Exclusive Updates*

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Abstract. This paper develops a type of dynamic semantics in which contexts include not only information, but also questions, whose answers are ranked by strength. The questions can be local to the restrictor of a quantifier, and the quantifier can bind into them. The proposed framework satisfies several desiderata arising from quantificational expressions involving exclusives (e.g. *only, just*, *mere* and *sole*), allowing: (i) presupposed questions; (ii) presuppositional constraints on the strength ranking over the answers to the question under discussion; (iii) quantificational binding into such presupposed questions; and (iv) compositional derivation of logical forms for sentences.

1 Introduction

Contemporary work on information structure commonly relates focus to questions. For example, "Pedro feeds SAM" might answer the question of who Pedro feeds. In current question-based theories of focus such as that of Roberts (1996), questions are root-level entities, in the sense that there is one question per declarative utterance. In this paper, we explore the possibility that there are local, embedded questions, which may contain bound variables. Consider, for example: "If a man owns a DONKEY, then he BEATS it." The consequent here might be taken to answer the question "What does he do to it?". That question, however, is not one that could occur in current question-based theories of focus, since it contains locally bound pronouns and it is not at the root level. In this paper, we develop a dynamic model of discourse that makes it possible to bind into local questions under discussion.

We apply this model to sentences like (1) and (2), in which focus-sensitive elements occur in the restrictor of a quantifier.

(1) *No mere child* could keep the Dark Lord from returning. [web ex.]

(2) As a bilingual person I'm always running around helping *everybody who only speaks Spanish.* [web ex.]

For reasons discussed in Beaver and Clark (2008) and Coppock and Beaver (2011), we assume that exclusives such as *mere* and *only* relate to the current Question

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Under Discussion (CQ): this is what explains the focus sensitivity of such particles. We take the exclusives to presuppose that the prejacent is the weakest of the true answers to the CQ, and their ordinary semantic content is that the prejacent is the strongest of them, where strength is not necessarily determined by entailment. In (1) and (2), these questions are 'open', in the logical sense. For example, (1) relates to the question, 'What properties does x have?' where x is the variable bound by the negative quantifier. The question in (2) can be rendered as 'What does x speak?', where x is bound by *everybody.*

For (1), the answer 'x is a child' (the prejacent) is weaker than for example 'x is an adult', and *mere* contributes 'x is at least a child' as a presupposition, 'x is no more than a child' as ordinary semantic content. For (2), the answer 'x speaks Spanish' (the prejacent) is weaker than 'x speaks Spanish and English', and here the presupposition is 'x speaks at least Spanish', and the ordinary semantic contribution is 'x speaks no more than Spanish'. So exclusives place presuppositional constraints on the CQ, and make use of the CQ in the computation of their at-issue content; furthermore, these presuppositions may contain a variable that is bound externally to the question. For *only,* this problem only arises when it is inside a relative clause, as in (2), but for adjectival exclusives like *mere* and *sole,* this is the typical case.

Exclusives may also place their own constraints on the CQ. Consider:

(3) a. The mere student proved Goldbach's conjecture.
  b. The only student proved Goldbach's conjecture.

In (3a), the question that *mere* depends on is 'What are the properties of x (student, professor, etc.)?' (answer: x is only a student). In (3b), the question that the adjective *only* depends on is 'Which individuals are students?' (answer: only x). This difference stems from the choice of lexical item.

Presuppositions about the question under discussion are not like the presuppositions of factive or aspectual verbs (as they are standardly analyzed). The former do not constrain the context set, or the shared assumptions or beliefs of the interlocutors. They could be described as *interrogative presuppositions*: constraints on the Question Under Discussion. We need a framework that allows us to express such things. Indeed, this conclusion was reached independently by Jäger (1996) and Aloni et al. (2007) based on the apparent presupposition of a QUD by focus, and effects of questions on *only*'s quantificational domain.

Furthermore, we need to bind into such questions.[1] Binding into questions was addressed by Krifka (2001), but for a fully satisfactory solution to the problem at hand, we need a system that allows for: (i) presupposed questions; (ii) constraints on the strength ranking over the answers to presupposed questions;

[1] Note that similar problems could arise in alternative semantics (Rooth, 1992), as long as (a) the possibility of binding into alternatives is allowed, and (b) a strict separation is maintained between two dimensions of meaning (ordinary and alternative). The technical problems that would arise are familiar from the analogous problems observed in Karttunen and Peters's (1979) discussion of the example "Somebody managed to succeed George IV", where a quantifier appears to bind material that, for Karttunen and Peters, was in a separate dimension.

(iii) quantificational binding into such questions; and (iv) compositional derivation of meanings for sentences. We do not know of any prior system that satisfies all of these desiderata, and the present work aims to produce one that does.

2 Framework

Because Beaver's (2001) dynamic semantics deals successfully with quantified presuppositions, we use this as starting point, and introduce CQs and an answer strength ranking into the context. So a context S will determine: (i) $\textsc{info}_S$, a set of world-assignment pairs; (ii) $\textsc{cq}_S$, a set of answers, where each answer is an information state; (iii) $\geq_S$, a partial order over information states. For example, suppose that we have the following three information states: $I = \{\langle g, w_3\rangle, \langle g, w_2\rangle\}$, $J = \{\langle g, w_1\rangle\}$, and $K = \{\langle g, w_2\rangle\}$. Here is a possible context:

(4) a. $\textsc{info}_S = \{\langle g, w_1\rangle, \langle g, w_2\rangle, \langle g, w_3\rangle\}$
b. $\textsc{cq}_S = \{I, J, K\}$
c. $\geq_S = \{\langle I, I\rangle, \langle I, J\rangle, \langle J, J\rangle, \langle I, K\rangle, \langle J, K\rangle, \langle K, K\rangle\}$

These three components of context are not independent. Under the assumption that the strength ranking does not rank answers other than those in the CQ, the CQ is recoverable from the strength ranking; it is its *field*:[2]

(5) $\textsc{cq}_S = \textsc{field}(\geq_S)$
where $\textsc{field}(R) = \{x \mid \exists y[yRx \vee xRy]\}$

Likewise, the common ground is recoverable from the QUD.[3] As we are representing questions as sets of information states, we can recover the common ground by taking the union of all the answers (information states) in the question:

(6) $\textsc{info}_S = \bigcup \textsc{cq}_S$

Because all of the information that the context must provide is contained in the strength ranking, we can *identify the context with the strength relation*: $\geq_S = S$.

3 Theory of Exclusives

With the framework just introduced, we can formulate a proper theory of exclusives. We formalize Beaver and Clark's (2008) theory of *only* as follows (where infix notation is used for relations):[4]

[2] In his analysis of *at least* (which is strikingly similar to our MIN), Krifka (1999) represents alternative semantic values as relations corresponding to 'strength' in the same sense, and derives the ordinary alternatives as the field of the ranking.

[3] Jäger (1996) represents questions and information states as equivalence relations over possible worlds, which may be partial. "Hence each state nontrivially determines a certain proposition, which can be thought of as the factual knowledge shared by the conversants."

[4] We use the variables x, y, z for individuals, D for discourse markers, f, g, h for assignments (sets of discourse referent-individual pairs), I, J, K for information states (sets of world-assignment pairs), S for contexts (ranking relations over information states), C for CCPs (relations between contexts), and P for dynamic properties (functions from discourse referents to CCPs).

(7) $\text{ONLY} = \lambda C.\{\langle S, S'\rangle \mid S' \subseteq S \wedge S[\text{MIN}(C)]S \wedge S[\text{MAX}(C)]S'\}$

In (7), ONLY is defined to take a CCP (C) and return another CCP (a relation between S and S'). The presuppositional nature of the MIN component is expressed by requiring that the input state S be a reflexive point with respect to MIN and C.[5]

MAX is defined to take a CCP C and provide another CCP relating contexts S and S', where the CQ in S' is a subset of the CQ in S containing only information states J such that J is as strong (according to $\geq_S$) as the information state corresponding to C. We formalize this as in (8); the corresponding MIN is in (9).

(8) $\text{MAX} = \lambda C.\ \{\ \langle S, S'\rangle \mid S' \subseteq S \wedge \exists S''[S[C]S''] \wedge \forall J \in \text{CQ}_{S'}[J \leq_S \text{INFO}_{S''}]\ \}$

(9) $\text{MIN} = \lambda C.\ \{\ \langle S, S'\rangle \mid S' \subseteq S \wedge \exists S''[S[C]S''] \wedge \forall J \in \text{CQ}_{S'}[\text{INFO}_{S''} \leq_S J]\ \}$

These definitions differ from Beaver and Clark's (2008) definitions of MAX and MIN insofar as the meaning of the sentence is not be used as the object whose strength is being ranked, because here we have assumed that the meanings of sentences are CCPs and the answers to questions are information states. In (8) and (9) we extract an information state from C by applying C to the input state. Because we are treating CCPs as relations rather than functions, the formalism does not guarantee a unique output state, but in general we assume that there willl be a maximum of one output state.[6] So in (8) and (9) we require that it exists and refer to it by using an existential quantifier.

Similarly to Coppock and Beaver (2011), we use a type-raised (Geached) version of (7) for VP-*only* and adjectival exclusives as in (10) (D is a variable over discourse referents, and P is a variable over dynamic properties, i.e. functions from discourse referents to CCPs):

(10) $\text{G-ONLY} = \lambda P \lambda D.\ \{\ \langle S, S'\rangle \mid S[\text{ONLY}(P(D))]S'\}$

Adjectival exclusives like *mere* instantiate G-ONLY but also impose further constraints. *Mere* requires the CQ to be about what properties the referential argument has:

(11) $$\begin{aligned}\text{MERE} = \lambda P \lambda D.\ \{\ & \langle S, S'\rangle \mid S[\text{ONLY}(P(D))]S' \\ & \wedge\ \text{CQ}_S \subseteq \{I \mid \exists P' \exists S''[S[P'(D)]S''] \wedge I = \text{INFO}_{S''}\}\}\end{aligned}$$

This extra constraint ensures that in e.g. *mere herring*, *mere* ranges over a scale of properties, e.g. herring, octopus, caviar. In *(the) only herring,* in contrast, adjectival *only* would require the question to be 'What things are herrings?', and for stronger answers to imply the existence of more herrings.

[5] The requirement that $S \subseteq S'$ makes this a *declarative update* in Jäger's (1996) sense, as opposed to an *interrogative update,* which would not affect the information state of the context, but would change how it is divided up into smaller information states in the CQ.

[6] At this point one might question the decision to formulate dynamic meanings relationally rather than functionally. This is the strategic choice that enables Beaver (2001) to formulate a CCP model straightforwardly in a classical two-sorted type theory.

4 Examples

4.1 Predicative Example

Before addressing exclusives in quantifiers, let us warm up with a simpler example. Consider (12), where the subscript 7 on *he* indicates that the pronoun is associated with discourse referent 7.

(12) He_7 is a mere child.

According to our analysis, this sentence denotes the CCP in (13).

(13) $\text{MERE}(\text{CHILD})(7)$
$$= \{\langle S, S'\rangle |\ S' \subseteq S \wedge S[\text{MIN}(\text{CHILD}(7))]S \wedge S[\text{MAX}(\text{CHILD}(7))]S' \wedge \text{CQ}_S \subseteq \{I|\exists P'\exists S''[S[P'(7)]S''] \wedge I = \text{INFO}_{S''}\}$$

where CHILD is a function from discourse referents to CCPs which require the output context to be one where the discourse referent is mapped to a child. Formally (following Beaver 2001: 180) in many respects):

(14) $$\text{CHILD} = \lambda D.\{\langle S, S'\rangle | D \in \text{T-DOMAIN}(\text{INFO}_S) \wedge \text{INFO}_{S'} = \{\langle w, f\rangle \in \text{INFO}_S | \forall x[\langle D, x\rangle \in f \rightarrow \text{CHILD}'(x)(w)]\}\}$$

where (cf. Beaver 2001, p. 168, 170):

(15) $$\text{T-DOMAIN} = \lambda I.\{D|\forall w \forall f[\langle w, f\rangle \in I \rightarrow \exists x[\langle D, x\rangle \in f]]\}$$

and CHILD' is a a function of type $\langle e, \langle w, t\rangle\rangle$ that returns true given an individual and a world if the individual is a child in the world.

Let us consider an input context. Suppose the following has been announced:

(16) Somebody_7 has proven Goldbach's conjecture.

Let us assume further that the domain consists of the Simpsons family: Homer and Marge (adults), Bart and Lisa (children), Maggie (a baby), Santa's Little Helper (a dog), and Snowball (a cat). The conversational participants rule out 7 being mapped to a baby, dog, or cat, because such individuals lack the necessary mathematical competence. So the world-assignment pairs in the information state for the input context are all such that 7 is mapped to a child or an adult who proved Goldbach's conjecture. Let w_{hmbl} be the world where Homer, Marge, Bart, and Lisa all proved it, w_{hmb} the world where Homer, Marge, and Bart proved it, etc. The information state of this context consists of pairs such as $\langle w_b, \langle 7, \text{Bart}\rangle\rangle$, $\langle w_l, \langle 7, \text{Lisa}\rangle\rangle$, $\langle w_h, \langle 7, \text{Homer}\rangle\rangle$, $\langle w_m, \langle 7, \text{Marge}\rangle\rangle$, $\langle w_{hm}, \langle 7, \text{Marge}\rangle\rangle$, $\langle w_{hm}, \langle 7, \text{Homer}\rangle\rangle$, etc. In order to satisfy *mere*'s requirement on the CQ, these world-assignment pairs must be organized into information states that are answers to the question, "What properties does 7 have?" If this is satisfied, then all of the states where 7 is mapped to a child will be grouped into one information state ("7 is a child"), etc. So:

(17) $\text{CQ}_S = \{I_{child}, I_{adult}\}$
where $I_{child} = \{\langle w_b, \langle 7, \text{Bart}\rangle\rangle, \langle w_l, \langle 7, \text{Lisa}\rangle\rangle, \langle w_{hmb}, \langle 7, \text{Bart}\rangle\rangle, ...\}$, and
$I_{adult} = \{\langle w_h, \langle 7, \text{Homer}\rangle\rangle, \langle w_m, \langle 7, \text{Marge}\rangle\rangle, \langle w_{hm}, \langle 7, \text{Marge}\rangle\rangle, ...\}$

Let us assume further that I_{adult} outranks I_{child} according to $\geq_S$.

MIN requires that I_{child} be the weakest of the true answers in S, which it is, as we have assumed. So the MIN presupposition is satisfied. The further requirement that *mere* imposes is that every answer to the CQ is of the form $P(7)$ for some (appropriately contrasting) P. This is satisfied here, with P instantiated as ADULT and CHILD. MAX removes the possibility of 7 being an adult in the output state S', so the output CQ ($\text{CQ}_{S'}$) is just $\{I_{child}\}$. This is intuitively the right result; (12) means that 7 is a child.

4.2 Argument NP Example

Now let us consider an example in which *mere* occurs within the scope of a quantifier. We analyze (18a) as (18b) (as a first pass).

(18) a. Some$_7$ mere child succeeded.
b. SOME(7)(MERE(CHILD))(SUCCEED)

The quantifier SOME is defined as follows (cf. Beaver 2001 p. 185):

(19) $\text{SOME} = \lambda D.\lambda P.\lambda P'.\{\langle S, S'\rangle | \exists S_{in} \exists S_{res} S[+D]S_{in}[P(D)]S_{res}[P'(D)]S'\}$

where + requires that 7 is not in the domain of the input state and introduces it in the output state (see Beaver 2001 for details). So, expanded, (18b) is:

(20) $\{\langle S, S'\rangle | \exists S_{in} \exists S_{res}[S[+7]S_{in}[\text{MERE}(\text{CHILD})(7)]S_{res}[\text{SUCCEED}(7)]S']\}$

Imagine that (18a) is spoken in the context of a particular question under discussion, "Who kept the Dark Lord from returning?" – in homage to our naturally-occurring example, *No mere child could keep the Dark Lord from returning.* Let us assume that the domain contains three individuals: Maggie, Bart, and Marge. In every world under consideration, Maggie is a baby, Bart is a child, and Marge is an adult. It is common ground that babies cannot succeed at the task under consideration, so the possible answers to the question are (assuming that someone succeeded): Bart succeeded, Marge succeeded, and Bart and Marge succeeded. Let us introduce three possible worlds, one for each of these possibilities: w_b, w_m, and w_{bm}. Pairing each of these worlds with the empty assignment $\emptyset$, we obtain three singleton information states: $\{\langle w_b, \emptyset\rangle\}$, $\{\langle w_m, \emptyset\rangle\}$, and $\{\langle w_{bm}, \emptyset\rangle\}$. Let us refer to these as I_b, I_m, and I_{bm}, respectively. The input context is a ranking over these states corresponding to the individual-sum operation:

(21) $S = \{\langle I_b, I_b\rangle, \langle I_b, I_{bm}\rangle, \langle I_m, I_m\rangle, \langle I_m, I_{bm}\rangle, \langle I_{bm}, I_{bm}\rangle\}$

This is the context against which (20) is to be evaluated.

The first step in the evaluation of (20) is adding 7 as a new discourse referent. [+7] relates the input context S to a new context in which 7 is defined in all assignments, and assigned to an arbitrary individual:

(22) $S_{in} = \{\langle I'_b, I'_b\rangle, \langle I'_b, I'_{bm}\rangle, \langle I'_m, I'_m\rangle, \langle I'_m, I'_{bm}\rangle, \langle I'_{bm}, I'_{bm}\rangle\}$
where $I'_b = \{\langle w_b, \langle 7, \text{Maggie}\rangle\rangle, \langle w_b, \langle 7, \text{Bart}\rangle\rangle, \langle w_b, \langle 7, \text{Marge}\rangle\rangle\}$,
$I'_m = \{\langle w_m, \langle 7, \text{Maggie}\rangle\rangle, \langle w_m, \langle 7, \text{Bart}\rangle\rangle, \langle w_m, \langle 7, \text{Marge}\rangle\rangle\}$, and
$I'_{bm} = \{\langle w_{bm}, \langle 7, \text{Maggie}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Bart}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Marge}\rangle\rangle\}$

But now we have a problem. The discourse referent is required to be new, so nothing can be known about it. 7 could be Maggie, Bart, or Marge. But MIN requires it to be at least a child, and in normal contexts, babies are inherently ranked lower than children. So Maggie should not be assignable to 7.

To eliminate assignments of Maggie to 7, we can use domain restriction. There are at least two strategies we could employ to restrict the domain. The first approach, which is the more standard one, invokes a contextually-bound domain variable – this would be a discourse referent, say, 8 – which is to stand for the set of contextually-relevant entities. Under this approach, the logical form would become, for example:

(23) $\{\langle S, S'\rangle | \exists S_{in} \exists S_{dom} \exists S_{res}$
$S[+7]S_{in}[7 \in 8 \wedge \text{MERE}(\text{CHILD})(7)]S_{res}[\text{SUCCEED}(7)]S'\}$

Another potential solution would be to restrict the domain of a quantifier to those individuals that satisfy the scope predicate (here, *succeeded*) in any world. A possibility modal could be employed to restrict the domain, thus:

(24) $\{\langle S, S'\rangle | \exists S_{in} \exists S_{dom} \exists S_{res}$
$S[+7]S_{in}[\Diamond(\text{SUCCEED}(7))]S_{dom}[\text{MERE}(\text{CHILD})(7)]S_{res}[\text{SUCCEED}(7)]S'\}$

This approach has a certain intuitive appeal: It would seem rational to restrict quantification to entities that could conceivably satisfy the restrictor predicate. However it is formulated, its effect in this case is clear. The pair $\langle S_{in}, S_{dom}\rangle$ will be in the domain restriction CCP if S_{dom} is as follows:

(25) $S_{dom} = \{\langle I''_b, I''_b\rangle, \langle I''_b, I''_{bm}\rangle, \langle I''_m, I''_m\rangle, \langle I''_m, I''_{bm}\rangle, \langle I''_{bm}, I''_{bm}\rangle\}$
where $I''_b = \{\langle w_b, \langle 7, \text{Bart}\rangle\rangle, \langle w_b, \langle 7, \text{Marge}\rangle\rangle\}$,
$I''_m = \{\langle w_m, \langle 7, \text{Bart}\rangle\rangle, \langle w_m, \langle 7, \text{Marge}\rangle\rangle\}$, and
$I''_{bm} = \{\langle w_{bm}, \langle 7, \text{Bart}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Marge}\rangle\rangle\}$

But even with domain restriction taken care of, we are *still* not ready for MERE(CHILD)(7), because this presupposes the question "What properties does 7 have?" and that is not the current CQ. We propose to introduce a new CQ that takes scope only within the restrictor of *some*, and remove it and restore the CQ to its prior state once we are "done," so to speak, with the restrictor, modulo any information that we have gained in the process of processing the restrictor. We call these processes *question accommodation* and *question resetting,* respectively. Question accommodation converts the domain-restricted state S_{dom} into a new state $S_{localQin}$ where the CQ is structured correctly. In our case:

(26) $S_{localQin} = \{\langle I_{child}, I_{child}\rangle, \langle I_{child}, I_{adult}\rangle, \langle I_{adult}, I_{adult}\rangle\}$
where $I_{child} = \{\langle w_b, \langle 7, \text{Bart}\rangle\rangle, \langle w_m, \langle 7, \text{Bart}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Bart}\rangle\rangle\}$, and
$I_{adult} = \{\langle w_b, \langle 7, \text{Marge}\rangle\rangle, \langle w_m, \langle 7, \text{Marge}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Marge}\rangle\rangle\}$

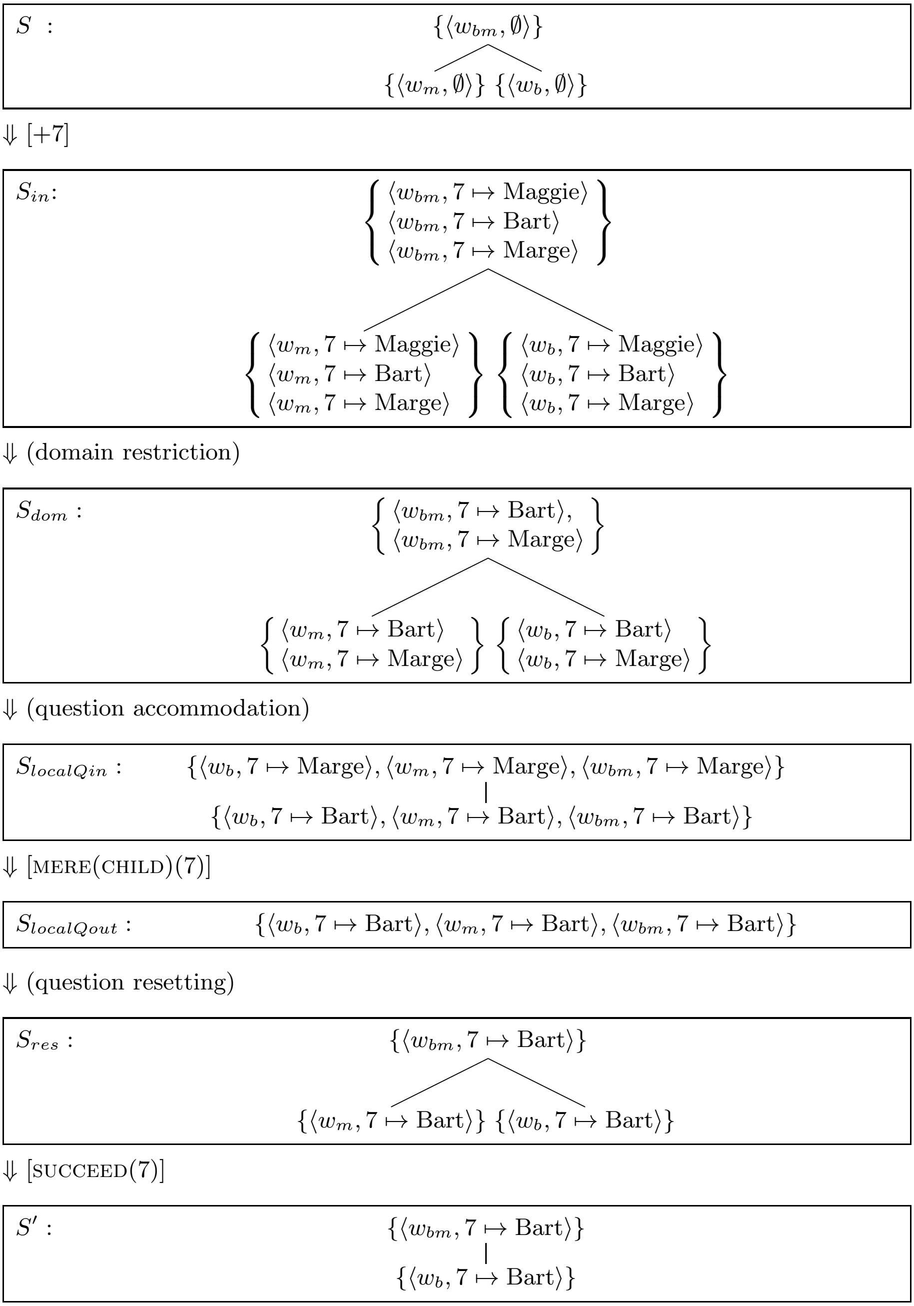

Fig. 1. Sequence of updates for *Some mere child succeeded*

We lack the space for a satisfactory characterization of question accommodation but two criteria that it should satisfy are: (i) that the information state of the pre-accommodation context should be the same as the information state of the accommodated context, and (ii) the accommodated context should be congruent to the focus alternatives of the linguistic material to be interpreted once the question has been accommodated (in this case, *mere child*). If the focus alternatives are themselves ranking relations over standard alternatives, as Krifka (1999) proposes, then this can be implemented as a constraint that the accommodated context, qua ranking relation, is a subset of the focus value of the linguistic material in question.

After question accommodation, it is possible to update with MERE(CHILD)(7). This update produces $S_{localQout}$, which will be $\{\langle I_{child}, I_{child}\rangle\}$ by the reasoning outlined above in the discussion of the predicative example. The final step in the processing of the restrictor is to restore the question to its original structure, taking into account the information that has been gained, yielding:

(27) $S_{res} = \{\langle I_b''', I_b'''\rangle, \langle I_b''', I_{bm}''\rangle, \langle I_m''', I_m'''\rangle, \langle I_m''', I_{bm}'''\rangle, \langle I_{bm}''', I_{bm}'''\rangle\}$

where $I_b''' = \{\langle w_b, \langle 7, \text{Bart}\rangle\rangle\}$; $I_m''' = \{\langle w_m, \langle 7, \text{Bart}\rangle\rangle\}$; $I_{bm}''' = \{\langle w_{bm}, \langle 7, \text{Bart}\rangle\rangle\}$.

Updating with SUCCEED(7) eliminates world-assignment pairs where 7 did not succeed. I.e. $S_{res}[\text{SUCCEED}(7)]S'$ will hold of S' if and only if $\text{INFO}_{S'} = \{\langle w_b, \langle 7, \text{Bart}\rangle\rangle, \langle w_{bm}, \langle 7, \text{Bart}\rangle\rangle\}$. Intuitively, this is the right result; *A mere child succeeded* basically means *A child succeeded*. Retaining the structure of the CQ from the previous state, this gives the following as a final result:

(28) $S' = \{\langle I_b''', I_b'''\rangle, \langle I_b''', I_{bm}''\rangle, \langle I_{bm}''', I_{bm}'''\rangle\}$

The entire process is summarized in Figure 1.

5 Conclusion

The system we have outlined satisfies the desiderata laid out in the introduction. Because the contexts contain questions and the meanings of sentences are CCPs over such contexts, sentences may impose presuppositional constraints on the CQ, and because the answers are ranked, the presuppositions may concern the ranking over those questions. Furthermore, our system inherits properties from that of Beaver 2001 which facilitate a successful treatment of quantified presuppositions. Our system is also compositional. With this combination of properties, we can capture the meaning of sentences in which focus particles occur within the scope of a quantifier. This apparatus also has clear potential applications in further domains such as clefts where the notion of a presupposed open question is relevant.

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