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Intervention Effects and Additivity

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Abstract

By discussing a novel paradigm, it is shown that the likeliness of an operator to trigger an intervention effect in a wh-in-situ question is determined by the logical properties of that operator (contra Beck 1996a, 2006, for instance). A new empirical generalization accounting for the differences between operators in their ability to cause intervention and improving on existing analyses is suggested. This generalization is fully predictive and allows one to not have to list in the lexicon whether an intervener is problematic or not. It is implemented as a formal condition on wh-questions in a version of Hamblin 1973's/Karttunen 1977's question semantics that makes crucial use of Chierchia 2006's domain alternatives.

1 INTRODUCTION

This article proposes a new analysis for *intervention effects* in German wh-questions. Beck (1996a,b) observed that multiple wh-questions become unacceptable if one of the wh-expressions linearly follows an element of a certain class of operators. Consider the difference between the examples in (1) and (2). (1), on the one hand, has the wh-in-situ expression linearly following the negative quantifier. On the other hand, if the quantifier is replaced by a referential expression as in (2), the question becomes acceptable.[1]

(1) *Wen hat niemand wo gesehen?
whom has nobody where seen
'Who did nobody see where?'
(Beck 1996a:1)

(2) Wen hat der Hans wo gesehen?
whom has the Hans where seen
'Who did Hans see where?'

[1] Following Beck (1996a: 3, fn. 2), I will not refer to the unacceptability in wh-questions like (1) as ungrammaticality. Ungrammaticality is reserved for syntactic unacceptability. And indeed, such questions do not seem to be as syntactically ill-formed as, say, cases of island violation are. The unacceptability we are dealing with rather seems to be one of uninterpretability, that is, a native speaker cannot assign an interpretation to a question like (1). The reported judgments of novel data are based on those of three native speakers of German and myself.

The problem presented by data like (1) and (2) is how to capture the difference in interpretability between them. The general intuition behind most analyses is that the quantifier in (1) inhibits a relationship between the wh-in-situ expression and a question (Q)-operator located somewhere around the clausal level, hence the term intervention effect, whereas a referential expression like *der Hans* does not cause any such effect. In principle, there are two ways to go when trying to implement this idea: first, one can blame the intervention effect on the syntax. The second route is to claim that the relationship is prohibited for semantic reasons.

While a principled explanation for why quantifiers cause intervention effects, whereas referential expressions do not is absent from both types of analyses, I show that in addition both face a problem with respect to quantifiers. The approaches mentioned are ill-equipped to account for a difference found between upward entailing (UE) indefinites and downward entailing (DE) indefinites without making stipulations in addition to the one already needed to distinguish between quantifiers and referential expressions. Such a difference is problematic for approaches where quantifiers are generally taken to block a relation between the Q-operator and the wh-in-situ expression, because it is unclear why the monotonicity of the intervener should matter. I show that what counts as an intervener and what does not is systematic and predictable given the logical properties of an operator. Moreover, I suggest that intervention effects should be derived using a semantic analysis.

The key feature of the new approach is that it dispenses with the intuition discussed above. Thus, the Q-operator is not prohibited from establishing a relationship with the wh-in-situ expression. I propose a new empirical generalization that captures the distribution of intervention effects correctly. Specifically, I propose that an intervener $\mathcal{Q}$ causes an intervention effect if a truth-conditional difference exists between $\mathcal{Q}.\exists x.\phi$ and $\exists x.\mathcal{Q}.\phi$, where ϕ is an open formula, that is, if $\mathcal{Q}$ does not scopally commute with existential quantifiers:

(3) *Intervention effects generalization* (IEG, to be revised)
An operator is a problematic intervener if it does not scopally commute with existential quantifiers.

Consider the case of the negative quantifier *niemand* in (1). It does not scopally commute with an existential quantifier, as (4) shows. Assume that the left side stands in for the proposition that no one kissed a girl, and the right side stands for the proposition that there is a girl that no one kissed. The two propositions are clearly not equivalent as the latter

one can be true when some girl was kissed, whereas the former is false in that situation. Therefore *niemand* does not scopally commute with existential quantifiers, and it is predicted to cause intervention effects.

(4) $\neg\exists x.\exists y.\phi \neq \exists y.\neg\exists x.\phi$

The article is structured as follows: in section 2, I demonstrate that the IEG enables one to correctly predict the harmful interveners. In particular, UE indefinites will not be problematic themselves. The following section 3 shows how the IEG can be tied to the semantics of wh-questions by imposing a formal condition on wh-questions and moreover develops the technical details of the question semantics assumed. Section 4 discusses the cross-linguistic picture and compares the analysis to other approaches. Section 5 concludes the article.

2 A NEW EMPIRICAL GENERALIZATION

In the present section, I discuss how and why the IEG captures the correct set of problematic interveners. Before that a short overview of the empirical phenomenon that the IEG actually has to account for is given. Given certain correct predictions that the IEG makes, a semantic account of intervention effects suggests itself.

2.1 *An empirical overview*

Beck (1996a,b) notices that in German a wh-expression when in situ must not be preceded by a negative expression, (5a). If, on the other hand, the wh-element is scrambled across the quantifier, the question becomes fully acceptable (5b). Only in the former example does the quantifier intervene between the two wh-phrases.

(5) a. *Wen hat kein Junge wann angerufen?
who has no boy when called
b. Wen hat wann kein Junge angerufen?
who has when no boy called
'Who did no boy call when?'

This effect is stable across the range of negative quantifiers:

(6) a. *Wen hat niemand wann angerufen?
who has no one when called
b. Wen hat wann niemand angerufen?
who has when no one called
'Who did no one call when?'

(7) a. *Wen hat der Hans nie wem vorgestellt?
who has the Hans never whom introduced

b. Wen hat der Hans wem nie vorgestellt?
who has the Hans whom never introduced
'Who did Hans never introduce to who?'

Moreover, Beck observes that universal quantifiers also cause intervention effects. Consider (8). Although the example is not strictly uninterpretable, (8) is unambiguous. (8) only has the distributive or list reading (8a). Thus, only answers that specify for each boy who he observed at which time are compatible with (8). In other words, only answers like *John observed Mary on Tuesday*, *Bill observed Sue on Wednesday*, etc. are possible answers to (8). The ordinary single/multiple answer interpretation in (8b) is blocked.

(8) Wen hat jeder Junge wann beobachtet?
who has every boy when observed
a. 'For every boy, who did he observe when?'
b. *'Who is such that every boy observed him when?'

That is, the following is not a good answer to (8): *Every boy saw John on Monday and Bill on Tuesday*. Beck assumes with Chierchia (1992), Groenendijk & Stokhof (1984), and Higginbotham (1993) that the list interpretation obtains when the universal quantifier has scope over the entire question (or alternatively over the question-act as argued by Krifka 2001). So the quantifier is 'outside' of the question and does not intervene between the wh-phrases, and therefore no degradedness results. (8b) is unavailable because of the intervening universal. If *wann* is scrambled across the universal quantifier as in the minimally differing (9), on the other hand, the single/multiple answer interpretation becomes available. Here the quantifier does not intervene between the wh-expressions any longer.[2]

(9) Wen hat wann jeder Junge beobachtet?
who has when every boy observed
a. 'For every boy, who did he observe when?'
b. 'Who is such that every boy observed him when?'

Kim (2002) observes for Korean (also cf. Beck 2006) that focus operators can also cause intervention effects. This holds for German, too. As can

[2] Some speakers report that the distributive interpretation for (9) is quite hard to get. I do not know why that should be, but I happen to agree with Beck (1996a)'s judgments. I speculate that it might have to do with the availability of the single/multiple answer interpretation serving as a competitor and thereby blocking the distributive interpretation. As is well-known covert scope shifting operations are costly, at least in German and other scrambling languages. Therefore, the surface scope interpretation is always preferred. In (8) the surface scope reading does not exist, for semantic reasons as I intend to show. Because of this the surface scope interpretation is not a competitor to the distributive interpretation.

be seen by (10a) and (11a), operators associating with focus on the subject cause an intervention effect when preceding a wh-in-situ. Both *nur* ('*only*') and *sogar* ('*even*') have this effect. If the wh-expression is scrambled, the intervention effect disappears, (10b) and (11b) (here and throughout capitals indicate focal stress).

(10) a. *Wen hat nur der HANS wann angerufen?
who has only the Hans when called
b. Wen hat wann nur der HANS angerufen?
who has when only the Hans called
'Who did only Hans call when?'

(11) a. *Wen hat sogar der HANS wann angerufen?
who has even the Hans when called
b. Wen hat wann sogar der HANS angerufen?
who has when even the Hans called
'Who did even Hans call when?'

These are the basic data that any analysis of intervention effects must account for.

2.2 *The intervention effects generalization*

I will now show that the main empirical generalization introduced as the IEG in (3) above establishes the correct set of problematic interveners. But first notice that we can restate the IEG more precisely. Those operators which do not scopally commute with existential quantifiers are the *non-additive* ones, where additivity is defined as in (12). The IEG can then be stated more accurately as in (13).[3]

(12) f of type $\langle\sigma,t\rangle$ is additive if for any g, h of type σ, $f(g \vee h) = f(g) \vee f(h)$.

(13) *Intervention effects generalization* (IEG, final version)
An operator is a problematic intervener iff it is non-additive.

All one has to do now is to show that the problematic interveners discussed in the preceding subsection are non-additive. That is, we have to show that the operators inducing intervention effects are such that the equivalence in (14) does not hold, where $\mathcal{Q}$ stands for the operator in question and ϕ and ψ are open formulas. In other words, we have to show that either the inference from left to right or the one from right to left in (14) does not go through.[4]

[3] The relation between non-additive operators and those not scopally commuting with existential quantifiers is discussed in subsection 3.1.

[4] For some pertinent discussion of such equivalences see Partee *et al.* (1990: 148f.) a.o. Also note that the notion of anti-additivity has been identified as playing a crucial role in NPI-licensing by Zwarts (1998). How closely NPI-licensing is related to the present issue, if at all, is currently not clear to me. I leave investigation of this question to future research.

(14) $\mathcal{Q}.\phi \vee \psi = \mathcal{Q}.\phi \vee \mathcal{Q}.\psi$

Consider first negation, in particular negated quantifiers. (15b) is true if no student smokes but some drink. (15a) is clearly false in that situation. Therefore, negative quantifiers and negation in general are non-additive and thus predicted to be problematic interveners.

(15) a. Kein Student raucht oder trinkt.
no student smokes or drinks
'No student smokes or drinks.'
↮
b. Kein Student raucht, oder kein Student trinkt.
no student smokes or no student drinks
'No student smokes, or no student drinks.'

Similar considerations apply to universal quantifiers. (16a) is true if every student engages in one of the two activities of smoking or drinking, but neither smoking nor drinking is a habit of all the students. Clearly, (16b) would be false. Thus, a universal quantifier is non-additive and therefore a problematic intervener.

(16) a. Jeder Student raucht oder trinkt.
every student smokes or drinks
'Every student smokes or drinks.'
↮
b. Jeder Student raucht, oder jeder Student trinkt.
every student smokes or every student drinks
'Every student smokes, or every student drinks.'

What about *only*? The two statements in (17) are not equivalent. (17b) is true if Hans is the only person smoking but there are other people than Hans drinking. In that situation (17a) is false. Therefore, *only* is non-additive and predicted to cause intervention effects.[5]

(17) a. Nur HANS raucht oder trinkt.
only Hans smokes or drinks
'Only Hans smokes or drinks.'
↮
b. Nur HANS raucht, oder nur HANS trinkt.
only Hans smokes or only Hans drinks
'Only Hans smokes, or only Hans drinks.'

Finally, (18a) is true whenever everyone is more likely to engage in smoking or drinking than Hans is to do so. In particular, it is true if some individuals are more likely to drink than Hans is, whereas the remaining individuals are more likely to smoke than Hans is. In that situation (18b) is false, because it requires that every individual is either more likely to

[5] I am assuming Horn (1969)'s non-monotonic analysis of *only*. See also (82) in the Appendix.

smoke or every individual is more likely to drink than Hans is to do so. That is, *even* is non-additive and therefore a problematic intervener.[6]

(18) a. Sogar HANS raucht oder trinkt.
even Hans smokes or drinks
'Even Hans smokes or drinks.'
↮
b. Sogar HANS raucht, oder sogar HANS trinkt.
even Hans smokes or even Hans drinks
'Even Hans smokes, or even Hans drinks.'

Thus, it appears that one can give a precise definition of what counts as a problematic intervener and what does not. Problematic interveners are non-additive. This makes the prediction that additive operators should not cause intervention effects. Proper names, for instance, are additive, as shown by the equivalence in (19), even though they can be construed as operators (e.g., Montague 1974). They do not cause intervention effects, as evidenced by example (2) above.

(19) a. Hans raucht oder trinkt.
Hans smokes or drinks
'Hans smokes or drinks.'
↔
b. Hans raucht, oder Hans trinkt.
Hans smokes or Hans drinks
'Hans smokes, or Hans drinks.'

Existential quantifiers are another case where equivalence holds and which should thus not cause an intervention effect:

(20) $\exists x[P(x) \vee Q(x)] = \exists x.P(x) \vee \exists x.Q(x)$

I investigate this prediction in detail in the following subsection.

2.3 *Additive interveners*

There is a systematic exception to intervention. It can be seen that UE indefinites, on the one hand, do not lead to intervention effects in the examples in (21a) and (22a) below or more precisely to very weak

[6] I thank an anonymous reviewer for pointing out a problem in the discussion of this point in a previous version. Notice moreover that under Karttunen and Peters 1979's analysis of *even*, the discussion of (18) actually talks only about the presuppositional requirements of the sentences (cf. (83) in the Appendix). Note that the judgments about (18) might be affected by this. In particular, the presupposition of (18b) might actually be even stronger by conforming to the union of the presuppositions of the two disjuncts (cf. Gazdar 1979 a.o.)—that is, it would require that every individual is more likely to drink and more likely to smoke than Hans is. In other words, *even* is at least non-additive and maybe even non-monotonic.

degradedness. DE indefinites, on the other hand, lead to strong uninterpretability, cf. (21b) and (22b).[7,8]

(21) a. ?Wen haben mehr als drei Studenten wann eingeladen?
who have more than three students when invited
'Who did more than three students invite when?'
b. *Wen haben weniger als drei Studenten wann eingeladen?
who have fewer than three students when invited

(22) a. ?Wen haben einige Regisseure in welchem Film gesehen?
who have a few directors in which film seen
'Who did a few directors see in which film?'
b. *Wen haben wenige Regisseure in welchem Film gesehen?
who have few directors in which film seen

Apparently, wh-questions where UE indefinites are in a position to intervene are systematically judged as more acceptable than the corresponding questions with DE indefinites. Why should that be so? In the following, I will argue that the slight degradedness in examples with UE indefinites is due to a distributive operator and not the UE indefinite itself. DE indefinites, however, do cause intervention effects.

2.3.1 *Distributive interpretations and intervention effects* Consider the sentences in (23). In each case, the NP-predicate of the indefinite bears plural marking.

(23) a. More than three students met.
b. Fewer than three students met.

A widely shared assumption about the interpretation for examples like (23a) and (23b) is that they denote propositions such as in (24a) and (24b), respectively. Here and below capital variables like X stand for non-atomic individuals. Following Link (1983) and much work since, the domain of individuals forms a join semi-lattice. That is, by taking two individuals a and b the join operation forms a new complex, that is,

[7] UE and DE functions are defined as follows:

(i) a. f of type $\langle\sigma,\tau\rangle$ is UE iff for any a and b of type σ such that $a \sqsubseteq b$, $f(a) \subseteq f(b)$.
b. f of type $\langle\sigma,\tau\rangle$ is DE iff for any a and b of type σ such that $a \sqsubseteq b$, $f(b) \subseteq f(a)$.

[8] Beck (1996a) already notes that there might be a difference between UE and DE indefinites, but she does not investigate the issue systematically. Also cf. Grohmann (2006). I do not discuss *mindestens n NPs* (*at least n NPs*) because of the unclear status regarding their semantics (cf. Geurts & Nouwen 2007; Nouwen 2010). Incidentally though, they seem to behave in parallel to the cases in the text:

(i) a. ?Wen haben mindestens zwei Studenten wem vorgestellt?
who have at least two students whom introduced
'Who did at least two students introduce to who?'
b. *Wen haben höchstens zwei Studenten wem vorgestellt?
who have at most two students whom introduced

non-atomic individual $a \oplus b$ of which a and b are parts of. a and b might be atomic or non-atomic themselves. Atomic individuals are those who have only themselves as a part of themselves, for instance the individual *John*. The plural individual *John* $\oplus$ *Mary*, on the other hand, is non-atomic. According to the present analysis of plural indefinites then, X in (24a) and (24b) stands for non-atomic individuals of the form just discussed.

(24) a. $\lambda w.\exists X\,[student_w(X) \wedge |X| > 3 \wedge meet_w(X)]$
b. $\lambda w.\neg\,\exists X\,[student_w(X) \wedge |X| \geq 3 \wedge meet_w(X)]$

Example (24a) roughly says that there is a non-atomic student individual X whose cardinality is more than 3 such that X met, whereas (24b) says that there is no non-atomic student individual X whose cardinality is three or more such that X met.[9] For arguments that plural indefinites quantify over pluralities and for analyses incorporating these assumptions see, for instance, Hackl (2000), Krifka (1999) and references therein. From now on non-capital letters denote exclusively atomic individuals.[10]

Given the treatment of plural indefinites in (24) and the IEG, it follows that UE indefinites are predicted to not cause intervention effects, in contrast to DE indefinites. The reason is that the former are existential quantifiers in nature, whereas the latter are negative quantifiers. Existential quantifiers, on the one hand, are additive as shown in (20) above. Negative quantifiers, on the other hand, were already shown to be non-additive. As already said, I will now argue that it is a distributive operator—that is, an operator that requires that the verbal predicate is true of *each* atomic individual that is part of a given non-atomic one—that causes the degradedness witnessed with UE indefinites such as in (21a) and (22a). But before doing so I will show based on our intuitions that UE indefinites really are additive, whereas DE ones are not. Given what was just said we must, however, make sure that no distributive operator is present. Because of this, it is crucial to use collective verbal predicates when testing for additivity in the following—that is, predicates that require their argument to be non-atomic and thus

[9] The discussion is somewhat superficial. First, the plural-marking on the NP-predicate presumably denotes a function turning the predicate into one that can apply to non-atomic individuals (e.g., Roberts 1987; Beck 2000), that is, the *-operator, which is left out. Second, I leave open the question of whether X might in principle also denote non-atomic individuals, which in turn hinges on our precise assumptions about the denotation of the plural morpheme involved (Link 1983). I do not want to take a stance on this issue as it is tangential to the discussion.

[10] For the present purposes, it would have been also fine to assume the generalized quantifier view (Barwise & Cooper 1981) according to which plural indefinites are existential quantifiers ranging over their witness sets. There are, however, other well-known shortcomings of this particular view.

defy a distributive analysis as *meet* in (23) does. As we will see immediately, however, even this is not sufficient.

Consider (25). If there is a plurality of more than three students such that that plurality either hugged or met (25a), then there is either a plurality of more than three who hugged or one who met (25b), and vice versa.

(25) a. ?Mehr als drei Studenten zusammen umarmten oder trafen sich, oder beides.
more than three students together hugged or met self or both
'More than three students together hugged or met, or both.'
↔
b. Mehr als drei Studenten zusammen umarmten sich, oder mehr als drei Studenten zusammen trafen sich, oder beides.
more than three students together hugged self or more than three students together met self or both
'More than three students together hugged, or more than three students together met, or both.'

It is crucial in (25) that *zusammen* ('*together*') is used, which following Schwarzschild (1994) is an anti-distributivity marker. It guarantees that the first sentence is false if there are, for instance, four students consisting of two groups with two students each, and one group hugs and the other meets. If we allowed an interpretation where we distribute over such subgroups of students, then the equivalence in (25) would be lost as the first sentence would be true and the second false in the situation just described. That is, without *zusammen* the equivalence would not hold given the availability of a distributive interpretation. Unfortunately, the addition of *zusammen* makes the sentences somewhat marginal. For this reason, whenever the presence of *zusammen* is not crucial for the argument made, it is in brackets below. Another anti-distributivity marker is *als Gruppe* ('*as a group*'), which can be substituted for *zusammen*.[11]

If, however, two students hugged but four met, then (26b) is true. But (26a) is false, as it requires for all pluralities of at least three students that they neither hugged nor met. Again, the intuitions reflect this.

(26) a. Weniger als drei Studenten (zusammen) umarmten oder trafen sich.
fewer than three students together hugged or met self
'Fewer than three students (together) hugged or met.'

[11] I thank an anonymous reviewer for pointing out this important complication. Furthermore, the addition of *or both* is supposed to avoid the scalar implicature generating the exclusive interpretation of *or* (cf. Gazdar 1979 a.m.o), which would make the equivalence disappear. No such problems arise in the preceding examples, where the equivalence was absent to begin with.

↔

b. Weniger als drei Studenten (zusammen) umarmten sich, oder
fewer than three students together hugged self or
weniger als drei Studenten (zusammen) trafen sich.
fewer than three students together met self
'Fewer than three students (together) hugged, or fewer than three students (together) met.'

As a consequence, only DE indefinites are predicted to cause intervention effects. That is, the IEG fully predicts the pattern observed above.

In addition, the IEG predicts that non-monotonic interveners such as *exactly three students* also cause intervention because they are non-additive, as shown by (27). If three students hugged and moreover three students met, then (27b) is true. But (27a) is false in that situation. The reason is that in all there are more than three students of who it is true that they hugged or met.

(27) a. Genau drei Studenten (zusammen) umarmten oder trafen sich.
exactly three students together hugged or met self
'Exactly three students (together) hugged or met.'

↔

b. Genau drei Studenten (zusammen) umarmten sich, oder genau
exactly three students together hugged self or exactly
drei Studenten (zusammen) trafen sich, oder beides.
three students together met self or both
'Exactly three students (together) hugged, or exactly three students (together) met, or both.'

The prediction that non-monotonic *genau drei Studenten* causes an intervention effect is borne out, as (28) shows.

(28) *Wen haben genau drei Studenten wann eingeladen?
who have exactly three students when invited

Why then, if UE indefinites are additive, are the examples with intervening UE indefinites still slightly deviant even though they are better than the questions with DE indefinites? Notice that in all the questions in (21) and (22) the verbs do not denote clearly plurality-seeking predicates. That is, distributive interpretations are possible. In fact, while the distributive interpretation with predicates such as *see* is probably obligatory, with predicates such as *introduce to* it still appears to be preferred to the group interpretation. Otherwise the sequence in (29) should be perfect. But without the addition of *alone* it seems as degraded as (30). Assuming that the distributive interpretation is unavailable for reasons to become clear momentarily, the forced interpretation of a wh-question with an UE indefinite is then the collective interpretation. That is, in an

example like (30) it is a non-atomic individual of three students or more who invited someone. But this interpretation is itself not the preferred one given the lexical semantics of the verbal predicate. I propose that because of this (30) and similarly questions like (21a) and (22a) above are slightly degraded.

(29) John and Mary introduced a student to Bill. But neither John nor Mary ??(ALONE) introduced a student to Bill.

(30) ?Wen haben mehr als drei Studenten wem vorgestellt?
who have more than three students whom introduced
'Who did more than three students introduce to who?'

Assume that in order to arrive at the preferred distributive interpretation of the plural in (30), a distributive operator as in (31) is needed (cf. Link 1983, Schwarzschild 1996 a.m.o), which requires that each individual that is part of the non-atomic individual to which the distributive predicate applies is in the denotation of the verb. $x \preceq X$ denotes that x is a part of X. Given that x is reserved for atomic individuals, this means that x is an atomic part of X.[12]

(31) $[\![\text{DIST}]\!](P_{\langle s,\langle e,t\rangle\rangle})(X_e) = 1$ iff $\forall x[x \preceq X \rightarrow P(x)]$

But this means that the distributive operator is a universal quantifier of some sort. Recall that universal quantifiers cause intervention effects. The options in (32) for possible LFs of (30) come to mind.

(32) a. [...mehr als drei Studenten [DIST 1[wem 2[t_1 t_3 t_2 vorgestellt]]]]
b. [...mehr als drei Studenten 1[wem 2[t_1 t_3 t_2 vorgestellt]]]
c. [...mehr als drei Studenten 1[wem 2[t_1 DIST [t_3 t_2 vorgestellt]]]]

If the speaker chooses the LF in (32a), an intervention effect obtains. No intervention effect is expected if DIST is absent altogether as in (32b) yielding a collective interpretation. Also no intervention effect is expected if DIST attaches very low as in (32c) and the wh-in-situ

[12] A reviewer reminds me of Kratzer (2008), who argues for an analysis of plurality in terms of cumulativity by means of a *-operator alone, that is, an analysis without DIST, which would be problematic for the argument presented. Such an approach is based on the idea that a sentence with a plural in it has a weak semantics that makes it true under collective, distributive and intermediate situations. Heim (1994: 6) and Klinedinst (2007: 20) show that a distinctly distributive reading must be available because distributive interpretations persist when plural sentences are embedded under negation. I therefore take it that a distributive reading must be somehow represented in the LF. In addition to employing DIST, this could be done by making use of the *-operator enriched with covers (cf. Heim 1994; Schwarzschild 1994), which are independently needed to account for the context dependency of distributive readings even when DIST is used (Schwarzschild 1996). But since * has scope effects, as shown by Kratzer (2008: (24)) and Schwarzschild (1994: 205), we then make the same predictions with respect to the IEG as with the account in the text. Also cf. Scha (1981)'s analysis of distributivity in terms of a meaning postulate for distributive predicates. I do not see how the latter would be compatible with the present proposal, though. But there are arguments in the literature against such an approach (cf. Schwarzschild (1996: 65); Winter (2000: 30) a.o.).

expression has been moved above it thereby yielding a distributive interpretation. Note that DIST cannot attach lower in the structure given that it takes a predicate as argument.

For the present argument to go through it is essential that an LF like (32c) is ruled out for independent reasons. Note that this hinges on the assumption that a surface representation—with the notion surface representation defined as the structure obtained before any covert movement—where DIST is below the wh-in-situ is not available. Otherwise the LF in (32c) could show a mutual scope relation for the wh-in-situ and DIST parallel to the corresponding surface representation if DIST were just QRed to the position indicated in (32c) from a lower position. I do not know why that restriction should hold. But two possibilities come to mind to rule out surface representations like (32c): first non-arguments—and therefore also DIST—might not appear below selected arguments of the verb making QR of DIST to the indicated position in (32c) impossible. Second one might argue against (32c) that the scopes of the plural and the distributive operator are dissociated. Bennett (1974) suggests that distributivity comes directly with the subject DP thereby making (32c) unavailable. Compare also Heim *et al.* (1991) who make a related proposal regarding reciprocals. Now, assuming that DIST has the same scope in the surface representation as at LF the scope relation between the wh-in-situ and DIST in (32c) would be different from the one in the respective surface representation. In the latter, the indirect object is arguably in the position indicated by the trace t_2. After QR, the wh-expression does not have scope below DIST anymore. Such LFs, where the wh-in-situ receives a scope that is different from the surface representation, must be blocked under any analysis of intervention effects. Otherwise, it should always be possible to generate an LF not triggering an intervention effect.

Therefore only (32a) and (32b) are actual LFs corresponding to the surface representation of the sentence. Only (32b) does not lead to an intervention effect. But it demands the group interpretation of the verbal predicate, which is not the lexically preferred one. Hence the slight degradedness of (30) and similarly of (21a) and (22a). Incidentally, the semantics in Section 3 will allow wh-expressions to actually take surface scope.

2.3.2 *Predictions* This makes a prediction. If we choose a clearly non-distributive predicate, the marginal degradedness should vanish. Consider the slight difference between (33) and (34). All that changes from (33) to (34) is that a collective predicate is used instead of a

distributive one. This has the consequence that the question becomes completely acceptable. (35) shows the same effect.

(33) ?Wo haben mehr als drei Maler wann vorgetragen?
where have more than three painters when presented
'Where did more than three painters give a talk when?'

(34) Wo haben sich mehr als drei Maler wann versammelt?
where have self more than three painters when gathered
'Where did more than three painters gather when?'

(35) Wo haben sich mehr als drei Professoren wann umarmt?
where have self more than three professors when hugged
'Where did more than three professors hug when?'

Bernhard Schwarz (p.c.) draws my attention to the interesting contrast in (36).

(36) a. Wo haben sich mehr als drei Maler wann eine Pizza geteilt?
where have self more than three painters when a pizza shared
'Where did more than three painters share a pizza when?'

b. *Wo haben sich mehr als drei Maler wann eine Arbeitshose
where have self more than three painters when a dungaree
angezogen?
put.on

World-knowledge, on the one hand, suggests that three painters cannot wear the same overalls. For the verbal predicate in (36b) to apply to a non-atomic individual therefore it is necessary that there is a distributive operator involved so that each painter put on his pair of dungarees (cf. Winter 2000: 4). I thus correctly predict that (36b) should be unacceptable. The predicate in (36a), on the other hand, is collective in nature and can thus be construed without a distributive operator. As a consequence (36a) is predicted to be acceptable.

Moreover, recall the intuitive equivalence discussed in (25) and repeated in (37) showing that UE indefinites when construed with collective predicates are indeed additive. It is now also clear why the anti-distributivity operator *zusammen* had to be used. Without it (37) would still allow a distributive analysis where two students hugged and two met, which would make (37b) false. The equivalence, however, vanishes when replaced by sentences with distributive predicates, as in (38). The reason for this non-equivalence is clear: (38b) is true if there are four students such that two of them smoke and two drink. But (38a) is clearly false in that situation. (38a) requires that there are at least four smokers or at least four drinkers. The culprit is, of course, the distributive operator, which has an effect parallel to an overt universal quantifier.

(37) a. ?Mehr als drei Studenten zusammen umarmten oder trafen sich,
more than three students together hugged or met self

oder beides.
or both
'More than three students together hugged or met, or both.'
↔

b. Mehr als drei Studenten zusammen umarmten sich, oder mehr
more than three students together hugged self or more
als drei Studenten zusammen trafen sich, oder beides.
than three students together met self or both
'More than three students together hugged, or more than three students together met, or both.'

(38) a. Mehr als drei Studenten rauchen oder trinken.
more than three students smoke or drink
'More than three students smoke or drink.'
↮

b. Mehr als drei Studenten rauchen, oder mehr als drei Studenten
more than three students smoke or more than three students
trinken, oder beides.
drink or both
'More than three students smoke, or more than three students drink, or both.'

We can now also note that singular UE indefinites behave as expected with respect to intervention, as shown in (39). DE singular indefinites modified by *fewer than* cannot be tested for obvious reasons. Moreover, as said in footnote 8 I do not include indefinites modified by *at least* in the discussion because of their unclear status in monotonicity and hence additivity.[13]

(39) ?Wen hat mehr als ein Student wem vorgestellt?
who has more than one student whom introduced
'Who did more than one student introduce to who?'

It must, however, be noted that intuitions about the equivalence necessary to show that singular UE indefinites are additive are difficult to obtain. The reason is that singular indefinites with collective predicates are ungrammatical for independent reasons, as (40) shows. The ungrammaticality of (40) has been independently observed by Hackl (2000: 62) among others. It is an instance of his *Minimal Number of Participants Generalization* (*ibid.* p. 67), as Bernhard Schwarz (p.c.) reminds me. Thus we could only use distributive predicates for the test. But as already shown in (38), these do not licence the equivalences we are after for reasons that are now clear. (41) shows the same for singular UE indefinites.

(40) *Mehr als ein Student traf sich.
more than one student met self

[13] The same applies to unmodified singular indefinites like *ein Student* ('*one/a student*'), as these could potentially be interpreted non-monotonically.

(41) a. Mehr als ein Student raucht oder trinkt.
more than one student smokes or drinks
'More than one student smokes or drinks.'
↮
b. Mehr als ein Student raucht, oder mehr als ein Student trinkt,
more than one student smokes or more than one student drinks
oder beides.
or both
'More than one student smokes, or more than one student drinks, or both.'

Thus, we conclude that it is a distributive operator that leads to intervention effects with UE indefinites. This operator is not obligatory in cases like (21a), (22a) and (30) thereby accounting for the fact that the deviance is weaker than with DE indefinites. But generally UE indefinites do not cause intervention. Moreover, the intervention effect is to be grouped together with the one found with universal quantifiers. But if this is on the right track, then we also expect slight degradedness with definite plural subjects in case they are interpreted distributively. This prediction is borne out. But one has to be careful when interpreting the relevant questions for a number of reasons: the contexts in (42) and (43) are chosen in such a way that list readings are unlikely and that moreover, more than one pair is expected to make the question predicate true.[14] In such a situation, the questions in (42) and (43) are slightly degraded. The effect is parallel to the one observed with UE indefinites.

(42) *Context: It sometimes happens during award ceremonies that each award winner cries. A wants to know in which years and during which ceremonies this happened . . .*
A: ?In welchem Jahr haben die Preisträger bei welcher Verleihung
in which year have the award winners at which ceremony
geweint?
cried
'In which year did the award winners cry at which ceremony?'

(43) *Context: It is not customary at award ceremonies that the presenters kiss the award winners. But there are cases where the presenters each kissed the female winner. A wants to know when which actress was kissed . . .*
A: ?In welchem Jahr haben die Moderatoren der Preisverleihung
in which year have the presenters of.the ceremony
welche Schauspielerin geküsst?

[14] The plural subject might be able to take scope over the question in order to obtain a pair-list interpretation. This would, as noted above, avoid an intervention effect. Bernhard Schwarz (p.c.) reminds me that in Krifka (1992)'s analysis plural DPs actually do not need to take scope over the question. In that case they are predicted to cause an intervention effect anyway. Regardless of that the context chosen in the example avoids a potential confound. Furthermore, as noted by Pesetsky (2000: 60ff.) if a single pair is expected to make the question predicate true, then the intervention effect tends to disappear. He attributes this observation to Sigrid Beck (p.c.). I do not know why this is. But again the context avoids this complication. I thank an anonymous reviewer for pointing out the possible prediction made by the present account.

which actress kissed
'In which year did the presenters kiss which actress?'

Beck (1996a) notes that certain universal quantifiers like *jede Aufgabe* in (44) are not allowed to take wide scope in order to generate a list reading for the question. This accounts for the degradedness of (44b) because only the representation triggering an intervention effect is available.

(44) a. Wer hat wann jede Aufgabe gelöst?
who has when every problem solved
'Who solved every problem when?'
b. ??Wer hat jede Aufgabe wann gelöst?
who has every problem when solved
'Who solved every problem when?'
(Beck 1996a: 26)

A parallel contrast is found with the corresponding definite plural *die Aufgaben* in (45). (45b) is still better than (44b), but this can be due to the fact that a representation without DIST is available, of course:

(45) a. Wer hat wann die Aufgaben gelöst?
who has when the problems solved
'Who solved the problems when?'
b. ?Wer hat die Aufgaben wann gelöst?
who has the problems when solved
'Who solved the problems when?'

We can thus conclude that definite plurals similar to UE indefinites lead to slight degradedness.

2.4 *Intermediate summary*

We already know that universal quantifiers are non-additive. By extension the DIST-operator is non-additive as well. Consequently it leads to intervention effects. UE indefinites themselves, however, do not do so. The intermediate status of (30) and other examples is fully expected, given the semantics of the verb. Finally, the IEG predicts that examples with collective predicates should never show an intervention effect.

It should also be stressed that the degradedness observed with DE indefinites is independent from any distributive operators possibly present. Thus, the effect found with DE indefinites should be stronger than the one found with UE ones. The present generalization

is the only one that straightforwardly makes this correct prediction, it appears.[15,16]

At this point it should be noted that the IEG suggests that intervention effects have a semantic root. The reason for this conclusion is that it is not clear how a syntactic approach could be sensitive to semantic properties such as additivity. For such an approach to be feasible, one would have to motivate the existence of a syntactic feature ±*additive* or possibly ±*DE*. But what this feature would be responsible for other than accounting for intervention effects is unclear.

3 IMPLEMENTING THE INTERVENTION EFFECTS GENERALIZATION

3.1 *Towards an understanding of the generalization*

So far, I argued that intervention effects arise if an intervener is non-additive, as stated by the IEG in (13) above. But why should this be so? As a first step towards an answer I want to suggest that the IEG is a reflex of a more specific condition on wh-questions. That is, I will argue that the IEG can be tied to the semantics of wh-questions in the way proposed in (46).

(46) *Formal condition on wh-questions* (to be modified)
An intervention effect arises in a wh-question if the disjunction of the alternatives in the Hamblin/Karttunen-denotation is not equivalent to the proposition resulting when the wh-expressions are interpreted as existential quantifiers in their surface scope position.

In order to show that the condition in (46) picks out the problematic interveners it is intended to, all one has to do is to check for each intervener whether the equivalence of the two propositions mentioned holds. Here I want to make a more general point, namely that (46) entails the IEG in (13). But before doing so I want to briefly discuss

[15] Grohmann (2006)'s approach is different as it does not derive the slight degradedness observed with UE indefinites. In fact, he claims that such an effect does not exist. But every speaker I consulted reports such effects.

[16] A reviewer reminds me that this specific approach straightforwardly predicts intervention effects with pied-piping structures as reported by Sauerland & Heck (2003). The negative quantifier in (ib) has an effect completely parallel to the one discussed in the text. The UE indefinite in (ia), again, is predicted to not intervene.

(i) a. Fritz möchte wissen ein wie schnelles Motorrad du fahren darfst
Fritz wants know a how fast motorbike you drive may
'Fritz would like to know how fast a motorbike you are allowed to ride.'
b. *Fritz möchte wissen kein wie schnelles Motorrad du fahren darfst
Fritz wants know no how fast motorbike you drive may
(Sauerland & Heck 2003: (8))

what the two propositions involved in the checking process introduced in condition (46) amount to. A technical implementation is offered in subsection 3.2. There I also show how (46) makes the correct predictions for negative interveners.

The proposition resulting from interpreting the wh-expressions as existential indefinites in their respective surface scope positions should be thought of as the proposition necessary for deriving a particular presupposition that the wh-question triggers. In acceptable wh-questions this will be tantamount to an existential presupposition. This has the consequence that I am following authors such as Horn (1972), Karttunen (1977), Dayal (1996), Haida (2007), Abusch (2010) a.o. in arguing that wh-questions have an existential presupposition, contra Groenendijk & Stokhof (1982). This, moreover, means that I do not see question–answer pairs such as (47) as an argument against the analysis assumed here.

(47) A: Who came?
B: No one did.

B's reply in (47) contradicts the existential presupposition of A's question, provided the latter has such a presupposition. In other words, B's utterance should be infelicitous as an answer to A's question. Following the usual idea to circumvent this problem argued for in the literature on this topic, I assume that B's utterance is not an answer to the question in the semantic sense contra Groenendijk and Stokhof. Rather an answer such as the one given denies the existential presupposition of the preceding wh-question (Dayal (1996: 122), also cf. Horn (1972 a.o).).

Coming to the second ingredient necessary to evaluate whether the equivalence used in condition (46) holds for a given wh-question, we have to address how the question denotation is determined. Following Hamblin (1973), I take the question denotation to be its Hamblin-set—that is, a set of propositions (also cf. Dayal (1996), Lahiri (2002) to mention just a few recent works). In the following I refer to this set as the Hamblin/Karttunen-denotation (H/K-denotation), although I do not assume that questions denote the set of their true answers as Karttunen (1977) does. The propositions in the denotation are determined by letting the wh-expression introduce alternatives. The wh-phrase *which boy*, for instance, will then contribute a set of individuals to the semantic computation of the wh-question where the individuals correspond to boys. The question in (48) therefore has the denotation in (49). Intuitively one can think of the denotation in (49) as being the set of possible answers to the question, that is, it has the form {that John invited Bill, that John invited Frank, . . . }.

(48) Which boy did John invite?
(49) $[\![(48)]\!]^w = \{p : \exists x[boy_w(x) \wedge p = \lambda w'.invite_{w'}(John, x)]\}$

A multiple wh-question like (50) then has the denotation in (51). This amounts to the set of propositions {that John invited Bill to Vienna, that John invited Bill to New York, that John invited Frank to Vienna, . . . }.[17]

(50) Who did John invite where?
(51) $[\![(50)]\!]^w = \{p : \exists x.\exists y[person_w(x) \wedge place_w(y) \wedge p = \lambda w'.invite_{w'}(John, x, y)]\}$

The question is of course how the denotations in (49) and (51) are derived compositionally from the syntax provided by the question. A parallel issue arises with respect to the presupposition discussed above. These issues are addressed in the following subsection.

Let us now return to the question in which relation the IEG stands to the formal condition on wh-questions (46). I will show that the latter entails the former (or more precisely that they are equivalent). In the following P_w is a variable over the denotation of a predicate P in world w. Assume an LF for an abstract wh-in-situ question such as in (52a) with intervener $\mathcal{Q}$ and question operator Q, for which I will offer a lexical entry in the implementation in subsection 3.2. Assume furthermore that the wh-expression and $\mathcal{Q}$ are the only scope-bearing elements. According to the discussion above, the question has a denotation as in (52b). If $\{a, b, c\}$ are the only individuals, this is the set of propositions $\{\lambda w.\mathcal{Q}(P_w(a)), \lambda w.\mathcal{Q}(P_w(b)), \lambda w.\mathcal{Q}(P_w(c))\}$, the disjunction of which returns (52c). The proposition resulting from interpreting the wh-expression in the surface scope position—that is, the presupposition of (52a)—is as in (52d). Here the existential quantifier denoted by the wh-expression is in the scope of $\mathcal{Q}$.

[17] It might be necessary to have an additional ingredient to obtain list-readings for (50) (cf. Dayal 1996, 2002). For the present purposes, however, the simple representation in (51) is enough, because also in these approaches both whs ultimately receive wide scope, which has the same consequences for the IEG. In particular, Dayal (1996) argues that multiple-pair interpretations are brought about by an underlying functional dependency, whereas for single-pair interpretations such a dependency is not needed. Therefore, one might conclude that it is the functional dependency that is disturbed by interveners, that is, intervention effects should be explained by making reference to such a functional dependency. This conclusion, however, cannot be quite right. Consider the Korean (i). Such simple wh-questions do not involve a functional dependency. It cannot be concluded that such a dependency is responsible for intervention effects. The present approach, of course, would treat (ia) on a par with multiple wh-questions. This, of course, does not imply at all that Dayal (1996)'s analysis is wrong.

(i) a. ?***amuto*** muôs-ûl sa-chi anh-ass-ni?
anyone what-Acc buy-CHI not do-Past-Q
b. muôs-ûl$_i$ ***amuto*** t$_i$ sa-chi anh-ass-ni?
what-Acc anyone buy-CHI not do-Past-Q
'What did no one buy?'
(Kim 2002: (10))

(52) a. [Q . . . $\mathcal{Q}$ . . . wh . . .]
b. $\{p : \exists x \in \{a, b, c\} \wedge p = \lambda w.\mathcal{Q}(P_w(x))\}$
c. $\lambda w.\exists x \in \{a, b, c\}.\mathcal{Q}(P_w(x))$
d. $\lambda w.\mathcal{Q}(\exists x \in \{a, b, c\}.P_w(x))$

Given the formal condition on wh-questions (46), an intervention effect arises if the disjunction of the H/K-propositions (52c) is not equivalent to presupposition (52d). I claim that this is the case if $\mathcal{Q}$ is non-additive; that is, an operator introducing an intervention effect in accordance with the IEG also does so when condition (46) is considered. Recall that $\mathcal{Q}$ is non-additive if the non-equivalence in (53) holds, where ϕ and ψ are open formulas. I now show that for each intervener $\mathcal{Q}$ whenever (52c) is not equivalent to (52d), the non-equivalence in (53) holds as well for that same $\mathcal{Q}$. Existential quantification over individuals $\{a, b, c\}$ is equivalent to a disjunction of propositions with $\{a, b, c\}$ in the place of the variable. For the disjunction of the H/K-propositions in (52c), on the one hand, we have the equivalence in (54a): if the left side is true, there is an individual i in $\{a, b, c\}$ such that $\mathcal{Q}(P_w(i))$ is true. Thus one of the disjuncts on the right side must be true making the whole disjunction true. It is transparent that entailment from right to left holds as well. For the presupposition in (52d), on the other hand, we find the equivalence in (54b): $P_w(a) \vee P_w(b) \vee P_w(c)$ is true if one disjunct is true—there is an individual i of $\{a, b, c\}$ such that $P_w(i)$—and it thus entails $\exists x \in \{a, b, c\}.P_w(x)$, and obviously vice versa. But then the equivalence in (54b) must hold. Whatever the denotation of $\mathcal{Q}$, it will output the same value when applied to $P_w(a) \vee P_w(b) \vee P_w(c)$ as when applied to $\exists x \in \{a, b, c\}.P_w(x)$.

(53) $\mathcal{Q}.\phi \vee \psi \neq \mathcal{Q}.\phi \vee \mathcal{Q}.\psi.$
(54) a. $\lambda w.\exists x \in \{a, b, c\}.\mathcal{Q}(P_w(x)) = \lambda w.\mathcal{Q}(P_w(a)) \vee \mathcal{Q}(P_w(b)) \vee \mathcal{Q}(P_w(c))$
b. $\lambda w.\mathcal{Q}(\exists x \in \{a, b, c\}.P_w(x)) = \lambda w.\mathcal{Q}(P_w(a) \vee P_w(b) \vee P_w(c))$

Consider (55a), the non-equivalence demanded by the formal condition on wh-questions for there to be intervention. Given (54a), we can substitute the right side of (55a) to obtain (55b). And given (54b), we can further substitute the left side of (55b) to get (55c), which corresponds to the non-equivalence demanded by the IEG for intervention to hold. In other words, (55a) entails (55c) (and in fact vice versa), and for $\mathcal{Q}$ to be a problematic intervener it must be non-additive.

(55) a. $\lambda w.\mathcal{Q}(\exists x \in \{a, b, c\}.P_w(x)) \neq \lambda w.\exists x \in \{a, b, c\}.\mathcal{Q}(P_w(x))$
b. $\lambda w.\mathcal{Q}(\exists x \in \{a, b, c\}.P_w(x)) \neq \lambda w.\mathcal{Q}(P_w(a)) \vee \mathcal{Q}(P_w(b)) \vee \mathcal{Q}(P_w(c)))$
c. $\lambda w.\mathcal{Q}(P_w(a) \vee P_w(b) \vee P_w(c)) \neq \lambda w.\mathcal{Q}(P_w(a)) \vee \mathcal{Q}(P_w(b)) \vee \mathcal{Q}(P_w(c))$

3.2 *A technical implementation*

Two intertwined questions arise with respect to the formal condition on wh-questions: first, how is the presupposition computed? Second, how is the question denotation computed? So far I have said that the presupposition is derived from interpreting all the wh-expressions in their surface scope positions, and that the resulting proposition must be equivalent to the disjunction of the H/K-denotation of the question. For the latter denotation, however, it was crucial that the wh-expressions have widest scope. Therefore one has to ask how it is possible that a wh-in-situ expression is interpreted in the scope of an intervener for presuppositional purposes, whereas at the same time it must be interpreted as having widest scope when computing the question denotation. The answer I will give is that the latter is only an illusion. In fact, it is possible to always interpret a wh-expression in its surface scope position. This has the consequence that the formal condition on wh-questions can be stated straightforwardly.

Where do alternatives come in wh-questions? I will not follow proposals made in the literature claiming that the denotation of a wh-element is a set of alternatives (cf. Hamblin (1973) and more recently Beck (2006), Hagstrom (1998), Kratzer & Shimoyama (2002), Shimoyama (2006), although the latter differ in their actual implementations). Rather I argue that wh-words are interpreted as existential quantifiers. These quantifiers range over a chosen domain. The wh-element is lexically marked as activating domain alternatives for a secondary semantic value. In particular, the domains must be singleton subsets of the domain chosen in the ordinary value not including the empty set. These assumptions are very similar to the ones made by Chierchia (2004, 2006) for NPIs.

Following Rooth (1985) and much work after him, the semantic system is assumed to be bi-dimensional. I follow Kratzer (1991) in the formal implementation of that idea rather than Rooth directly (also cf. discussion by Beck (2006), Wold (1996)). This means that each constituent is assigned two semantic values. One of them is the ordinary value, the other one is responsible for deriving alternatives, where wh-expressions are lexically marked by a numerical index i_{wh} to introduce alternatives. The ordinary value of a non-complex constituent ϕ is its usual denotation, which is derived by applying the interpretation function $[\![\ ]\!]^g$ to ϕ. For $[\![\ ]\!]^g$ the indices i_{wh} are ignored. For the secondary value of constituent ϕ a designated assignment function h, $[\![\phi]\!]^{g,h}$, is invoked. Indices i_{wh} serve as distinguished variables subject to interpretation by h. h maps the variable on ϕ onto an object of the same type as

$[\![\phi]\!]^g$. The secondary value of a constituent ϕ without any distinguished variables is just its normal denotation:

(56) *Semantic values for non-complex constituents*
If A is a non-complex constituent, then
a. (i) $[\![A]\!]^g = [\![A]\!]$ if A is assignment-independent, where $[\![A]\!]$ is specified in the lexicon, and $g(A)$ otherwise
(ii) $[\![A]\!]^{g,h} = [\![A]\!]^g$
b. (i) $[\![A_{i_{wh}}]\!]^g = [\![A]\!]^g$
(ii) $[\![A_{i_{wh}}]\!]^{g,h} = h(i)$

The secondary value of a complex constituent ψ is defined recursively by taking the secondary values of the subconstituents of ψ and applying the usual semantic rules to them. The rules of functional application and predicate abstraction are defined as in (57) and (58), respectively. In both cases, the ordinary value and secondary value are derived following the same schema essentially (σ and τ indicate types).

(57) *Functional application*
If A is a branching node with daughters B of type $\langle\sigma,\tau\rangle$ and C of type σ,
a. $[\![A]\!]^g = [\![B]\!]^g([\![C]\!]^g)$,
b. $[\![A]\!]^{g,h} = [\![B]\!]^{g,h}([\![C]\!]^{g,h})$.

(58) *Predicate abstraction*
If A is a branching node with daughters B and a numerical index i,
a. $[\![A]\!]^g = \lambda x.[\![B]\!]^{g[x/i]}$,
b. $[\![A]\!]^{g,h} = \lambda x.[\![B]\!]^{g[x/i],h}$.

The interpretation of the wh-element is specified as follows: the ordinary value corresponds to an existential quantifier, (59a). Its first argument C is of type $\langle e,t\rangle$, which is the argument for the domain over which the quantifier ranges. In other words, C stands for a set of individuals. The secondary value is the ordinary value, (59b).

(59) a. $[\![\text{wh}]\!]^g = \lambda C_{\langle e,t\rangle}.\lambda P_{\langle s,\langle e,t\rangle\rangle}.\lambda Q_{\langle s,\langle e,t\rangle\rangle}.\lambda w_s.\exists x \in C[P_w(x) \wedge Q_w(x)]$
b. $[\![\text{wh}]\!]^{g,h} = [\![\text{wh}]\!]^g$

I assume that wh-expressions come with a domain variable D similar to the assumptions by Chierchia (2006: 579f.) about NPI *any*. The domain variable D is present in the LF and obligatorily bears a distinguished index i_{wh}. The ordinary value of D is $g(D)$, (60a). The secondary value according to the rules above is $h(i)$. The distinguished variable i_{wh} comes with the presupposition that $h(i)$ be a singleton subset of the ordinary value of D—that is, $g(D)$.

(60) a. $[\![D_{i_{wh}}]\!]^g = g(D)$
b. $[\![D_{i_{wh}}]\!]^{g,h} = h(i)$
if $h(i) \subseteq g(D) \wedge |h(i)| = 1$, otherwise undefined

The wh-element and D combine via functional application. In the case of the ordinary value we obtain an existential quantifier over domain $g(D)$. The secondary value differs from this in the domain chosen, as the quantifier ranges over $h(i)$ in the secondary value given (60b). Moreover, the presupposition that $h(i)$ be a subset of $g(D)$ and in addition a singleton is added. This has the effect that the alternatives to wh-expressions are essentially individuals:

(61) a. $[\![\text{wh } D_{i_{wh}}]\!]^g = \lambda P.\lambda Q.\lambda w.\exists x \in g(D)[P_w(x) \wedge Q_w(x)]$
b. $[\![\text{wh } D_{i_{wh}}]\!]^{g,h} = \lambda P.\lambda Q.\lambda w.\exists x \in h(i)[P_w(x) \wedge Q_w(x)]$
if $h(i) \subseteq g(D) \wedge |h(i)| = 1$, otherwise undefined

Consider now a simple wh-question with its LF, where it is assumed that the Q-operator is adjoined to the CP-constituent. We will turn to the semantics of the Q-operator immediately below. The interpretation of the constituents up to CP is given in (63).

(62) a. Who did John call?
b. Q [$_{CP}$ who $D_{3_{wh}}$ [$_{C_2}$' 1 [$_{C_1}$' did John call t_1]]]

(63) a. (i) $[\![C_1']\!]^g = \lambda w.call_w(John, g(1))$
(ii) $[\![C_1']\!]^{g,h} = [\![C_1']\!]^g$
b. (i) $[\![C_2']\!]^g = \lambda x.\lambda w.call_w(John, x)$
(ii) $[\![C_2']\!]^{g,h} = [\![C_2']\!]^g$
c. (i) $[\![\text{who } D_{3_{wh}}]\!]^g = \lambda P.\lambda w.\exists x \in g(D)[person_w(x) \wedge P_w(x)]$
(ii) $[\![\text{who } D_{3_{wh}}]\!]^{g,h} = \lambda P.\lambda w.\exists x \in h(3)[person_w(x) \wedge P_w(x)]$
d. (i) $[\![CP]\!]^g = \lambda w.\exists x \in g(D)[person_w(x) \wedge call_w(John, x)]$
(ii) $[\![CP]\!]^{g,h} = \lambda w.\exists x \in h(3)[person_w(x) \wedge call_w(John, x)]$

The Q-operator is defined as follows: it states that the denotation of the question is equivalent to the set derived from the secondary value of CP where one quantifies over designated assignments h. In other words, the propositions in the denotation differ in at most the value for the domain chosen for the existential quantifier. Notice moreover that all alternatives employ only singleton domains which are subsets of the domain chosen in the ordinary value of CP. Since this has the consequence that the existential quantifiers range over singleton sets, we arrive at a version of the H/K-denotation for questions. Moreover, the question is only defined if the ordinary value of CP is true in the world of evaluation. The secondary value of the question is set identical to its ordinary value (H is the set of designated assignments h):

(64) a. $[\![[\text{Q CP}]]\!]^g = \{[\![CP]\!]^{g,h} \mid h \in H\}$
if $[\![CP]\!]^g(w) = 1$, otherwise undefined
b. $[\![[\text{Q CP}]]\!]^{g,h} = [\![[\text{Q CP}]]\!]^g$

Assuming that the relevant individuals in $g(D)$ are $\{a, b, c\}$,[18] we derive for the question above the interpretation in (65). Notice again that the propositions in the denotation only have singleton domains for the existential quantifiers, all of which are (proper) subsets of $g(D)$. In other words, the set in (65) is equivalent to the set {that John called *a*, that John called *b*, that John called *c*}. The question has a defined value if the following holds: it must be true that John called someone of $\{a, b, c\}$, that is, the proposition corresponding to the ordinary value of CP must be true.

(65) $[\![(62b)]\!]^g = \{\lambda w.\exists x \in h(3)[person_w(x) \wedge call_w(John, x)] \mid h \in H\}$
$= \{\lambda w.\exists x \in D'[person_w(x) \wedge call_w(John, x)] \text{ j } D' \subseteq D \wedge |D'| = 1\}$

Now, according to the formal condition on wh-questions in order for no intervention effect to arise in (46), the disjunction of the alternatives in the H/K-denotation should be equivalent to the proposition resulting from interpreting the wh-expressions as existential quantifiers in their surface scope positions. This latter proposition can be seen as the ordinary value of CP. In other words, the formal condition on wh-questions requires that the disjunction of the H/K-alternatives return the existential presupposition:

(66) *Formal condition on wh-questions* (final version)
An intervention effect arises in a wh-question if $\vee\{[\![\text{CP}]\!]^{g,h} | h \in H\} \neq [\![\text{CP}]\!]^g$.

Since the denotation in (65) only contains H/K-alternatives, it follows that disjoining all the members returns the ordinary value of CP, as required by the formal condition on wh-questions in (66). Thus, the wh-question should be acceptable.

Let us see how the present approach handles an example of intervention by the negative quantifier *niemand*:

(67) a. *Wen hat niemand wem vorgestellt?
who has no one whom introduced
b. Wen hat wem niemand vorgestellt?
who has whom no one introduced
'Who did no one introduce to who?'

Assume that the LFs for (67a) and (67b) are as in (68a) and (68b), respectively.

(68) a. Q [$_{\text{CP}}$ wen $D_{3_{wh}}$ 1 [$_{\text{C'}}$ hat niemand 2 [$_{\text{VP'}}$ wem $D_{6_{wh}}$3 [$_{\text{VP}}$ t_2 t_3 t_1 vorgestellt]]]]
b. Q [$_{\text{CP}}$ wen $D_{3_{wh}}$ 1 [$_{\text{C'}}$ hat wem $D_{6_{wh}}$ 3 [$_{\text{IP}}$ niemand 2 [$_{\text{VP}}$ t_2 t_3 t_1 vorgestellt]]]]

[18] For simplicity I ignore pluralities here and below.

The non-complex constituents are interpreted the same in the derivations in (68):

(69) a. (i) $[\![\text{wen } D_{3_{wh}}]\!]^g = \lambda P.\lambda w.\exists x \in g(D)[person_w(x) \wedge P_w(x)]$
(ii) $[\![\text{wen } D_{3_{wh}}]\!]^{g,h} = \lambda P.\lambda w.\exists x \in \text{h}(3)[person_w(x) \wedge P_w(x)]$
b. (i) $[\![\text{wem } D_{6wh}]\!]^g = \lambda P.\lambda w.\exists x \in g(D)[person_w(x) \wedge P_w(x)]$
(ii) $[\![\text{wem } D_{6wh}]\!]^{g,h} = \lambda P.\lambda w.\exists x \in h(6)[person_w(x) \wedge P_w(x)]$
c. (i) $[\![\text{niemand}]\!]^g = \lambda P.\lambda w.\neg\exists x[person_w(x) \wedge P_w(x)]$
(ii) $[\![\text{niemand}]\!]^{g,h} = [\![\text{niemand}]\!]^g$
d. (i) $[\![\text{vorstellen}]\!]^g = \lambda y.\lambda z.\lambda x.\lambda w.introduce_w(x,y,z)$
(ii) $[\![\text{vorstellen}]\!]^{g,h} = [\![\text{vorstellen}]\!]^g$

Now consider the compositional steps for (67a) and its LF (68a). For each node we derive two values, where the restrictors of the quantifiers involved are ignored for reasons of space. Assuming that individuals cannot be introduced to themselves, the H/K-denotation can then be paraphrased as {that no one introduced *a* to *b*, . . . , that no one introduced *c* to *b*}.

(70) a. $[\![\text{VP}]\!]^g = \lambda w.introduce_w(g(2),\ g(1),\ g(3))$
b. $[\![\text{VP}]\!]^{g,h} = [\![\text{VP}]\!]^g$
c. $[\![\text{VP'}]\!]^g = \lambda w.\exists z \in g(D)[introduce_w(g(2),\ g(1),\ z)]$
d. $[\![\text{VP'}]\!]^{g,h} = \lambda w.\exists z \in h(6)[introduce_w(g(2),\ g(1),\ z)]$
e. $[\![\text{C'}]\!]^g = \lambda w.\neg\exists y.\exists z \in g(D)[introduce_w(y,\ g(1),\ z)]$
f. $[\![\text{C'}]\!]^{g,h} = \lambda w.\neg\exists y.\exists z \in h(6)[introduce_w(y,\ g(1),\ z)]$
g. $[\![\text{CP}]\!]^g = \lambda w.\exists x \in g(D).\neg\exists y.\exists z \in g(D)[introduce_w(y,\ x,\ z)]$
h. $[\![\text{CP}]\!]^{g,h} = \lambda w.\exists x \in h(3).\neg\exists y.\exists z \in h(6)[introduce_w(y,\ x,\ z)]$
i. $[\![(68a)]\!]^g = \{\lambda w.\exists x \in h(3).\neg\exists y.\exists z \in h(6)[introduce_w(y,\ x,\ z)] \mid h \in H\}$
$= \{\lambda w.\exists x \in D'.\neg\exists y.\exists z \in D''[introduce_w(y,\ x,\ z)] \mid$
$D',\ D'' \subseteq;\ D \wedge |D'| = |D''| = 1\}$
j. $[\![(68a)]\!]^{g,h} = [\![(68a)]\!]^g$

According to (64), first the ordinary value of CP in the world of evaluation must be true, and second according to (66) the ordinary value of CP should be equivalent to the disjunction of the propositions in the question denotation. The ordinary value says that there is someone such that no one introduced him to anyone. The disjunction of the question denotation says that for some *x* there is some *y* such that no one introduced *x* to *y*. Thus the equivalence does not hold. This means that the wh-question is predicted to show an intervention effect.

Consider now the interpretation for the non-degraded question (67b) with LF (68b). The only thing that changes is that the negative quantifier is now in the scope of both wh-expressions. The H/K-denotation is again best paraphrased as {that no one introduced *a* to *b*, . . . , that no one introduced *c* to *b*}.

(71) a. $[\![\text{VP}]\!]^g = \lambda w.introduce_w(g(2),\ g(1),\ g(3))$
b. $[\![\text{VP}]\!]^{g,h} = [\![\text{VP}]\!]^g$
c. $[\![\text{IP}]\!]^g = \lambda w.\neg\exists y[introduce_w(y,\ g(1),\ g(3))]$
d. $[\![\text{IP}]\!]^{g,h} = [\![\text{IP}]\!]^g$
e. $[\![\text{C'}]\!]^g = \lambda w.\exists z \in g(D).\neg\exists y[introduce_w(y,\ g(1),\ z)]$
f. $[\![\text{C'}]\!]^{g,h} = \lambda w.\exists z \in h(6).\neg\exists y[introduce_w(y,\ g(1),\ z)]$
g. $[\![\text{CP}]\!]^g = \lambda w.\exists x \in g(D).\exists z \in g(D).\neg\exists y[introduce_w(y,\ x,\ z)]$
h. $[\![\text{CP}]\!]^{g,h} = \lambda w.\exists x \in h(3).\exists z \in h(6).\ \neg\exists y[introduce_w(y,\ x,\ z)]$
i. $[\![(68b)]\!]^g = \{\lambda w.\exists x \in h(3).\exists z \in h(6).\ \neg\exists y[introduce_w(y,\ x,\ z)] \mid h \in H\}$
$= \{\lambda w.\exists x \in D'.\exists z \in D''.\ \neg\exists y[introduce_w(y,\ x,\ z)] \mid D',\ D'' \subseteq D \wedge |D'| = |D''| = 1\}$
j. $[\![(68b)]\!]^{g,h} = [\![(68b)]\!]^g$

The ordinary value of CP states that for some individual there is another individual such that no one introduced the former to the latter. The disjunction of the propositions in the question denotation says exactly the same thing. In sum, the two are equivalent. As a result the question does not exhibit an intervention effect. One can therefore see that the crucial difference between the two questions lies in the differing ordinary values for CP. The present section discussed a rather simple example, but the system proposed can derive the empirical facts for constructions with intervening focus operators as well.[19]

3.3 *Intermediate summary*

By introducing the formal condition on wh-questions, we have linked the IEG to the semantics of questions. This link was then implemented in a particular way. Thus we have paved the way for a semantic account of intervention effects. Of course, one would ultimately like to derive the formal condition on wh-questions from independent principles. This goal is, however, beyond the reach of this article.

It should be noted that the technical system introduced in the second part of this section gives us the following: first wh-expressions are always interpreted as existential quantifiers, both when introducing alternatives for the H/K-denotation and when computing the presupposition. The only difference is that in the former case the domain is restricted to a singleton thereby making the resulting proposition equivalent to one where an individual is used instead of the existential quantifier. It would, of course, also be possible to assume a system where the alternatives for wh-expressions are elements of an individual-denoting type. But this would mean that the type for the alternatives for a wh-expression would

[19] Such examples are more complex than the ones with intervention by a simple quantifier because they in addition necessitate focus alternatives. I introduce another designated assignment function for focus variables in the Appendix in order to deal with such cases.

differ from the type that a wh-expression has when computing its ordinary value. This would run against a central assumption in a Roothian system. I do not want to take a stance on this point.[20] Second, the system introduced allows us to interpret wh-expressions in their surface scope both when computing the H/K-denotation and when computing the presupposition. That is, one can assume that the presupposition is derived from the same LF as the actual denotation, which seems desirable from a purely conceptual point of view. As with the first point, however, other systems are imaginable that derive the IEG as well. But the particular option proposed here links the two issues just discussed in a fairly straightforward way.

Should one have the desire to assume a different system for wh-interpretation, the ingredients that one needs can be summarized as follows: wh-questions with scrambling across an intervener and without scrambling should give rise to the same H/K-denotation. This is what alternative proposals for an H/K-semantics of questions get as well. Second the existential presuppositions associated with the two wh-questions should differ. In the first case all existential quantifiers corresponding to the wh-expressions should have widest scope, whereas in the latter case the wh-in-situ should have narrow scope with respect to the intervener. This will guarantee that in the former situation the required equivalence holds, whereas in the latter it does not. It is this part that is tricky to derive. In a different system it would not be clear why the scope of the wh-expressions in the presuppositions associated with the questions should differ, unless one adopts the view that the presuppositions are derived in a way that is blind to the actual LF of the question.[21]

4 CROSS-LINGUISTIC CONSIDERATIONS AND COMPARISON WITH OTHER APPROACHES

4.1 *Cross-linguistic considerations*

Although this article is about intervention effects in German in particular, one has to address the question of how other languages for which such effects have been reported relate to the present proposal. Recall that the approach outlined above has the consequence that not all

[20] Thanks to Ede Zimmermann (p.c.) for bringing up this question.

[21] An anonymous reviewer points out that the present way of stating the existential presupposition of the question differs from Abusch (2010), for who the presupposition corresponds to the disjunction of the H/K-alternatives. Abusch's account would be incompatible with the present account.

quantifiers will cause intervention effects. The question is whether other languages with intervention effects confirm the empirical picture suggested by the IEG.

Kim (2002) (also cf. Beck (2006)) notes that cross-linguistically intervention effects with quantifiers are not as stable as intervention effects caused by focus operators, citing Korean as a language supporting this view. She shows that whereas focus operators always lead to intervention effects, quantifiers like *taepupun* ('*most*') do not lead to degradedness, (72).

(72) **taepupun-ûi hansaeng-tûl-i** nuku-lûl hoichang-ûlo
most-Gen student-PL-Nom who-Acc president-as
ch'uch'ônha-ôss-ni?
recommend-Past-Q
'Who did most students recommend as president?'
(Kim 2002:(14))

(72) is not surprising from the present perspective. *Most* is arguably UE. Therefore we do not expect it to cause intervention. (73) also does not show intervention effects. This is expected for the quantifier *chachu* ('*often*'), which is again arguably UE.[22] One could therefore take the data in (72) and (73) to be additional motivation for the analysis argued for in the present paper.

The universal quantifier *hangsang* ('*always*') in Korean, on the one hand, is problematic. Our approach would expect an intervention effect. But as (73) also shows, this is not the case. The universal quantifier *nukuna* ('*everyone*'), on the other hand, does cause intervention, (74).

(73) Minsu-nûn **hangsang/chachu** nuku-lûl p'at'i-e teliko ka-ss-ni?
Minsu-Top always/often who-Acc party-to take-Past-Q
'Who did Minsu always/often take to the party?'
(Kim 2002:(15))

(74) a. ??**nukuna-ka** ônû kyosu-lûl chonkyôngha-ni?
everyone-Nom which professor-Acc respect-Q
b. ônû kyosu-lûl$_i$ **nukuna-ka** t$_i$ chonkyôngha-ni?

[22] Two qualifications are in order: Beck (2006) cites (i) as showing that the German equivalent of *often* causes intervention. It seems, however, that the effect is not as strong as indicated in (i) (the judgments are Beck's). Moreover distributivity might also play a role in (i), as *often* picks out non-atomic events.

(i) a. *Luise zählt auf, welche Uni oft welche Linguisten eingeladen hat.
Luise enumerates which university often which linguists invited has
b. Luise zählt auf, welche Uni welche Linguisten oft eingeladen hat.
Luise enumerates which university which linguists often invited has
'Luise enumerates which university often invited which linguists.'
(Beck 2006: 9)

Second, given the plural nature of the restrictor of *most* in (72), I also predict a slight degradedness for that example, as with other UE indefinites. This might well be the case. I thank Nathan Klinedinst for urging me to clarify this.

which professor-Acc everyone-Nom respect-Q
'Which professor does everyone respect?'
(Kim 2002:(13))

Furthermore, Beck (2006) cites a paper presented by Sugunya Ruangjaroon in 2002 where it is argued that the equivalent of the negative quantifier *nobody* in Thai (75) does cause intervention, whereas sentential negation does not, (76) (cited after Beck (2006)). This situation is puzzling.

(75) *mâymiikhray chôop ?àan nangsii lêmnay
nobody like read book which
'Which books does nobody like to read?'
(Beck 2006: 8)

(76) Nít mây síi ?aray
nit not buy what
'What didn't Nit buy?'
(Beck 2006: 10)

Given the fact that focus always causes intervention in Korean, Beck (2006) draws the conclusion that the typologically stable interveners are the ones that are focus related. Intervention by quantifiers she argues to be subject to variation, as evidenced by the data in (72)–(76). Beck's explanation of intervention effects is modelled on this intuition—that is, focus causes intervention in all cases, even in the cases where it seems that a quantifier is the culprit. The fact that UE interveners in (72) and (73) do not cause intervention for her means that they do not involve focus. The situation is different for universal quantifiers in Korean; some involve focus, others do not. This is unexpected. Presumably, a given class of elements should cause intervention within one language—that is, quantifiers should somehow involve focus and thereby cause intervention. Or at least universal quantifiers should involve focus and cause intervention. But the focus-based approach does not make predictions, even within a single language, in as far as what should be an intervener and what should not.

Given the fact that in both Korean and in Thai—the two main languages drawn on by Beck (2006) to argue that intervention effects caused by quantificational interveners are typologically unstable—there are in fact universal and negative interveners, respectively, it does not seem likely to me that a theory relegating intervention effects to focus is better off than the present theory. In fact what such a theory has to do, is to stipulate that the universal quantifier in (74) evaluates focus and thereby causes intervention, whereas the one in (73) does not do so, and respectively for the negative elements in Thai. That is, the line between interveners and non-interveners is drawn at a completely

arbitrary point even in a focus-based theory of intervention effects. Moreover, it is unclear why UE interveners do not cause intervention, whereas at least some universal quantifiers do. In other words, for Beck's approach to be feasible, one would have to make for each language a list of quantifiers that involve focus and thereby cause intervention and deny the systematicity with which UE indefinites do not cause intervention. The decision whether this approach is on the right track, however, is complicated by the fact that quantifiers do not always appear to involve association with focus, as acknowledged by Beck who cites Büring (1997) and Beaver & Clark (2003) for this observation. That is, Beck's prediction is that those quantifiers which cause intervention effects but lack apparent focus association effects nevertheless evaluate focus in their scope, even if they do not make use of it.

What about the present approach? The IEG, on the one hand, handles the data with UE interveners in Korean straightforwardly. As shown by (73) and (74), some universal quantifiers in Korean and some negative ones in Thai, respectively, do cause intervention effects. This suggests that in general the present approach is also tenable for these languages. It is unclear to me why the Korean question in (73) and the Thai one in (76), on the other hand, do not behave as predicted by the IEG. It might, of course, be that hearers of (73) interpret the question distributively, that is with the universal quantifier as having wide scope. This would explain its improved status. Be that as it may, at least there is a straightforward analysis for the UE indefinites and for a proper subset of the universal and negative interveners for why they behave the way they do. This means that for these we do not need to resort to a lexical property to make them cause intervention. Regarding the problematic data, it must be said that I could also make stipulations to exclude them from causing intervention. But since I would be relying only on the two problematic sentences drawn from other people's work when doing so, I will leave this important issue for further research. But the present discussion shows that the IEG is not in a worse position with respect to certain challenges posed by some languages than other analyses. If anything, it explains more data than others, given that it can straightforwardly deal with the systematic difference between UE and DE indefinites, which was further substantiated by the Korean data presented in this subsection.[23]

[23] An anonymous reviewer notes, as has been observed in the literature, that simple multiple wh-questions in English in contrast to German do not lead to intervention effects (but cf. Pesetsky (2000: chapter 5) who notes that in certain environments even English shows intervention effects). I do not have an explanation for why this cross-linguistic difference exists. I would, however, suggest that the difference is a syntactic one and must be somehow connected to the fact that German and

4.2 *Comparison with other semantic approaches*

To my knowledge, three types of semantic analyses of intervention effects have been proposed: the first type of approach is exemplified by Haida (2007)'s expansion on Honcoop (1998)'s ideas. The common feature of the two analyses is that the intervener is claimed to block binding of variables in a way parallel to, say, negation blocking anaphoric relations. Therefore, we expect harmful interveners to be rather strict in their triggering of intervention effects. Even if such an approach might be able to predict why UE indefinites do not cause intervention effects, there appear to be problems. Such an analysis says that intervention effects should not be distinguished from the phenomenon of negative islands. As discussed by Beck (2006: 48ff.), this is a questionable assumption: negative islands block overt movement, whereas intervention effects only arise with wh-in-situ expressions. Overt movement crucially is not blocked by harmful interveners. It is therefore unclear whether the two phenomena should be treated on a par.

In contrast to this analysis, both Grohmann (2006) and Tomioka (2007) argue that the problematic interveners are elements that cannot be interpreted as topics. But due to their syntactic position they are necessarily interpreted as such. From this it follows that the questions will be degraded. I cannot comment on Tomioka's approach, which might be correct for the two languages he investigates. It cannot, however, be extended to German, as I will show. But this also means that I have to disagree with Grohmann's analysis of German intervention effects, which is based on questionable assumptions apart from the one that only DE operators cause intervention, which we have seen to be false. In particular, if one can show that problematic interveners can serve as topics in German, then the consequence will be that Grohmann's suggestions must be incorrect.[24] Consider (77). Here A's question asks for a property that no individual has—that is, the only part of A's question that could serve as a topic in a potential answer is

most other intervention effect languages are scrambling languages, and English is not. That is, German allows an intervention effect to be remedied by overt scrambling of the wh-in-situ across the offending intervener. English cannot do so, only covert movement is an option. But if overt movement is less costly than covert movement, it follows that in a language where the former is an option it must be chosen. No such economy considerations would play a role in English, though. It is well-known that covert movement in English is freer than in German. So an approach along the lines just sketched does not seem untenable. Needless to say, this cannot be the complete story. I must leave this issue for future research.

[24] Grohmann (2006) does not offer a definition of topic hood. I will therefore assume a traditional definition of topic: a topic is the old information in a discourse.

niemand. Indeed, B's utterance makes clear that *niemand* is interpreted as a topic in the answer.

(77) A: Was hat niemand gemacht?
what has nobody done
'What did no one do?'
B: *Krieg und Frieden* hat zum Beispiel niemand gelesen.
War and peace has for instance nobody read
'For instance, no one read *War and Peace*.'

Grohmann (2006) cites data like (78) to show that *wenige* ('*few*') in German cannot be used as a topic. According to him the degradedness of (78) is due to the topicalization of *wenige Bücher*, which is prohibited (the reported judgment is Grohmann's).

(78) *Wenige Bücher hat Peter gestern gelesen. (Er ist faul.)
few books has Peter yesterday read he is lazy
*'Few books, Peter read yesterday. (He is lazy.)'
(Grohmann 2006: (20b))

While (78) might indeed be not so good without a context, we find that it dramatically improves in a discourse like (79). Here B's utterance, on the one hand, contrasts *die Kinder* with *Hans*, whereby *Hans* becomes focused. *Wenige Bücher*, on the other hand, is old information. It clearly is the topic of the sentence. And clearly, B's utterance is acceptable. This shows that contrary to Grohmann's claims DE quantifiers can be topics in German.

(79) A: Die Kinder haben alle wenige Bücher gelesen, weil sie faul
the kids have all few books read because they lazy
sind.
are
'The kids all read few books because they are lazy.'
B: Moment mal. Wenige Bücher hat nur der HANS gelesen.
moment just few books has only the Hans read
'Wait a minute. Only Hans read few books.'

A third very common approach proposes that intervention effects follow from the behaviour of semantic operators in an alternative-based semantics (cf. Kratzer & Shimoyama (2002), Beck (2006), Shimoyama (2006), Cable (2010)). The idea unifying these approaches is that wh-elements contribute alternatives to the interpretation procedure. Some operators, and in particular focus operators, make use of these alternatives and thereby prohibit them from being accessible to higher operators, such as the Q-operator. However, the Q-operator must have access to the wh-alternatives, otherwise uninterpretability results.[25] We saw in subsection 4.1 that what functions as a problematic

intervener in Beck (2006)'s account must be stipulated lexically. And we also saw that the generalization that UE indefinites intervene, whereas DE ones do not is missed. Both problems extend to the other accounts mentioned. I therefore conclude that these semantic approaches to intervention effects are in need of modification in order to insightfully account for the data that the present account straightforwardly predicts.[26]

Moreover, the following problem arises for theories where an operator is said to cause intervention due to its alternative-consuming behaviour: the general setup of these theories is such that certain operators evaluate the unevaluated alternatives provided by all the elements contributing alternatives in their scope. This way higher operators do not have any information to work on anymore. Therefore, it is essential that focus operators like *only* are at least able to associate with all foci c-commanded by them and not yet evaluated by another operator. As is well-known, German *nur* does not seem to behave this way. Preverbal *nur*, in particular, cannot associate with a focus embedded in the verbal constituent. (80) cannot have the reading where all propositions with both *Hamburg* and *neue* replaced by alternatives except for the prejacent itself are false. Rather *neue* must be contrastively focused. If *nur* is adjoined to the DP rather than to the clause—as would be predicted under a V2-analysis of German

[25] Although Kratzer and Shimoyama do not extend their analysis to intervention effects in wh-questions, one could try to carry over their approach to the data discussed in this article. In fact, they are careful not to assume the analysis sketched in the text for classical intervention effects. They assume Pesetsky (2000)'s proposal, according to which feature movement is subject to intervention, whereas covert phrasal movement is not. But Pesetsky himself does not offer a reason as for why intervention arises in the first place.

[26] There is also an issue with Beck (2006)'s specific proposal. In her theory, wh-expressions literally contribute focus alternatives but do not have a defined ordinary value. This raises the question how to deal with focus on wh-expressions such as in (i). In order to account for the contribution of focus on the wh-expression, it is necessary to have an ordinary value at one's disposal as well. But Beck's analysis does not provide for this. In fact, it is essential for her that wh-expressions do not have an ordinary value: if a focus operator consumes the focus alternatives of a wh-expression, it prevents a higher Q-operator from associating with the alternatives itself. The question does not have a defined value. Slade (2011) makes a related point of criticism. Apart from the issues just noted, (i) also poses the problem that *nur* should cause intervention in Beck's system, contrary to fact.

(i) Wen hat der Hans nur WO gesehen?
who has the Hans only where seen
'Who did Hans see only where?'

The considerations sketched here suggest that an extension of the interpretational system introduced in subsection 3.2 along the lines of the Appendix is in order. There wh-expressions and focused constituents introduce differing distinguished variables dependent on different designated assignment functions for interpretation. These assumptions coupled with a defined ordinary value for wh-expressions, as is the case in the present proposal, allow for a successful account of (i). Needless to say that this goes against the heart of Beck's proposal.

anyway—this state of affairs immediately follows. But if one allows low attachment of *nur* when in preverbal position, it should also be possible to have low attachment when the constituent is not moved. This, however, would have the consequence that it cannot be ensured that *nur* always evaluates all the alternatives in its c-command domain in wh-questions either. That is, the explanation of intervention effects vanishes.[27]

(80) Nur in HAMBURG hat der Hans eine NEUE Idee vorgestellt.
only in Hamburg has the Hans a new idea presented
a. 'Hans presented a new idea only in Hamburg, and in all other places he presented an old idea.'
b. *'Hans only presented a new idea in Hamburg, and he did not present any idea whatsoever in any other place.'

5 CONCLUSION AND OUTLOOK

The present paper reduced intervention effects to the logical properties of intervening operators. Empirically, I showed that there is a systematic difference between UE and DE indefinites. Only the latter cause intervention in wh-questions. I then proposed that intervention effects are caused by non-additive operators. Based on this observation, I argued for a formal condition on wh-questions: the proposition used for the existential presupposition of a wh-question must be equivalent to the disjunction of the H/K-alternatives. I implemented these ideas by making crucial use of domain alternatives in the sense of Chierchia (2004, 2006) and of a bi-dimensional semantics à la Rooth (1985). Although the analysis seems to make the right predictions, some data reviewed in subsection 4.1 raise potential complications. They must be left for future research. Moreover, it has been shown that the present account is empirically and also theoretically superior to some competing analyses which also attempt to derive intervention effects semantically.

A possible avenue for further research would be a comparison between the present proposal and Szabolcsi & Zwarts (1992) and more recent works such as Abrusán (2007) and Abrusán & Spector (2011). These authors deal with weak-island phenomena and try to derive them

[27] Beck (2006) is seemingly aware of this fact, as she notes in her footnote 7 that she assumes a syntax for *nur* inspired by Jacobs (1983) and Büring & Hartmann (2001), who propose that *nur* always attaches to clausal nodes. This way intervention effects follow necessarily. Then it must, however, be stipulated that association by preverbal *nur* in (80) with *neue* is blocked for some other reason making it unclear why *nur* should ever evaluate more than one focus. The issues surrounding *nur* are further complicated by the fact that such a theory would also have to give up the V2-analysis of German. It must therefore be left for future research to determine whether this is the right approach. I thank Irene Heim (p.c.) for pointing out (80) to me.

semantically, in particular by claiming that no answer can be given to such questions. One would like to see if our formal condition on wh-questions can be derived in a similar way. But there are important differences between the empirical domains. First, these works are concerned with questions involving overt movement, whereas intervention effects do not arise with overt movement. Second, weak islands are subject to obviation by modals as shown by Fox & Hackl (2006). I must leave a thorough investigation whether such obviation exists for intervention effects as well for future research.

APPENDIX: INTERVENTION BY FOCUS OPERATORS

In order to predict intervention effects by focus operators in the present analysis, it is necessary to assume that the ~-operator interpreting focus (Rooth 1992) only has access to the contribution made by focus but not the one made by wh-expressions.

Following Kratzer (1991), focus marks introduce another set of distinguished variables i_{foc} which are subject to interpretation by a designated assignment function h'. The focus value is then the set derived by quantification over designated assignments h'. So the secondary value is dependent on three assignments, $[\![\ ]\!]^{g,h,h'}$. The ~-operator and focus operators such as *only* and *sogar* are co-indexed, which has the consequence that $g(C)$ is identical to the set provided by ~, which is moreover dependent on the focus value of the sister node of ~. Following Rooth (1992) and Beck (2006) ~ resets all focus contribution:

(81) a. $[\![\sim]\!]^g(g(C)_{\langle\tau,t\rangle})([\![\phi]\!]^g{}_\tau) = [\![\phi]\!]^g$
if $g(C) \subseteq \{[\![\phi]\!]^{g,h,h'} \mid h' \in H'\}$,
otherwise undefined

b. $[\![\sim]\!]^{g,h,h'}\ (g(C)_{\langle\tau,t\rangle})([\![\phi]\!]^{g,h,h'}{}_\tau) = [\![\phi]\!]^{g,h}$

Following Rooth (1985)'s modification of Horn (1969) *nur* (*only*) takes two arguments: a set of contextually relevant alternatives $g(C)$ and the prejacent p, that is, the sentence without *only*. *Only* presupposes that p is true. Further it asserts that all alternatives not entailed by p are false. $g(C)$ contains alternatives to p which differ from p at most by varying the denotation of the focused constituent:

(82) $[\![\text{nur}]\!]^g(g(C)_{\langle\langle s,t\rangle,t\rangle})(p_{\langle s,t\rangle})(w) = 1$ iff $\forall q \in g(C)[q(w) = 1 \rightarrow p \subseteq; q]$
if $p(w) = 1$, otherwise undefined

For *sogar* ('*even*') assume the semantics in (83), following the arguments given by Karttunen & Peters (1979), Rooth (1985) and Guerzoni (2004) a.o. This entry asserts that the prejacent is true. Moreover, it presupposes

that all alternatives to the prejacent are more likely than the prejacent itself. $q > p$ denotes that q is more likely than p.

(83) $[\![\text{sogar}]\!](g(C)_{\langle\langle s,t\rangle,t\rangle})(p_{\langle s,t\rangle})(w) = 1$ iff $p(w)$
if $\forall q \in g(C)[q \neq p \rightarrow q > p]$,
otherwise undefined

The Q-operator in contrast to ~ only accesses and resets the contribution made by wh-expressions. Q should thus be updated from (64) to (84).

(84) a. $[\![[\text{Q CP}]]\!]^g = \{[\![\text{CP}]\!]^{g,h,h'} \mid h \in H\}$
if $[\![\text{CP}]\!]^g(w) = 1$, otherwise undefined
b. $[\![[\text{Q CP}]]\!]^{g,h,h'} = [\![[\text{Q CP}]]\!]^{g,h'}$

Finally, the formal condition on wh-questions must also take h' into account:

(85) *Formal condition on wh-questions*
An intervention effect arises in a wh-question if $\vee\{[\![\text{CP}]\!]^{g,h,h'} \mid h \in H\} \neq [\![\text{CP}]\!]^g$.

The rules for the ~- and Q-operators guarantee that wh-information will be visible to a Q-operator even if a ~ intervenes, and focus information will be accessible to ~ even if a Q-operator intervenes. The entries for *only* and *even* in combination with (85) predict intervention effects exactly under those conditions that the IEG specifies.

Three comments are in order: first, for sake of simplicity, *nur* and *sogar* take propositional arguments. This predicts that (80b) should be an interpretation of (80) contrary to fact. This is, however, not problematic. Our account of intervention effects does not rely on such an assumption. Therefore it is possible in the present analysis to assume an alternative LF under a cross-categorial analysis of *nur* where is not dissociated from the DP *der Hans*.[28]

Second, it would also be possible to set up the system in such a way that the ~-operator consumes both the focus and the wh-information. This would make the theory more similar to Beck (2006). Prima facie it is unclear why the ~-operator should behave the way Beck proposes (cf. footnote 26 for arguments against this). But should it turn out that intervention by focus operators is cross-linguistically more stable, it is imaginable that the cause of this is as Beck proposes. In other words, the IEG is assumed, but in addition a stronger effect would obtain if the intervening focus operator resets both the focus and the wh-information.[29]

[28] I thank an anonymous reviewer for urging me to clarify this.

[29] Also note that this issue is independent from the question of whether focus association across an intervening focus operator is possible or not. For Beck it is necessary that such association is blocked, as argued by Beck and Vasishth (2009). In the present system this is an orthogonal issue.

Third, what about questions where there is an intervening focused constituent but where there is no overt focus operator? Beck (2006) cites (86) as a case in point. I am forced to claim that the intervention effect is caused by an exhaustive interpretation of the focused constituent. That is, I would assume a covert exhaustivity operator with a meaning similar to *only* (cf. Groenendijk & Stokhof (1984), Krifka (1995), Schulz & van Rooij (2006), Fox (2007), Spector (2007) a.o.), which should be in a position above *Luise* and below *wen*. This way the analysis offered for *only* would carry over to examples like (86). It should also be noted that intervention effects in cases like (86) are somewhat weaker than the ones discussed in the text. This follows naturally if both an interpretation with an exhaustivity operator and one without it is available.

(86) ??Wen hat LUISE wo gesehen?
who has Luise where seen
'Where did LUISE see who?'
(Beck 2006:32)

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