of Q that were mentioned in the discourse in $\mathfrak{c}$ and is closed under canonical subquestions.

If both arguments of the determiner are modified by RESTRICT_i, as in (39), the truth conditions are as predicted by our hDP generalization 4 in (35). Modifying only one argument with RESTRICT_i would also get most cases right, but makes different predictions for 'asymmetrical' scenarios like the $a \vee b/a$ scenario in (23); however, since I do not fully understand the conditions under which restricted higher-order existentials are accepted in such scenarios, I cannot rule out the existence of a reading on which only one argument of $\exists_{\langle s,t\rangle}$ is restricted. The real problem is that, if RESTRICT_i is completely optional, we could have an LF which does not contain it and therefore fails to trigger the monotonicity effect.

(39) $[\exists_{\langle s,t\rangle}$ [RESTRICT_2 [-*was*$_{\langle\langle s,t\rangle,t\rangle}$[$(1,\langle s,t\rangle)$ [*Peter* [$t_{(1,\langle s,t\rangle)}$ *glaubt*]]]]]]
[RESTRICT_2 [$(2,\langle s,t\rangle)$ [*Maria* [$t_{(2,\langle s,t\rangle)}$ *glaubt*]]]]

While we could make RESTRICT_i syntactically obligatory, this would give rise to the same problems as an analysis based on two distinct determiner meanings. Among other issues, the syntax would have to be sensitive to the distinction between informational object nouns and other predicates of basic-type entities. This invites the speculation that insertion of RESTRICT_i is forced by a semantic (or possibly pragmatic) constraint on DP quantification that applies cross-categorially, but does not have noticeable effects in the case of quantification over concrete individuals. This constraint would have to be such that it is never met if the determiner combines with predicates of propositions that are both upward-monotonic or both downward-monotonic, while for ordinary predicates of concrete individuals, it would trivially be met.

To illustrate what this constraint could look like, let us return to the puzzle from Section 2: An analysis based on unrestricted quantification over propositions predicts (40a) to be true whenever John has some belief and Mary has some belief. Similarly, if there are no further restrictions on the propositional content of 'pieces of information', upward-monotonicity predicts that (40b) is true whenever John has some information and Mary has some information.[14] In both cases, it follows from the semantics of the predicates related by the determiner that, whenever both predicates have non-empty extensions, their intersection will be non-empty.

(40) a. *John believes something Mary (also) believes.*
b. *John has some information Mary (also) has.*

[14]The assumption that *have information* is upward-monotonic with respect to the propositional content of the information has the counterintuitive consequence that one can 'have information' whose content is trivial. I leave the question to what extent this is a problem to future work.

This suggests the descriptive claim that indefinite DPs are only felicitous if this type of entailment does *not* hold. Taken literally, this is too strong since it would exclude all cases of entailment relations between the two arguments of the determiner (cf. *Some linguists are good linguists*). However, the following weaker formulation seems to make adequate predictions:

(41) If there is no entailment relation between the restrictor P and the nuclear scope Q, then $\lambda w.\exists x.P(w)(x)$ and $\lambda w.\exists x.Q(w)(x)$ do not jointly entail $\lambda w.\exists x[P(w)(x) \wedge Q(w)(x)]$.

The idea is that if we interpret (40a) and (40b) with an upward-monotonic predicate meaning and no domain restriction, (41) is violated unless we apply a domain-restriction mechanism which then gives rise to the non-monotonicity effect. In contrast, cases like (42a) satisfy (41) regardless of how domain restriction works. A more interesting prediction involves predicates of abstract mass individuals that are 'monotonic' with respect to the part-of relation. For instance, if you have read a piece of text, it arguably follows that you have read its parts, to the extent that these are also text. One might therefore expect to find a counterpart of the non-monotonicity effect in (42b). (41) predicts – correctly, I suspect – that this is not the case, since two pieces of text do not necessarily have a common part while two propositions (and, if my assumption is correct, two pieces of information) always have a common entailment.

(42) a. *Some linguists are asleep.*
b. *John read some text that Mary had (also) read.*

It is therefore worth investigating whether the constraint in (41) makes plausible predictions in other situations – for instance in cases where the monotonicity properties of the restrictor and the nuclear scope are distinct – and if so, how it could be implemented. While (41) could be added to the cross-categorial determiner meaning as a presupposition, it should arguably follow from some deeper, possibly pragmatic principle that also applies to other determiners.[15]

7. Conclusion

This paper investigated the truth conditions of sentences with 'higher-order DPs' (hDPs) quantifying over propositions. The main focus was on the 'non-monotonicity effect': the observation that, given the monotonicity properties we standardly take attitude verbs to have, certain propositions are unexpectedly missing from the domains of hDPs selected by such verbs. According to the descriptive generalization I proposed, hDPs are sensitive to a contextually given question meaning, which provides the 'structure' needed to determine the domain of propositions that the hDP quantifies over. In particular, this domain depends on the Hamblin set of the question, rather than just the set of propositions that partially answer it or are relevant to it. If true, this is relevant for the choice between theories of question semantics, since e.g. partition semantics (Groenendijk and Stokhof, 1984) provides no way of deriving Hamblin sets.

While I did not provide an analysis of hDPs that explains the monotonicity effect, the generalization is compatible with various ways of building the effect into the DP meaning, which would remove the need for a non-monotonic verb semantics (cf. Zimmermann 2006). Further, I argued that the effect is not tied to higher-type quantification and proposed a tentative generalization about the class of predicates that give rise to it. If this generalization holds up, the lexical monotonicity properties of different predicates actually play a role in predicting when

[15]Note that the effect cannot be due to a Quantity implicature, even if $\lambda w.\exists x[P(w)(x)] \wedge \exists x[Q(w)(x)]$ is assumed to be an alternative of $\lambda w.\exists x[P(w)(x) \wedge Q(w)(x)]$: If (41) is violated, the two putative alternatives are equivalent.

the effect occurs. Needless to say, many empirical questions where left open here. The need for a cross-linguistic study of the non-monotonicity effect, which could decide between different implementations, was already discussed in Section 6. Another open question is whether the effect is found with asymmetric determiners like *every*. Finally, the effect should be related more explicitly to the work of Sutton and Filip (2019) on 'individuation schemas' – a contextual parameter that influences how we count abstract entities with propositional content.

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