Gesture Projection and Cosuppositions*

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(several modifications – and an error in Appendix II has been corrected)

Abstract: In dynamic theories of presupposition, a trigger *pp*' (e.g. *it stopped raining)* with presupposition *p* (*it rained)* and assertive component *p*' (*it doesn't now rain)* comes with a requirement that *p* should be entailed by the local context of *pp*'. We argue that some co-speech gestures should be analyzed within a presuppositional framework, but with a twist: an expression *p* co-occurring with a co-speech gesture *G* with content *g* comes with the requirement that the local context of *p* should guarantee that *p entails g;* we call such assertion-dependent presuppositions 'cosuppositions'. We show that this analysis can be combined with a predictive analysis of local contexts (e.g. Schlenker 2009) to account for complex patterns of gesture projection in quantified and in attitudinal contexts, and compare our account to two potential alternatives: one based on supervaluations, and one that treats co-speech gestures as supplements (Ebert and Ebert 2014). We argue that the latter is correct, but for 'post-speech' gestures (= gestures that come after the expressions they modify), rather than for co-speech gestures.

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1 Introduction

Co-speech gestures provide a way to enrich the meaning of spoken language expressions. A very simple example is provided in (1). Without a co-speech gesture, the sentence is neutral as to the kind of help that was provided. With the upward movement of the palms co-occurring with *help*, one naturally infers that John helped his son by lifting him in some way.

(1) John UP_  helped his son.

Important research has been conducted in psychology and linguistics on the typology of gestures (see for instance Kendon 2004, McNeill 2005 and Giorgolo 2010 for discussion)[1]. Here we will be primarily concerned with *iconic co-speech gestures*, i.e. gestures that occur with spoken words and enrich their meaning by depicting an aspect of the denoted situations. We will not be concerned with how a gesture such as *UP* in (1) comes to have the content that it does. Rather, we will ask how co-speech gestures interact with the logical structure of a sentence. For although the example in (1) is very simple, gestures may appear in the scope of a variety of logical operators, hence a question: *how are the enrichments of expressions modified by co-speech gestures inherited by complex sentences*? This is the 'projection problem' for co-speech gestures;[2] to our knowledge, it was initially studied in pioneering work by Ebert and Ebert 2014, who took the line that the semantic contribution of co-speech gestures should be likened to that of appositive relative clauses– henceforth a 'supplemental analysis'.

In this piece, we argue instead that a broad class of co-speech gestures should be analyzed within a presuppositional framework, albeit with a twist. In standard theories, a presupposition trigger *pp*' (e.g. *it stopped raining)* with presupposition *p* (*it rained)* and assertive component *p*' (*it doesn't now rain)* comes with a requirement that *p* should be entailed by the local context of *pp*'. By contrast, an expression *p* co-occurring with a co-speech gesture *G* with content *g* comes with the requirement that the local context of should guarantee that *p entails g*. In other words, the co-speech gesture triggers an assertion-dependent presupposition, something we call a 'cosupposition'. Importantly, no modification of presupposition theory is needed to handle such cases, since nothing prevents a trigger *pp*' from having a presupposition *p* with the content *(p*' $\Rightarrow$ *q)*, which is thus conditionalized on the assertive component *p*'. We show that this 'cosuppositional' analysis can be combined with a predictive analysis of local contexts (e.g. Schlenker 2009) to account for complex patterns of gesture projection in quantified and in attitudinal contexts, and we compare our account to two potential alternatives: a theory based on supervaluations, which we take to be interesting but probably flawed; and Ebert and Ebert's (2014) supplemental analysis. We argue that the latter is likely correct, but for 'post-speech' gestures (= gestures that come after the expressions they modify), rather than for co-speech gestures. Thus the *timing* of a gestural enrichment can significantly alter its semantic status.

The intuition we pursue can be described rather simply by inserting the example in (1) in various contexts, as in (2). Here and throughout, we adopt the convention of *writing co-speech gestures in capital letters (and sometimes with a picture illustrating them) right before the expression they modify* (a single word, unless the scope of the modification is marked by square brackets). We also write under the examples the relevant inferences we take them to trigger, preceded by =>.

(2) a. John UP_  helped his son.
=> John helped his son by lifting him

b. John didn't UP_  help his son.
=> if John had helped his son, he would have done so by lifting him

[1] As summarized in Giorgolo 2010 (pp. 4-5), one prominent distinction is that between (i) 'emblems', which 'are 'typically culture specific gestures, associated with a fixed meaning' – for instance the 'thumb up' 👍 gesture used in Western culture; (ii) 'pantomimes', which are 'usually sequences of movements that reproduce some kind of motor or physical activity, either by directly reenacting the described scene or by visualizing it through some form of iconic mapping'; and (iii) co-speech gestures, with which we are concerned in the presence piece. Besides iconic gestures, the latter category also includes 'beats', which are 'short and simple movements that pattern quite closely with the prosodic peaks of the accompanying utterance'; deictic signs; and 'metaphorics', which 'spatially represent abstract entities'.

[2] This expression should be understood by analogy with the 'projection problem for presuppositions', which consists in determining how the presuppositions of complex sentences are inherited from the assertive and presuppositional contributions of their component parts.

c. Did John UP_  help his son?
=> if John helped his son, he did so by lifting him

As noted, one can get in (2)a the inference that John helped his son by some kind of upwards movement. Now in (2)b we infer that John didn't help his son, but that *if* he had this would have been through an upwards movement. As for the question in (2)c, it leaves open *whether* John helped his son, but suggests that *if* he did, it was by lifting him.

The intuition, then, is that the context should be such as to guarantee that the co-speech gesture merely illustrates the expression it modifies, and thus that relative to that context the expression entails the content of the co-speech gesture. In unembedded cases, one might want to posit that the relevant inference follows from the context of the conversation. But in embedded cases a more sophisticated notion is needed, that of a *local context*. To see why this notion is helpful, consider the example in (3).

(3) If John is present at the right time, will he UP_  help his son?
=> if John is present at the right time, if he helps his son, he will do so by lifting him

The requirement that the content of the gesture follow from the meaning of *help* relative to the global context would give rise to an overly strong inference, namely that *in general*, helping is understood to mean 'helping by lifting'. The inference which is in fact obtained is narrower: besides the fact that it only applies to John, it is relative to the hypothesis that he should arrive at the right time. In modern theoretical parlance, the entailment need not hold with respect to the global context of the sentence, but only with respect to the *local context* obtained by 'updating' the global one with the antecedent of the conditional. The notion of a 'local context' is standardly used to motivate dynamic approaches to presupposition projection in the tradition of Heim 1983. Informally, the local context of an expression recapitulates the semantic content already contributed by expressions that precede it. In most cases, we will take for granted the value of the local contexts, as it can be established on the basis of standard presuppositional data. When things are less clear, we will base our discussion on the reconstruction of local contexts offered in Schlenker 2009, as it has the advantage of giving a *recipe* to compute the local context of an expression in any sentence once the bivalent (classical) behavior of the latter has been specified.[3]

Some cautionary notes might be useful at the outset.

• First, we are primarily concerned with *patterns of gesture projection*, defined as the way in which the gestural enrichments of elementary expressions are inherited by complex sentences. A separate issue is to determine which *epistemic status* these gestural enrichments have. The difference matters because in many cases co-speech gestures are informative. But by now there is a sizable literature on informative presuppositions, and hence the informative nature of co-speech gestures need not necessarily get in the way of a presuppositional account (e.g. Stalnaker 2002, von Fintel 2008, Schlenker 2012). Alternatively, one might take gestures to be evaluated with respect to what one might term the 'speaker's local context', obtained by computing local contexts not with respect to the standard Context Set (which corresponds to what is common belief among the speech act participants), but rather with respect to the speaker's belief state. We come back to this point below.

• Second, presuppositional phenomena notoriously give rise to patterns of local accommodation, whereby a presupposition essentially gets incorporated into the assertive component. This happens for instance in the sentence *John doesn't know that he is going to be hired – because he won't be!:* the factive inference triggered by *know* is in this case evaluated within the scope of negation. Some presupposition triggers are thought to be weaker than others. For instance, *stop* is typically thought to be weak, which explains why in the discourse in (4), it does not lead to the inference that the interlocutor used to smoke (see also Beaver 2010).

(4) I notice that you keep chewing on your pencil. Have you recently stopped smoking? (Geurts 1994, cited in Simons 2001)

[3] In simple cases, nothing is lost in this way because Schlenker 2009 shows that, *modulo* some technical assumptions, standard results of dynamic semantics are derived by this procedure. But the algorithm developed in Schlenker 2009 will allow us to derive predictions for some non-standard cases (notably, embedding under factive expressions such as *be unaware that,* where we will need to compute the local context of the embedded clause).

As we will see, we will have to posit at several junctures that *co-speech gestures are usually weak triggers*, and can easily give rise to local accommodation, especially under contrastive focus[4]. While we will focus on cases in which co-speech gestures have a non-at-issue contribution, it should be kept in mind that *modulo* local accommodation some at-issue uses can be obtained as well.

• Third, and relatedly, we will use standard linguistic methodology in basing our generalizations on introspective judgments, both our own and those of other linguists we have consulted. But there are obvious limitations to this method, especially when judgments are subtle – which is sometimes the case with gestures. Experimental means should thus prove very useful to investigate patterns of gesture projection. But we are convinced that they will prove particularly useful *after* one has explored the initial space of possible theories – which is primary goal in the present study.

• Fourth, as briefly mentioned above, the timing of co-speech gestures matters. For most of the discussion, we will focus on gestures that co-occur with certain constituents. But when similar gestures are uttered right *after* these constituents, and are thus 'post-speech gestures' (with their own timing slot) rather than co-speech gestures, they may give rise to different inferential patterns, rather reminiscent of appositive relative clauses – a claim made about all co-speech gestures by Ebert and Ebert 2014. We come back to this point in Section 4.2.2.

• Fifth, if our ideas are on the right track, they should in the end be combined with those of Lascarides and Stone 2009, who developed a framework in which gestures can be integrated into Logical Forms by way of explicit anaphoric and narrative relations. But since their emphasis was not on the projection problem *per se* (as they did not consider the interaction of co-speech gestures with logical operators[5]), we will leave the integration of these two frameworks for future research.

• Finally, since the study of gesture projection is only in its infancy, we should be careful not to overstate the generality of our findings. We believe we have found one broad class of co-speech gestures that behave in a cosuppositional fashion; but further investigations (in particular ones that connect to corpus work conducted by other researchers) will certainly uncover further projective behaviors among co-speech gestures.

2 Patterns of Gesture Projection

2.1 The Problem

To introduce the projection problem for co-speech gestures, we start from a few examples without embedding, as in (5).

(5) a. John brought LARGE_  [a bottle of beer].
=> John brought a bottle of beer, and it was large

a'. John found LARGE_  [a bottle he liked]
=> John found a bottle he liked, and it was large

b. John UP_  helped his son.
=> John helped his son by way of an upwards movement of his hands

c. John SLAP_  punished his son.
=> John punished his son by slapping him

Now le us embed (5)a' under the quantifier *exactly one philosopher* so as to obtain a bound reading, as in (6)a. We also consider a control sentence without a co-speech gesture, as in (6)b; and one in which the co-speech contribution has been made part of the assertive component with an explicit modifier, as in (6)c. Importantly, in the latter the content of the gesture is integrated by a standard

[4] This observation is due to Rob Pasternak (p.c.).
[5] Stone and Lascarides do discuss the interaction between gestures and expressions that introduce discourse referents, in particular dynamic existential quantifiers. Their formal framework also contains standard logical connectives, but the examples they discuss do not involve embedding under any of the operators discussed in this piece; as a result, the issue of the assertive, presuppositional or supplemental status of co-speech enrichments does not arise in their article.

demonstrative mechanism: the denotation of *this* is given by the demonstration, and *like this* modifies the verb in a standard, at-issue fashion. We also include similarly modified versions of (5)b,c in (7).

(6) a. Exactly one philosopher found LARGE_  [a bottle he liked].
=> exactly one philosopher found a bottle he liked, and that bottle was large.
b. Exactly one philosopher found a large bottle he liked.

c. Exactly one philosopher found a bottle like LARGE_  this that he liked.

(7) a. Exactly one of these 10 guys UP_  helped his son.
=> exactly one of these 10 guys helped his son, and he did so by lifting him

b. Exactly one of these 10 guys SLAP_  punished his son.
=> exactly one of these 10 guys punished his son, and he did so by slapping him

With the co-speech gesture in (6)a, the inference we obtain is that (i) a philosopher found a bottle he liked (with bound *he),* (ii) no other philosopher found a bottle *he* liked, and (iii) the bottle the first philosopher found was large. (i) and (ii) taken together are just the literal meaning of the sentence. What is interesting is that initially (iii) seems to only modify the positive part of the literal meaning, not its negative part. Importantly, the example crucially involves a bound variable, and we must thus explain how the gestural inference interacts with the compositional semantics of the sentence. This is of course also the case of the control sentences in (6)b and (6)c. But in the latter two examples, the modifier restricts the extension of the relevant Noun Phrase, and yields a meaning that does *not* entail that of the sentence without the modifier (this is because *exactly one philosopher* creates a non-monotonic environment). For instance, *Exactly one philosopher found a large bottle he liked* does not entail *Exactly one philosopher found a bottle he liked:* it could be that exactly one philosopher found a large bottle he liked, while another philosopher found a *small* bottle he liked, in which case the first sentence would be true but the second would be false. By contrast, we believe that (6)a can naturally be read in a way that implies that exactly one philosopher found a bottle he liked – with the additional implication that this bottle was large (similar facts arguably hold of (7)). The challenge is to explain why this is. (As noted at the outset, we do not claim that the co-speech gesture in (6)a does not *also* allow for a reading that restricts the extension of the Noun Phrase. For us, this will be due to the possibility of applying local accommodation to the relevant presupposition.)

To see where we are going, it will be useful to state a simplified generalization (the analysis we develop in Section 3 will make more precise predictions, and thus this informal statement is just included to guide intuition).

(8) **Initial generalizations [for simple cases]**
a. [Setting aside local accommodation] Co-speech gestures usually strengthen the meaning of utterances.
b. If a co-speech gesture *G* modifies an n-ary predicate *p* in a sentence …*p* …, then:
(i) if the sentence …*p* … entails that at least one n-tuple of objects satisfies *p*, then one infers that those tuples satisfy the content of *G*;
(ii) if the sentence …*p* …*fails* to entail that at least one n-tuple of object satisfies *p*, then one infers that if there were such (relevant) tuples, they would satisfy the content of *G*.

To illustrate, (6) *Exactly one of these 10 guys punished his son* entails that there is one pair <x, x's son> that satisfies the predicate *punish*. This case falls under (8)b(i), and we infer that the pair that satisfies *punish* also satisfies the content of *SLAP* – and thus that the punishment involved some slapping. (2)b illustrates (8)(ii): it is asserted that the pair <John, John's son> does not satisfy the predicate *help*, but we obtain an inference that if it did, it would also satisfy the content the content of *SLAP* – and thus that slapping would be involved.

We now turn to propositional, quantificational and attitudinal examples to establish and refine these generalizations.

2.2 Propositional examples

In questions and under negation, the co-speech gestures under consideration here trigger conditional inferences, as is illustrated in (9)-(10).

(9) a. John won't bring LARGE_  [a bottle of beer].
=> if John brought a bottle of beer, it would be a large one

b. John won't UP_  help his son.
=> If John helped his son, he would do so by lifting him

c. John won't SLAP_  punish his son.
=> If John punished his son, he would do so by slapping him

(10) a. Will John bring LARGE_  [a bottle of beer]?
=> if John brings a bottle of beer, it will be a large one

b. Will John UP_  help his son?
=> If John helps his son, he will do so by lifting him

c. Will John SLAP_  punish his son?
=> If John punishes his son, he will do so by slapping him

As mentioned, both cases fall under (8)b(ii). To illustrate, we note that *John' won't punish his son* and *Will John punish his son* fail to entail that there is at least one pair <x, y> that satisfies *punish*, and as stated in (8)b(ii) we infer that *if* there were a pair <x, y> satisfying *punish*, it would satisfy the content of *SLAP* and would thus involve some slapping.

To study projection in upward-monotonic environments, it is useful to embed some of the examples in questions so as to distinguish the presuppositional component (which is preserved or 'projects' under questions) from the assertive component (which doesn't project). In (11)a, we obtain a (doubly) conditional inference: if John comes to our workshop, then if he brings a bottle of beer, it will be a large one. (These complex cases do not work well to illustrate the initial generalizations in (8), but they will follow from the analysis in Section 3.)

(11) a. If John comes to our workshop, will he bring LARGE_  [a bottle of beer]?
=> if John comes to our workshop, if he brings a bottle of beer, it will be a large one

b. If John shows up in a minute, will he UP_  help his son?
=> if John shows up in a minute, if he helps his son, he will do so by lifting him

c. If John shows up in a minute, will he SLAP_  punish his son?
=> if John shows up in a minute, if he punishes his son, he will do so by slapping him

As mentioned at the outset, examples such as (11) are important to disprove a simpler theory, one on which it is relative to the *global* (rather than *local*) context that the modified expression must entail the content of the co-speech gesture. This would seem to be too strong for these examples. But the point can be made more forcefully by including a discourse in that makes reference to a variety of situations that satisfy the relevant predicate. Thus in (12) the first occurrence of *help* is used to indicate (by way of a presupposition) that John helps his son in all sorts of circumstances. Only the second occurrence of *help* is modified by the gesture *UP*, and it does not trigger an inference that all helping events involve lifting, but only that if John comes in a minute, any help he'll provide will involve lifting.[6] It will thus prove essential to compute the entailment between *help* and the content of *UP* relative to the *local* context of *help* rather than with respect to the *global* context of the conversation – a result that will be obtained by the analysis developed in Section 3.

[6] By contrast, informants tell us that in the following examples the gestural enrichment is preferably read as being at-issue. From the present perspective, these are cases of local accommodation, which do not make it possible to test the relevant cosuppositional inferences.

(i) a. John and I don't have quite the same drinking habits. If John comes to our workshop, will he bring LARGE [a bottle of beer]?
b. John and his wife don't quite agree on how to discipline their children. If John shows up in a minute, will he SLAP punish his son?

(12) Since John helps his son no matter what, if he comes in a minute, will he UP_  help him?
=> if John shows up in a minute, if he helps his son, he will do so by lifting him
≠> helping is always involves an upwards movement (John helps his son in diverse ways)

Turning to the antecedent of conditionals (a non-upward-monotonic environment – which obviates the need for the question test), we seem to get the same inferences as under negation and in questions, possibly in weakened form:

(13) a. If John comes to our workshop and brings LARGE_  [a bottle of beer], peope will talk about it.
=> if John comes to our workshop, if he brings a bottle of beer, it will be a large one

b. If John shows up in a minute and UP_  helps his son, people will talk about it.
=> if John shows up in a minute, if he helps his son, he will do so by lifting him

c. If John shows up in a minute and SLAP_  punishes his son, people will talk about it.
=> if John shows up in a minute, if he punishes his son, he will do so by slapping him

Finally, under existential modals (which create an upward-monotonic environment), the facts are subtle and possibly controversial; as things stand, we believe that a weak inference is triggered, and we believe that it is preserved in questions, as is illustrated in (14)-(15); these facts should be further investigated in the future.

(14) a. John might bring LARGE_  [a bottle of beer].
=>? if John brings a bottle of beer, it will be a large one

b. John might UP_  help his son.
=>? if John helps his son, he'll do so by lifting him

c. John might SLAP_  punish his son.
=>? if John punishes punishes his son, he'll do so by slapping him

(15) a. Could John bring LARGE_  [a bottle of beer]?
=>? if John brings a bottle of beer, it will be a large one

b. Could John UP_  help his son?
=>? if John helps his son, he will do so by pushing her upwards

c. Could John SLAP_  punish his son?
=>? if John punishes his son, he will do so by slapping him

2.3 Quantified examples

We turn to quantified examples, and as before place them in questions when this is needed to distinguish between presupposition and assertion (we henceforth omit pictures from the transcription of the gestures, unless these have not been exemplified yet). We start with cases involving a quantificational adverb, which has the advantage of making for particularly minimal pairs with the propositional examples discussed before (here too, the initial generalizations in (8) would be refined to be applicable, but the analysis of Section 3 will derive the desired results).

(16) a. On Mondays, did John always bring LARGE [a bottle of beer]?
=> on Mondays, when John brought a bottle of beer, it was a large one
b. On Mondays, did John always UP help his son?
=> on Mondays, when John helped his son, he did so by lifting him
c. On Mondays, did John always SLAP punish his son?
=> on Mondays, when John punished his son, he did so by slapping him

Similar generalizations hold of nominal quantifiers:

(17) a. Did each of these 5 philosophers find LARGE [a bottle he liked]?
=> for each of these 5 philosophers, if he likes a bottle, it's a large one

b. Did each of these 10 guys UP help his son?
=> for each of these 10 guys, if he helped his son, he did so by lifting him
c. Did each of these 10 guys SLAP punish his son?
=> for each of these 10 guys, if he punished his son, he did so by slapping him

As we noted at the outset, embedding under *exactly n* numerals is particularly informative, as these have both a positive and a negative component, which are differentially affected by gestural enrichments.

(18) a. On exactly four occasions last month, John brought LARGE [a bottle of beer] to the seminar.
=> on exactly four occasions last month, John brought a bottle of beer to the seminar, and in each case it was a large bottle
b. On exactly four occasions last month, John UP helped his son.
=> on exactly four occasions last month, John helped his son, and in each case he did so by lifting him.
c. On exactly four occasions last month, John SLAP punished his son.
=> on exactly four occasions last month, John punished his son, and in each case he did so by slapping him

(19) a. Exactly one of these 5 philosophers found LARGE [a bottle he liked].
=> exactly one of these 5 philosophers found a bottle he liked, and the bottle he found was large
b. Exactly one of these 10 guys UP helped his son.
=> exactly one of these 10 guys helped his son, and he did so by lifting him
c. Exactly one of these 10 guys SLAP punished his son.
=> exactly one of these 10 guys punished his son, and he did so by pulling slapping him

As was mentioned at the outset, such examples illustrate a part of the initial generalizations in (8), namely (8)b(i): *Exactly one of these 10 guys helped his son* entails that there is exactly one pair <x, x's son> that satisfies *help*, and the co-speech gesture triggers the inference that slapping was involved in that pair's interaction.

Under negative quantifiers such as *never* or *none of these 5 philosophers,* co-speech gestures give rise to conditional inferences, as is expected given our initial generalization in (8)b(ii).

(20) a. On Mondays, John never brought LARGE [a bottle of beer].
=> On Mondays, John never brought a bottle of beer, but if he had brought one, it would have been a large bottle
b. On Mondays, John never UP helped his son.
=> On Mondays, John never helped his son, but if had done so, it would have been by lifting him
c. On Mondays, John never SLAP punished his son.
=> On Mondays, John never punished his son, but if had done so, it would have been by slapping him

(21) a. None of these 5 philosophers found LARGE [a bottle he liked].
=> none of these 5 philosophers found a bottle he liked; but for each of them, if he had found a bottle he liked, it would have been a large one
b. None of these 10 guys UP helped his son.
=> none of these 10 guys helped his son; but for each of them, if he had helped his son, it would have been by lifting him
c. None of these 10 guys SLAP punished his son.
=> none of these 10 guys punished his son; but for each of them, if he had punished his son, it would have been by slapping him

We now note that our initial generalization in (8)b(ii) is not precise enough to do justice to the facts. Consider for instance (21)c. *None of these 10 guys punished his son* fails to entail that at least one pair <x, y> satisfies *help*, and thus our statement of (8)b(ii) would lead us to expect a broad inference to the effect that if there were pairs <x, y> satisfying *help*, their interaction would involve some slapping. But of course the inference we obtain is much more precise: it is only for the 10 guys involved, and their sons, that this counterfactual inference holds. The correct prediction will be made by the analysis of Section 3, but it will hinge on the details of a presuppositional analysis based on local contexts.

For future reference, we note that the non-monotonic quantifier *between 3 and 5* gives rise to the inferences we expect in view of the generalization in (8)b(i).

(22) a. Between 3 and 5 of these 10 philosophers found LARGE [a bottle they liked].
=> Between 3 and 5 of these 10 philosophers found a bottle they liked, and in each case it was a large bottle
b. Between 3 and 5 of these guys UP helped their son.
=> Between 3 and 5 of these guys helped their son, and in each case it was by lifting him
c. Between 3 and 5 of these guys SLAP punished their son.
=> Between 3 and 5 of these guys punished their son, and in each case it was by slapping him

2.4 Attitudinal examples

We turn to gesture projection under attitude verbs. In possible worlds semantics, *x believes that F* is given an analysis in terms of universal quantification over worlds compatible with what x believes, and thus we expect to find the same patterns of projection as under universal quantifiers. We note that projection facts are harder to assess in questions, as in (24); we leave a closer investigation of the data for future research.

(23) a. Sam believes that John brought LARGE [a bottle of beer].
=> Sam believes that John brought a large bottle of beer
b. Sam believes that John UP helped his son.
=> Sam believes that John helped his son and did so by lifting him
c. Sam believes that John SLAP punished his son.
=> Sam believes that John punished his son and did so by pulling him upwards

(24) a. Does Sam believe that John brought LARGE [a bottle of beer]?
=>?? Sam/the speaker believes that if John brought a bottle of beer, it was a large one
b. Does Sam believe that John UP helped his son?
=>?? Sam/the speaker believes that if John helped his son, it was by lifting him
c. Does Sam believe that John SLAP punished his son?
=>?? Sam/the speaker believes that if John punished his son, it was by slapping him.

More striking are the patterns we find under *be unaware that __*. *x is unaware that F* is a particularly interesting construction because it has a negative component – *x doesn't believe that F* – and also a positive one, which is presupposed – namely that *F* is in fact the case.[7] In accordance with generalization (8)(ii)a, the gestural inference makes itself felt in the positive but not (or not clearly) in the negative component of the meaning, as is illustrated in (25)-(26).

(25) a. Sam is unaware that John brought LARGE [a bottle of beer].
=> Sam doesn't believe that John brought a bottle of beer
=> John brought a large bottle of beer
b. Sam is unaware that John UP helped his son.
=> Sam doesn't believe that John helped his son
=> John helped his son by lifting him
c. Sam is unaware that John SLAP punished his son.
=> Sam doesn't believe that John punished his son
=> John punished his son by lapping him

(26) a. Is Sam unaware that John brought LARGE [a bottle of beer]?
=> John brought a large bottle of beer
b. Is Sam unaware that John UP helped his son?
=> John helped his son by lifting him
c. Is Sam unaware that John SALP punished his son?
=> John punished his son by slapping him

Similar data can be obtained with *x doesn't realize that F* as with *x is unaware that F*, as can be seen in (27).

(27) a. Sam doesn't realize that John brought LARGE [a bottle of beer].
=> Sam doesn't believe that John brought a bottle of beer
=> John brought a large bottle of beer
b. Sam doesn't realize that John UP helped his son.
=> Sam doesn't believe that John helped his son
=> John helped his son by lifting him
c. Sam doesn't realize that John SLAP punished his son.
=> Sam doesn't believe that John punished his son
=> John punished his son by slapping him

2.5 Facial Expressions

We believe that some of the same generalizations hold of some co-speech facial expressions. The advantage of facial expressions is that they seem rather natural over long stretches over which it would be unnatural to produce a single co-speech gesture. In simple cases, we replicate the inferences obtained with co-speech gestures. Here *:-(* stands for an unhappy or disgusted face, which we illustrate in (28)a.

[7] See Spector and Sudo, to appear, for other theoretical uses of this construction (specifically, for the analysis of the interaction between implicatures and presuppositions).

(28) **Propositional examples**

a. Sam went :-(_  [skiing with his parents].
=> for Sam to go skiing with Sam's parents wasn't fun
b. Sam won't go :-([skiing with his parents].
=> for Sam to go skiing with his parents wouldn't be fun
c. Did Sam go :-([skiing with his parents]?
=> for Sam to go skiing with his parents wouldn't have been fun
d. If Sam goes :-([skiing with his parents], I'll hear about it.
=> for Sam to go skiing with his parents wouldn't be fun

In more complex examples, we can see the effect of a facial modifier co-occurring with an expression that contains a bound variable. The same generalizations hold as in our earlier examples involving manual gestures.[8]

(29) **Quantificational examples**
a. Each of my friends goes :-([skiing with his parents].
=> for each of my friends, skiing with his parents isn't fun
b. Does each of your friends go :-([skiing with his parents]?
=> for each of my friends, skiing with his parents wouldn't be fun
c. None of my friends goes :-([skiing with his parents]
=> for each of my friends, skiing with his parents wouldn't be fun
d. Exactly four of my friends went :-([skiing with their parents]
=> exactly four of my friends went skiing with their parents, and
(i) for each of these four friends, skiing with his parents wasn't fun, or possibly
(ii) for my friends in general, skiing with their parents isn't fun.
d. An odd number of of my friends went :-([skiing with their parents]
=> an odd number of my friends went skiing with their parents, and
(i) for each of these friends, skiing with his parents wasn't fun, or possibly
(ii) for my friends in general, skiing with their parents isn't fun.

As mentioned at the outset, timing matters. Thus we believe that when a disgusted or sad facial expression *follows* a quantified statement, as in (30), one can obtain very different readings – similar to ones that could be obtained with an appositive relative clause modifying an entire proposition (as in (30)(i)) or a VP (as in (30)(ii)).

(30) None of my friends goes skiing with his parents – :-(.
=> None of my friends goes skiing with his parents,
(i) which is sad [i.e. it is sad that none of my friends goes skiing with his parents];
(ii) which is unpleasant [i.e. it is generally unpleasant to go skiing with one's parents].

We come back to appositive readings of co-speech gestures and facial expressions in Section 4.2.2.

Additional complexities are involved with facial expressions in attitudinal environments. It seems to us that their content may be attributed to the agent, or maybe to the speaker, and possibly even to both, as illustrated in (31); we leave this issue for future research.[9]

(31) John thinks that his son goes :-([skiing with his parents].
=> the speaker and possibly John finds that for his son to go with her parents wouldn't be fun

3 A Cosuppositional Analysis of Co-Speech Gestures

3.1 Main idea

Let us turn to the analysis. The main intuition is straightforward: we take a co-speech gesture to come with a requirement that its content should follow from the contextual meaning of the constituent it co-occurs with. In order to account for the interaction of gestural enrichments with the compositional semantics of the sentences they interact with, we take the relevant notion of 'contextual meaning' to be: meaning *relative to the local context* of the expression. Dynamic semantics has offered an

[8] See Schlenker, to appear c for initial data that suggest that similar data can be replicated with some facial expressions in ASL.
[9] See Schlenker to appear b, 2015a for a discussion of happy faces in attitude reports in sign language (in that piece, the focus is on happy faces co-occurring with 'role-shifted clauses', which are context-shifting constructions. But the controls involve happy faces on standard indirect discourse, which is comparable to English indirect discourse.

articulated account of local contexts and dynamic updates. But because that account is intrinsically lexicalist (the update behavior of connectives and operators is stipulated on a case-by-case basis), we will occasionally follow the framework of Schlenker 2009, which provides a general recipe to compute local contexts once the bivalent semantics and syntax of a sentence have been specified.

Our analysis can be stated in presuppositional terms, as in (32): a co-speech gesture triggers a presupposition that its content is entailed by that of the expression it modifies.

(32) **Cosuppositions triggered by co-speech gestures**
Let *G* a co-speech gesture co-occurring with an expression *d'*, and let *g* be the content of *G*. Then *G* triggers a presupposition $d' \Rightarrow g$, where $\Rightarrow$ is generalized entailment (among expressions whose type 'ends in t').[10]

To put things differently, a co-speech gesture triggers a presupposition of a particular sort, namely one that is conditionalized on the assertive content of the expression it modifies, as specified in (33).

(33) **Cosuppositions as conditionalized presuppositions**
An expression *E* triggers a cosupposition if *E* triggers a presupposition of the form $a \Rightarrow e$, where *a* is the assertive content of an expression that *E* modifies.

It should be kept in mind that cosuppositions are presuppositions of a particular sort, and thus that we can rely on the theory of presupposition to make predictions about cosuppositions. The general insight is that the presupposition triggered an expression must be entailed by the 'local context' of that expression (this insight is incorporated in the dynamic update rules posited by Heim 1983; and it plays a direct role in the reconstruction of local contexts of Schlenker 2009). The general case is stated in (34)a, and the special case of presuppositions in (34)b, with the notation in (34)c.

(34) **Presupposition Satisfaction (dynamic approach)**
Let *E* be an expression with an assertive component *a* and a presupposition π occurring in a sentence … *E* … uttered relative to a Context Set C.

a. **General case of presuppositions**
Then *E* is licensed in … *E*… relative to C only in case the local context of *E* given C entails π.

b. **Special case of cosuppositions**
Suppose that π is of the form $a \Rightarrow e$. Then *E* is licensed in … *E*… relative to C only in case its local context entails $a \Rightarrow e$.

c. **Notation:** in simple cases, local contexts may be of propositional or predicative type. If lc is a local context and *F* is a formula of the appropriate type, we write lc $\models$ F in case lc entails F by generalized entailment.[11]

Let us immediately illustrate the main intuition with a particularly simple example, involving an expression of disgust co-occurring with the consequent of a conditional.

(35) Context: it is hot and humid.
a. If you go running, :-([you'll sweat].
b. if r, G s

We analyze this sentence as having the Logical Form in (35)b, where *r* stands for *you go running*, *s* for *you'll sweat*, and *G* for the speaker's disgusted expression. We now apply the satisfaction condition in (34) to (35)b.

• First, we need to compute the local context of *s* in *if r, s* given C; we call this local context lc(s). Standard dynamic analyses as well as the reconstruction of local contexts of Schlenker 2009 take lc(s) to correspond to the set of worlds in C that also satisfy *r*, as is written in (36).

(36) Local context of *s* in (35)b given a Context Set C
$lc(s) = \lambda w_s$ w is in C and w satisfies *r*

• Second, the licensing condition in (34)b specifies that relative to lc(s), *s* should entail the content *g* of *G*. Since in this case *G* is a disgusted facial expression, its content is something like: 'disgust is licensed'. We obtain the result in (37).

---

[10] If x and x' are two objects of a type τ that 'ends in t', and can take at most n arguments, $x \Rightarrow x'$ just in case whenever $y_1, ..., y_n$ are objects of the appropriate type, if $x(y_1) ... (y_n) = 1$, then $x'(y_1) ... (y_n) = 1$

[11] More precisely, we can define the relevant notion of generalized entailment (between a set-theoretic object and formula) as follows:

If o is a type-theoretic object of type t or such that, for some objects $x_1, \ldots, x_n$ of types $\tau_1, \ldots, \tau_n$, $o(x_1)\ldots(x_n)$ is of type t, and if *F* is a formula of the same type as o with meaning **F**, then o $\models$ F just in case for all objects $x_1, \ldots, x_n$ of types $\tau_1, \ldots, \tau_n$, if $o(x_1)\ldots(\tau_n) = 1$, then $\mathbf{F}(x_1)\ldots(\tau_n) = 1$.

(37) **Licensing condition on *G* in (35)b given a Context Set C**
a. lc(s) as computed in (36) should guarantee that lc(s) ⊨ s => g, where *g* is the content of *G*
b. [λw_s w is in C and w satisfies *r*] ⊨ [s => g]
and thus we get the result that every world w in C that satisfies *r* should satisfy *s => g*.
In words, every world in C in which the addressee goes running guarantees in one in which the addressee's sweating would be disgusting

This seems appropriate: we obtain an inference that, given the hot and humid weather, if the addressee runs, then sweating will be disgusting.

Finally, we must make provisions for local accommodation of the presupposition (Heim 1983). The condition is standard; one version is defined in (38)a for the general case, and applied in (38)b to the case of cosuppositions (in either one of versions defined in (39)).

(38) **Local Accommodation**

a. General case
A presupposition which is 'locally accommodated' is treated as part of the assertive component of the expression it belongs to.

b. Application to cosuppositions
A cosuppositional expression with assertive component *a* and presupposition *a => e* acquires an assertive component *(a & (a => e))*, i.e. *a & e*, after local accommodation (the same result is obtained for the 'official' condition in (39)a and for the equivalent condition in (39)b: it is immediate in the latter case that *a & e* gets locally accommodated to *a & e*).

In the case of gestural enrichments, the effect of local accommodation will simply be to turn the gestural enrichment into part of the assertive component. A systematic comparison between the accommodation properties of co-speech gestures and of standard presupposition triggers is beyond the scope of this study; we conjecture that co-speech gestures are often weak triggers, which easily give rise to local accommodation.

3.2 Near-equivalent condition

Having illustrated the licensing condition in (34)b, it is worth noting that within standard dynamic semantics it is equivalent to a treatment of the co-speech gesture as a separate and purely presuppositional conjunct *following* the expression it modifies. The reason is that in a sentence of the form … *[e & g]* …, where the second embedded conjunct *g* is purely presuppositional, standard rules of presupposition projection require that, relative to its local context, *e* should materially entail *g* – which is precisely the result we obtain for a sentences … *e => g e** …, where *e => g e** has an assertive component *e** and a presupposition *e => b*. As a result, … *e => g e** … and … *(e & g)* … trigger the same presupposition, as is stated in (39)a (if *e** = *e*, the result of the dynamic update is also the same).

(39) **Presuppositional equivalence of … *e => g e** … and … *(e & g)* …**
Let *e => g e** be a propositional expression with presupposition with content *e => g* and an assertive component with content *e**, and let *(e & g)* the conjunction of an expression with content *e* with an expression with a presuppositional content *g* and a trivial assertive component.

a. A Heimian dynamic semantics guarantees that for any Context Set C, C[e => g e*] is defined if and only if C[e & g] is. Furthermore, if *e** = *e*, C[e => g e*] = C[e & g]. It immediately follows that if … ***e => g e**…* and *…**e & g**…. are identical sentences except for the boldfaced material, they trigger the same presuppositions.

Proof: A Heimian dynamic semantics has the following rules (where c may range over sequence-world pairs, for instance):
(i) atomic case: C[pp'] = # iff C = # or for some c in C, *p* isn't true of c. If ≠ #, C[pp'] = {c∈C: p' is true of c}.
(ii) conjunctions: C[F & G] = C[F][G]
From (i), C[e => g e*] = # iff **C = # or for some c in C, *e* is true of c and *g* is false of c**. If ≠ #, C[e => g e*] = {c∈C: e* is true of c}.
From (ii) and (i), C[e & g] = C[e][g] = # iff C = # or for some c in C[e], *g* isn't true of c, iff C = # or for some c in {c∈C: e is true of c}, *g* isn't true of c, iff **C = # or for some c in C, *e* is true of c and *g* is false of c**. If ≠ #, C[e & g] = {c∈C: e is true of c}
The two boldfaced conditions are identical, hence C[e => g e*] = # iff C[e & g] = #. Futthermore, by inspecting the result of the updates, if *e* = *e**, C[e => g e*] = C[e & g]

b. Due to the equivalence of the propositional fragment of Schlenker 2009 and of (a version of) Heim's

dynamic semantics, it also follows that within that propositional fragment … ***e => g e****… and …***e & g***…. trigger the same presuppositions.

The propositional fragment of Schlenker 2009 is equivalent to (a version of) Heim's propositional dynamic semantics, and thus the presuppositional equivalence of … *e => g e** … and … *(e & g)* … is derived as well in the system of Schlenker 2009, as stated in (39)b. As is explained in Appendix I, things are more complicated in the quantificational case: the fragment of Schlenker 2009 has neither variables nor complex predicates, hence it makes no prediction when, say, *(e & g)* contains bound variables or is predicative. But the general mechanism used to compute local contexts can be extended to this case, and when this is done … *e => g* * … sometimes derives slightly stronger presuppositions than … *(e & g)* … .

3.3 Simple cases

We turn to a treatment of a few sample cases. As before, co-speech gestures appear in capital letters, e.g. *S* (for *SLAP*); and their content appears in normal letters, e.g. *s*. We write the global Context Set as C. We take presuppositions to provide constraints on the Context Set, while assertions provide information on (must be entailed by) the speaker's beliefs, which are more specific. In each case, line a. (a'., a".) include an English sentence with co-speech gestures, and a simplified representation of its Logical Form; line b. states the licensing condition and the inferences that can be drawn from it. When needed, we write as **F** (in boldface) the semantic value of an expression *F*.

3.3.1 Propositional examples

We start with simple propositional examples. In (40), we consider cases in which the local context of the enriched expression is identical to the global context of the conversation.[12] In case the sentence is a question, as in (40)a, we obtain the desired cosupposition: if John punished his son, this involved some slapping, or with our notation (introduced in (34)c): C ⊨ p => s. If instead of a question we have an assertion, as in (40)a, it interacts with the cosupposition to yield the inference that the content of the gesture was in fact instantiated – in our example, this is the inference that John in fact punished his son by slapping him. .

(40) a. John SLAP punished his son.
a'. Did John SLAP punish his son?
a". Sp (?)
b. Licensing condition:
lc(Sp) ⊨ p => s
hence
C ⊨ p => s
and when a is asserted, we thus infer: p and s.

In (41), we obtain a further relativization to the antecedent of the conditional, as is desired as well. And in (42), the same cosupposition is obtained as in (40), simply because negation does not affect the computation of local contexts.

(41) a. If John is present at the right time, will he SLAP punish his son?
a'. if r, Sp?
b. Licensing condition:
lc(Sp) ⊨ p => s
hence
C ⊨ r => (p => s)
hence an inference (which survives under questions) that
if John is present at the right time, then if he punishes his son, he will do so by slapping him.

(42) a. John didn't SLAP punish his son.
a'. not Sp
b. Licensing condition:
lc(Sp) ⊨ p => s
But in a'. lc(Sp) = C, the global context, hence
C ⊨ p => s
In the end, we have two inferences:
relative to the Context Set, if John punishes his son, he does so by slapping him;
relative to the (more specific) speaker's beliefs, John didn't punish his son.

[12] This is true to the extent that *John punished his son* is treated as an atomic propositional expression. In a less simplified system, *punished his son* would have a predicative meaning enriched by the co-speech gesture, and the enriched predicative meaning would then be applied to the subject.

3.3.2 Quantified examples

Let us turn to quantified examples.

❑ *Basic results*

As desired, we derive a universal conditional presupposition in the case of embedding under *none of these 10 guys*. They key is that this quantifier gives rise to universal presuppositions – for instance, *None of these 10 guys takes good care of his computer* presupposes that *each of these 10 guys has a computer,* a result confirmed with experimental means in Chemla 2009. On a theoretical level, Heim 1983 incorporates this pattern of 'universal projection' in her analysis of all generalized quantifiers; and Schlenker 2009 shows that the local context of the Verb Phrase in such cases is the property of being one of these 10 guys relative to the Context Set – which derives the very same result (since the property of being one of these 10 guys must entail the relevant presupposition).

(43) a. None of these 10 guys SLAP punished his son.
a'. [No g] Sp
b. Licensing condition:
lc(Sp) ⊨ p => s
Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:
C ⊨ ∀x (g(x) => (p(x) => s(x))
In the end, we have two inferences:
relative to the Context Set, if any of the 10 guys punishes his son, he does so by slapping him;
relative to the speaker's beliefs, none of these 10 guys punished his son.

In Heim's analysis (Heim 1983), all generalized quantifiers trigger universal presuppositions in their nuclear scope. This result is derived, *modulo* some technical assumptions, in the reconstruction of local contexts developed in Schlenker 2009 (see Appendix I of the present paper for a summary). This makes it possible to derive the desired inferences about the 'positive' part of the sentences in (44)-(45). The key is that in each case we derive a universal presupposition to the effect that for each of the relevant guys, if he punished his son, he did so by slapping him. This universal conditional presupposition then interacts with the assertive component to yield the inference that the individuals that did in fact punish their sons did so by slapping them.

(44) a. Exactly one of these 10 guys SLAP punished his son.
a'. [=1 g] Sp
b. Licensing condition:
lc(Sp) ⊨ p => s
Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:
C ⊨ ∀x (g(x) => (p(x) => s(x))
In the end, we have two inferences:
relative to the Context Set, if any of the 10 guys punishes his son, he does so by slapping him;
relative to the speaker's beliefs, exactly one of the 10 guys punished his son; by the first inference, he did so by slapping him.

(45) a. Between 3 and 5 of these 10 guys SLAP punished their sons.
a'. [3 ≤ • ≤ 5 g] Sp
b. Licensing condition:
lc(Sp) ≤ p => s
Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:
C ⊨ [∀x: g(x)](p(x) => s(x))
In the end, we have two inferences:
relative to the Context Set, if any of the 10 guys punished his son, he did so by slapping him;
relative to the speaker's beliefs, between 3 and 5 of these 10 guys punished their sons; by the first inference, they did so by slapping them.

❑ *A problem and some potential solutions*

Still, in addition to the desirable inferences we derive, we also predict a universal conditional inference which is more dubious, namely that it is presupposed that *for each of these 10 guys, if he had punished his son, he would have done so by slapping him*. While this inference seems appropriate

when the target sentence is *None of these 10 guys SLAP punished his son*, it is more dubious in (44) and (45). If this empirical problem is confirmed, various strategies could be explored to solve it.[13]

(i) First, this difficulty might be related to an independent problem with the theory of presupposition projection: as shown with experimental means by Chemla 2009, universal presupposition projection is much stronger under *No* than under modified numerals. This does not solve our problem but might reduce it to an independent one.

(ii) Second, one could posit that gestural cosuppositions are very easily accommodated globally. More precisely, we could assume that gestural cosuppositions may be assessed relative to the speaker's beliefs rather than to the Common Ground of the conversation, with one proviso: the gestural cosupposition should not be accommodated globally if doing so would make the co-speech gesture vacuous, in the sense that the sentence with the co-speech gesture has the very same entailments as the sentence without it. This is stated

(46) **Global accommodation of gestural cosuppositions** (tentative)
a. A gestural cosupposition may be assessed with respect to the speaker's beliefs rather than with respect to the Context Set...
b. ... unless doing so would make the co-speech gesture vacuous, in the sense that the sentence with the co-speech gesture triggers the very same inferences as the sentence without it (if so, the gestural cosupposition must be evaluated with respect to the Context Set).

Let us see how our proposed modification could solve our empirical problem.

• Since the assertive component of (43)a is that none of the relevant individuals punished his son, the additional conditional inference that *for each of these guys, if he had punished he son, he would have so by slapping him* is vacuous when evaluated with respect to the speaker's belief state. The reason is that this conditional is a material implication evaluated with respect to the speaker's belief state B (formally: if B $\models \forall x$ (g(x) => **(p(x) => s(x))**, where the conditional is boldfaced). It is clear that if the speaker believes that none of the relevant individuals punished his son, this material implication will be vacuously satisfied (formally: since B $\models \forall x$ (g(x) => not p(x)), the boldfaced implication will be vacuously satisfied). Thus the strategy outlined in (46)a fails because it makes the gestural contribution vacuous, so one must resort to the strategy in (46)b, which yields a stronger conditional presupposition – one that must hold throughout the Context Set C rather than just throughout the set of worlds B compatible with what the speaker believes.

• Things are different in the case of quantifiers that have a positive component, for instance those in (44) and (45): in such cases, the universal conditional presupposition yields inferences that the gesture-less sentence wouldn't. As a result, we can assess (44) and (45) relative to the beliefs B of the speaker, yielding the (assertive-like) inference that *those guys who punished their sons did so by slapping them*.

(iii) A third solution would be to posit that in all cases gestural presuppositions are evaluated with respect to the speaker's belief states, but that when the result is to make the gestural contribution vacuous, the rightmost material implication in formulas such as $\forall x$ (g(x) => (p(x) => s(x)) is reinterpreted as a stronger conditional – e.g. a counterfactual conditional. This would yield for (43)a an inference that for each of the relevant individuals, *if he had punished his son, he would have done*

[13] We are not certain of the data. In (i)a, the universal inference (= *for each of these 10 guys, if he had punished his son, he would have done so by slapping him*) might be too strong. But in (i)b, we do get the inference that each of the guys that *did* slap his son did so by slapping him.

(i) a. Exactly one of these 10 guys SLAP punished his son.
b. Exactly one of these 10 guys didn't SLAP punish his son.
c. Maybe exactly one of the 10 guys didn't SLAP punish his son.
d. Did exactly one of the 10 guys not SLAP punish his son?

Now the observed inference in (i)b could be derived simply on the basis of the assertive component of (i)b, on the assumption that the presupposition is *also* part of the assertive component (see Sudo 2012, 2014 for a discussion of such a hypothesis): from *exactly one of these 10 guys didn't punish his son by slapping him,* we can infer that *each of the other nine guys punished his son by slapping him*. In order to observe the specific contribution of the presupposition, we must thus consider cases such as (i)c,d, where the inference that *each of the guys who punished his son did so by slapping him* is not licensed by the assertive component. Unfortunately, judgments are subtle in such cases.

so by slapping him. This seems adequate as well, although it is not trivial to see how this stronger conditional interpretation could be derived in the case at hand.

For present purposes, the solution in (ii) seems to be preferable, as it relies on principles that are independently plausible: first, the fact that global accommodation might be 'easy'; second, the fact that one probably doesn't want to use a co-speech gesture that won't have any inferential effect whatsoever.

3.3.3 Simple attitudinal examples

Let us turn to co-speech gestures that are embedded within belief reports. Since belief reports are standardly analyzed in terms of universal quantification over possible worlds, we obtain the same types of predictions as co-speech gestures embedded under universal quantifiers. The simplest case involves embedding under *believe,* as in (47); the prediction seems roughly accurate.

(47) a. Sam believes that John SLAP punished his son.
a'. Bel_s Sp
b. Licensing condition:
C $\models$ Bel_s p => s

Heim 1983, 1992 and Schlenker 2009 derive the result that for a presupposition trigger *qq'* with presupposition *p*, Bel_s *qq'* presupposes Bel_s *q*. In a'. the presupposition is of the form *p => s,* hence the result.[14]
The assertive component yields Bel_s *p*, hence also an inference that Bel_s *s*: Sam believes that John punished his son and slapped him.

The data are more subtle and harder to assess in the negative example in (48). The predicted cosupposition is the same as in (47), but given the negative nature of the assertive component, the overall inferences obtained are of course different.

(48) a. Sam doesn't believe that John SLAP punished his son.
a'. not Bel_s Sp
b. Licensing condition:
C $\models$ Bel_s p => s
The presuppositional result is the same as in (47), but the assertive component is negative and thuswe do not obtain the inference that Sam believes John did in fact punish his son and slapped him.

3.4 *The case of* be unaware *and* not realize

Let us turn to the case of *be unaware* and *not realize,* which yield the interesting inferences we discussed in Section 2.4. While one is typically interested in the local context of the entire constituent *[be unaware that F]* or *[realize that F]* (as these are presupposition triggers), we need to compute the local context of the embedded clause *F* in order to be able to assess the effects of a gesture that co-occurs with it. Dynamic accounts do not provide a straightforward (or a predictive) way to assess what the value of that local context is, and thus it is particularly useful to make use of the reconstruction of local contexts in Schlenker 2009 (presented in more concise form in Schlenker 2010).

By way of motivation, let us explain what would go wrong if we simply assumed that the gestural inference is simply conjoined with the embedded clause, so that *John SLAP punished his son* means *p & (p => s): John punished his son, and if he punished him, he did so by slapping him*. This is immediately equivalent to: *p & s,* i.e. *John punished his son and slapped him*. Under *be aware, be unaware, realize* and *not realize*, this conjunction becomes presupposed, which is compatible with the observed inferential facts (e.g. *Sam realizes that John SLAP punished his son* does give rise to the inference that John did in fact punish his son, and did so by slapping him). But under *be unaware*

[14] More precisely, the condition we derive is that the local context of the embedded clause entails its cosupposition, as stated in (i):

(i) lc(Sp) $\models$ p => s

Schlenker 2009 shows that the value of the local context of the embedded clause in a formula Bel_s *F* is lc(F) = $\lambda w^* \lambda w$ ($w^* \in C$ and $w \in Dox_s(w^*)$), where abstraction over w* corresponds to the context parameter and abstraction over w corresponds to the world parameter, while $Dox_s(w^*)$ is the set of worlds compatible with what individual p believes in world w*. As a result, we obtain the presupposition in (ii), which is also what Heim 1992 posits:

(ii) C $\models$ Bel_s p => s

and *not realize*, the assertive component derived for the entire sentence is now too weak: we infer that *Sam doesn't believe that John punished his son by slapping him,* whereas the correct result is arguably that *Sam doesn't believe that John punished his son*.

We will now show that this stronger result does follow from the mechanism of local context computation of Schlenker 2009 (though we might also obtain a result which is in some respects too strong). We start with the case of *be aware* and *be unaware,* where can assume that the bivalent meaning of a formula *Unaware_s F* is in essence that (i) *F* is true, and (ii) individual s doesn't believe that *F*; and that the bivalent meaning of a formula *Aware_s F* is that (i) *F* is true, and (ii) individual s believes that *F*. With these assumptions, it can be shown that the local context of the embedded clause is in essence the union of the actual world and of the worlds compatible with the agent's beliefs. As a result, the gestural cosupposition will impose conditions both on the actual world and on the worlds compatible with the agent's beliefs.

Specifically, *modulo* a technical assumption, the local context of *F* in both constructions is the function that assigns to each world w* the null set if w* is not in the Context Set C, and otherwise the set of worlds compatible with what individual s believes in w* (as was the case for the local context of a clause embedded under *believe*), *augmented* with the world w* itself (due to the factive entailment of *be unaware)*. In technical terms: lc(F) = λw* λw (w* $\in$ C and (w $\in$ Dox_s(w*) or w = w*)). This result is stated in (49) and proven in Appendix II. But a word of explanation might be useful. In the simple framework of Schlenker 2009, one should think as the first world argument *w** as the context parameter. Thus if *(Un)aware_s F* is evaluated within a context c of the context set C, the local context of *F* is lc(F)(c) = λw (w $\in$ Dox_s(c) or w = c), which can be thought of as the set Dox_s(c) $\cup$ {c}; this, in turn, captures the intuition that when evaluating the embedded clause one can restrict attention to the worlds compatible with the agent's beliefs (given c) and to c itself, as the embedded clause will only provide information about such worlds.

(49) **Local context of *F* in *(Un)aware_s F***
Assume that *(Un)aware_s F* is equivalent to *F & (not) Bel_s F*.

In the framework of Schlenker 2009, *modulo* some technical assumptions stated in Appendix II, the local context of the embedded clause *F* is:
lc(F) = λw* λw (w* $\in$ C and (w $\in$ Dox_s(w*) or w = w*))

We are now in a position to consider the case of *Sam is aware that John SLAP punished his son*, analyzed in (50).

(50) a. Sam is aware that John SLAP punished his son.
a'. $Aware_s$ Sp
b. Licensing condition:
lc(Sp) $\vDash$ p => s
By (49), lc(Sp) = λw* λw (w* $\in$ C and (w $\in$ Dox_s(w*) or w = w*)), where Dox_s(w*) is the set of worlds compatible with what individual s believes in world w*. As a result, we obtain the presupposition that

(i) C $\vDash$ p => e & Bel_s p => s

In addition, we can derive a factive presupposition triggered by *aware* (we do not provide the derivation here, as it is straightforward in dynamic semantics or in the reconstruction of local contexts of Schlenker 2009). Thus we also have:

(ii) C $\vDash$ p & (p => s), hence C $\vDash$ p & s

Since *$Aware_s$ Sp* is asserted, if the speaker is sincere we obtain the result in (iii), with B = the set of worlds compatible with the speaker's beliefs:

(iii) B $\vDash$ Bel_s(p & s)

The presuppositions are the same if *aware* is replaced with *unaware,* but we lose the inference in (iii):

(51) a. Sam is unaware that John SLAP punished his son.
a'. $Unaware_s$ Sp
b. Since the local context of the embedded clause is the same under *Unaware* and under *Aware*, and since the factive presupposition is the same for both constructions, we obtain exactly the same presuppositions in the two cases, hence:

(i) C $\vDash$ (p => s) & Bel_s (p => s)

(ii) C $\vDash$ p & s

The assertive component gives us in the present case:

(iii) B $\models$ not Bel_s(p & s)

and by (i) and (iii)

(iv) B $\models$ not Bel_s p

since for w $\in$ B, if w $\models$ Bel_s p, by (i) w $\models$ Bel_s (p => s) [because C $\models$ F implies B $\models$ F], hence w $\models$ Bel_s (p & s), which contradicts (iii).

Now it might seem that $Bel_s(p \Rightarrow s)$ in (i) is still too strong. This is directly related to the problem we already encountered in (44)-(45), and the same solutions could be considered. In particular, we could posit that in this case the gestural cosupposition is globally accommodated and thus assessed with respect to the beliefs B of the speaker. If in addition (iv) is strengthened to B $\models$ Bel_s not p, the conditional embedded under the belief operator will be vacuously satisfied, and thus the effect of $Bel_s (p \Rightarrow s)$ will be hard to detect (see for instance Gajewski 2007 for arguments that *believe* often satisfies a homogeneity presupposition, to the effect that the agent either believes a proposition or believes its negation). Whether this is the right line of analysis remains to be seen, however – a point we leave for future research.

Since the local context of the embedded clause is the same under *aware* and *unaware*, we also get the result that *Sam is not aware that John SLAP punished his son* is predicted to behave like (51)a.

(52) a. Sam is not aware that John SLAP punished his son.
a'. not $Aware_s$ Sp
b. Since the local context of the embedded clause is the same under *Unaware* and under *Aware*, and since the factive presupposition is the same for both constructions, we obtain exactly the same presuppositions in the two chases, hence:

(i) C $\models$ p=>e & Bel_s p => s

(ii) C $\models$ p & s

The assertive component gives us in the present case:

(iii) B $\models$ not Bel_s(p & s)

and by (i) and (iii)

(iv) B $\models$ not Bel_s p

since if B $\models$ Bel_s p, by (i) B $\models$ Bel_s p => s [because C $\models$ F implies B $\models$ F], hence B $\models$ Bel_s p & s, a contradiction.

3.5 Refining the analysis within event semantics

As M. Krifka (p.c.) has noted, the inferences we predict are in some respect too weak. Consider again the sentences *John SLAP punished his son* or *Did John SLAP punish his son?* We predict a presupposition to the effect that *if John punished his son, some slapping occurred* – but our framework does not specify what kind of connection, if any, there should be between the punishment and the slapping. We clearly want something stronger, namely: *if John punished his son, slapping was involved in the punishment in question*. As Krifka points out, this more adequate inference can be obtained by integrating cosuppositions to an event semantics, one in which *punished* holds true of events and individuals rather than just of individuals.

Without going into the full details of a proper event semantics (see for instance Rothstein 2004), we can follow Krifka's suggestion in positing the event-theoretic analysis in (53)a: *punish* will compose with two individual arguments y (corresponding to the patient) and x (corresponding to the agent) to yield an event predicate true of punishments involving x and y as an agent and as a patient respectively. For concreteness, we adopt a trivalent framework in which *SLAP punish* yields a failure unless punishing (relative to certain arguments) entails slapping, as is encoded in (53)b (using the notation of Heim and Kratzer 1998, where $\lambda x: F . G$ yields a failure on x unless F is true of x).

(53) a. Lexical entry of *punish* (where *punish'* is a meta-linguistic predicate true of punishments)
[[punish]] = $\lambda y \lambda x \lambda e$ [punish'(e) and agent(e) = x and patient(e) = y]

b. Cosupposition triggered by *SLAP* co-occurring with *punish*

[[SLAP punish]] = λy λx λe: [punish'(e) and agent(e) = x and patient(e) = y] => slap'(e) . [punish'(e) and agent(e) = x and patient(e) = y]

c. [[John SLAP punish his son]]

= [λy λx λe: [punish'(e) and agent(e) = x and patient(e) = y] => slap'(e) . punish'(e) and agent(e) = x and patient(e) = y](john's_son')(john')

= λe: [punish'(e) and agent(e) = john' and patient(e) = john's_son'] => slap'(e) . punish'(e) and agent(e) = john' and patient(e) = john's_son'

For *John SLAP punish his son,* we obtain in (53)c a predicate of events which is true of punishments inflicted by John on his son, with a cosupposition that such events are slappings. To obtain truth conditions, we need to 'feed' an event argument to this predicate. This can for instance be done by way of an existential quantifier over events with a domain restriction *D*, as in (54).

(54) [∃e: De] John SLAP punish his son

The final result depends on presupposition projection in existentially quantified structures – a controversial topic. Assuming we obtain universal projection, and thus that every event that satisfies the restrictor *D* must satisfy the presupposition of the predicate, we will get a presupposition to the effect that *for every event e satisfying* D*, if e is an event in which John punishes his son, e is a slapping*. This seems adequate. Of course further refinements should be explored, but since we are interested in the projection properties of gestural cosuppositions rather than in the details of their lexical specifications, we will leave this issue for future research.

3.6 Summary

In this section, we have implemented the idea that *the contextual meaning of an expression should entail the content of a co-speech gesture that modifies it*. By taking the contextual meaning of an expression to be the meaning it has *relative to its local context,* we were able to predict a subtle interaction between co-speech gestures and logical operators. For a (presupposition-less) expression *p* modified by a co-speech gesture *G* in a sentence … *G p*… uttered in a Context Set C, the key condition was that lc ⊨p => g, where lc is the local context of *G p* and *g* is the content of the gesture G. We were able to derive several instances of the initial generalizations in (8). First, barring local accommodation, co-speech gestures strengthen the meaning of sentences because their contribution is presuppositional (in the special, cosuppositional form they take). Second, in cases in which the cosuppositional inference *p => g* projects universally, we get the inference that those tuples that satisfy *p* must satisfy g. Third, we derive a conditional inference that those objects that don't satisfy *p* would satisfy *g* if they satisfied *p*. This was a good inference in some cases (e.g. under the quantifier *no*), and possibly an overly strong inference in some other cases. More appropriate results can in some cases be obtained if we assume that cosuppositions are easily accommodated globally and end up providing information about the speaker's beliefs, unless this procedure makes the co-speech gesture vacuous.

4 Alternative Accounts

In this section, we consider two alternative accounts. One treats co-speech gestures as having a supervaluationist semantics; the intuition is that the Context Set should guarantee that the same semantic result is obtained whether the content of the co-speech gesture is taken into account or not. This makes interesting predictions, but ones which, in the end, are flawed. The second alternative follows Ebert and Ebert 2014 in treating co-speech gestures as having a 'supplementary' contribution, or in other words as having the same kind of contribution as appositive relative clauses. We argue that this analysis is incorrect for co-speech gestures, but that it works well for post-speech gestures, which come after the expressions they modify and have their own time slot.

4.1 Supervaluationist accounts

As noted, our initial cosuppositional analysis predicted some inferences that were somewhat too strong. This was in particular the case in (44)a (*Exactly one of these 10 guys SLAP punished his son*.), for which we initially predicted a universal conditional presupposition to the effect that for each of these 10 guys, if he punished his son, he did so by slapping him. The same potential problem arose in (51)a (*Sam is unaware that John SLAP punished his son*.), for which we initially predicted a presupposition that Sam believes that either John didn't punish his son, or he did so by slapping him. Several possible solutions were sketched in Section 3.3.2. But these difficulties motivate the

exploration of a different theory, which goes like this: when we perceive a co-speech gesture, we interpret it as enriching the meaning of the sentence, but instead of doing so in a cosuppositional fashion, we simply take the conjunction of the sentence without the co-speech gesture, and of the sentence with the co-speech gesture.

In effect, this amounts to treating the sentence in a supervaluationist fashion: we take the presence of the co-speech gesture to be somehow 'vague', and we require that the sentence should be have the same truth value both with and without the co-speech gesture (this could be motivated by the fact that we wish to interpret co-speech gesture, but without any risk of somehow 'losing' the literal meaning; a similar idea was explored in unpublished work by Fox and Spector on the interpretation of the covert exhaustivity operator that accounts for embedded implicatures). This leads us to an initial statement of the following Basic Supervaluationist Account:

(55) **Basic Supervaluationis Account**
A sentence for the form … *Ge* … with a co-speech gesture *G* with a content expressed by *g* modifying an expression *e* of the same (conjoinable) type is true (resp. false) just in case the two sentences … *e* … and … *[e & g]* … are both true (resp. false).

When the sentence has different truth values depending on whether the co-speech gesture is taken into account or disregarded, the sentence will be neither true nor false – hence a trivalent account of gesture projection. It is also immediate that on this analysis a co-speech gesture is predicted to always strengthen the meaning of a sentence: if the enriched sentence is true, so is the bare sentence (this property is shared with our cosuppositional account, at least given standard assumptions about presupposition projection).

Let us see how this mechanism can be applied to the sentence *Sam is unaware that John SLAP punished his son*. As shown in (56), this ends up yielding the strongest of the presuppositions of $Unaware_s\ p$ and $Unaware_s\ (p \& s)$, hence a presupposition that John punished his son by slapping him; while this also yields the strongest of the two assertive components, and hence (since the assertive component is negative) an assertion that Sam doesn't believe that John punished his son – irrespective of whether this was by slapping him or by other means.

(56) a. Sam is unaware that John SLAP punished his son.
a'. Unaware_s Sp
b. (a') is true iff $Unaware_s\ p$ and $Unaware_s\ (p \& s)$ are both true,
iff it is presupposed that p, and s doesn't believe that p, and it is presupposed that (p & s), and s doesn't believe that (p & s)
iff it is presupposed that p and e, and s doesn't believe that p.

Importantly, we do not derive in this way the somewhat questionable inference that Sam believes that if John punished his son, he did so by slapping him (or more precisely: Sam believes that John didn't punish his son, or that he did so by slapping him).

This initial success of the Basic Supervaluationist Account extends to other non-monotonic environments such as *exactly one*, as shown in (57).

(57) a. Exactly one of these 10 guys SLAP punished his son.
a'. [=1 g] Sp
b. (a') is true and felicitous iff *[=1 g] p* and *[=1 g] (p & s)* are both true and felicitous. It follows that exactly one guy punished his son, and furthermore he did so by pulling his ear.

This result can be compared to the stronger inference we obtained in our presuppositional approach in (44). As will be recalled, we had derived two relevant inferences:
–relative to the Context Set, if any of the 10 guys punishes his son, he does so by slapping him.
–relative to the (more specific) speaker's beliefs, exactly one of the 10 guys punished his son; by the first inference, he did so by slapping him.
The supervaluationist approach has the apparent advantage of not generating a conditional presupposition about the 9 guys who didn't punish their sons.

Several supervaluationist treatments are discussed in greater detail in Appendix III. As we explain there, the Basic Supervaluationist Account suffers from two deficiencies.

(i) First, it predicts no gestural inference at all in downward-monotonic environments (unless the gesture is embedded under a presupposition trigger, as was the case above with *be unaware*). The reason is that in such cases the version of the sentence with the gestural enrichment is *weaker* than the one without it, and thus conjoining the two yields the same result as if there had been no gestural enrichment in the first place. For instance, for *None of these 10 guys SLAP punished his son,* we obtain in essence the conjunction of *None of these 10 guys punished his son,* and *None of these 10 guys punished his son by slapping him* – which is equivalent to the first conjunct.

In Appendix III, we consider a more complex Mixed Supervaluationist Account, which combines mechanisms of the Basic Supervaluationist Account and of our cosuppositional analysis, as stated in (58).

(58) **Mixed Supervaluationist Account**
A co-speech gesture
(i) is treated in terms of the Basic Supervaluationist Account in (55)...
(b) ... unless this fails to strengthen the meaning, in which case it is treated as a cosupposition (as outlined in Section 3).

The resulting theory combines many of the advantages of the supervaluationist and of the cosuppositional theory – but is it conceptually odd.

(ii) Still, there are further problems with both versions of the Supervaluationist Account. As we discuss in Appendix III, it predicts odd inferences under expressions such as *an odd number of*, or *between 3 and 5*. Consider for instance the sentence *Between 3 and 5 guys SLAP punished their son*. In essence, the Basic Supervaluationist Account treats this as a the conjunction of *Between 3 and 5 guys punished their son,* and *Between 3 and 5 guys punished their son by slapping him*. This turns out to be true in case exactly 5 guys punished their son, and exactly 3 guys punished their son by slapping him – which seems to us to be a counterintuitive result. We believe the desired inference is closer to: *Between 3 and 5 punished their son, and those that did slapped him*. The latter inference is correctly obtained within the cosuppositional approach of Section 3.

We also discuss in Appendix III a stronger ('pointwise') supervaluationist account, which solves some of these problems (with *an odd number*) but not others (with *between 3 and 5)*. It still has the drawback of predicting no gestural enrichment in downward-monotonic environment, and thus it too must be transformed into a 'mixed theory' in which in these cases the cosuppositional approach is adopted. Further variants are discussed in Appendix III.

4.2 Gestures as Supplements?

4.2.1 Supplementary analyses of co-speech gestures

Ebert and Ebert 2014 suggested that co-speech gestures should be analyzed as supplements. As we will see in Section 4.2.2, some speech-accompanying gestures do indeed display a supplementary behavior, but in the cases we have studied this happens if they are *post*-speech gestures, i.e. if they come *after* the expressions they modify. If they co-occur *with* them, we obtain the behavior that was described above. And *that* behavior cannot be easily accounted for in terms of supplements. The point is made in Schlenker 2014 by focusing on negative environments in which supplements are degraded – but in which co-speech gestures appear rather freely, as seen in (59)-(60).

(59) a. It's unlikely that the next speaker will bring LARGE_  [a bottle of beer] to his talk.
=>? if the session chairman brings a bottle of beer, it will be a large one

b. #It's unlikely that the next speaker will bring a bottle of beer, which is LARGE_  this large.
(Schlenker 2014)

(60) a. No philosopher brought LARGE_  [a bottle of beer] to the workshop.
=>? when a philosopher brings a bottle of beer, it is usually a large one

b. #No philosopher brought a bottle of beer, which is LARGE_  this large.
(Schlenker 2014)

As mentioned in Schlenker 2014, a supplementary approach could deal with (59)a-(60)a by taking the gestures to behave like the appositives in (59)b-(60)b, but with *which would be* replacing *which is*. On the assumption that the resulting sentence is more acceptable, one would still need to ask why such an option should be available – and importantly why it *fails* to be available in the case of post-speech gestures, to which we now turn.

4.2.2 Post-speech gestures as supplements

As announced, we believe that unlike co-speech gestures, post-speech gestures have the status of supplements. Thus to our ear (and eye), there is a sharp acceptability contrast between (61)a and (61)b, which mirrors that between (62)a and (62)b.

(61) a. A philosopher brought a bottle of beer – LARGE_ 
=> a philosopher brought a bottle of beer, and it was a large bottle.

b. ??No philosopher brought a bottle of beer – LARGE_ 

(62) a. A philosopher brought a bottle of beer, which was LARGE_  this large.
=> a philosopher brought a bottle of beer, and it was a large bottle.

b. ??No philosopher brought a bottle of beer, which was LARGE_  this large.

We submit that gestures can receive a supplementary reading when they are post-posed rather than simultaneous with the expressions they modify (see Pasternak 2014 for further discussion). Importantly, if one wishes to account for (59)a-(60)a within a supplemental analysis by positing the presence of a covert counterfactual mood, one would have to explain why the same strategy cannot be applied to (61)b and (62)b as well – which would incorrectly predict that these sentences should be (somewhat) acceptable).

Similar conclusions about post-speech gestures can arguably be obtained on the basis of facial expressions. (63)a is an example we already discussed to highlight the presuppositional effect of facial expressions co-occurring with a predicate under the quantifier *no*. In (63)b, the same facial expression is post-posed. We believe this yields several readings, which can be paraphrased with different supplements, depending on the size of the constituent that the post-speech gesture modifies.

(63) a. None of my friends goes :-([skiing with his parents]
=> for each of my friends, skiing with his parents wouldn't be fun
b. None of my friends goes skiing with his parents – :-(.
c. None of my friends goes skiing with his parents,
(i) which is sad [i.e. it is sad that none of my friends goes skiing with his parents];
(ii) which is unpleasant [i.e. it is generally unpleasant to go skiing with one's parents].

4.2.3 Alternative analyses of post-speech gestures

At this point our discussion shows that a distinction must be posited between co-speech and post-speech gestures, and that the latter can be analyzed within a supplemental account. But alternative theories could be explored. In particular, one could grant that post-speech gestures share with appositive relative clauses the property of containing an anaphoric element that must be resolved (in standard appositive relative clauses, this anaphoric element the relative pronoun , which has been argued to display the semantics of an E-type element, e.g. in Del Gobbo 2003). But from this assumption it need not follow that post-speech gestures have the semantics of supplements. In particular, one could argue instead (i) that they make a standard at-issue contribution; or (ii) that they have a cosuppositional semantics. We discuss each theory in turn.

First, could post-posed gestures have an at-issue semantics? If so, they should be able to take scope under operators. The deviance of (61) already suggests that under the negative quantifier *No NP* is impossible. But one could argue that the post-speech gesture is in this case attached 'too high' to be in the scope of the quantifier, possibly because it can only be conjoined to full-fledged clauses. It is thus useful to consider the paradigm in (64). The question is whether (64)a resembles (64)c-d rather than (64)b in triggering an inference that *if John punishes his daughter, slapping will be involved*.

(64) a. If John punishes his daughter – SLAP, she'lls scream.
=>? if John punishes his son, slapping will be involved
b. If John punishes his daughter by slapping her, she'll scream.
≠> if John punishes his son, slapping will be involved
c. If John punishes his daughter, which would involve some slapping, she'll scream.
=> if John punishes his daughter, slapping will be involved
d. If John punishes his daughter (this would involve some slapping), she'll scream.
=> if John punishes his daughter, slapping will be involved

Although the judgments would need to be investigated more thoroughly, it would seem that the post-speech gesture in (64)a takes scope under *if* much less easily than the post-posed modifier in (64)b,

although possibly a bit more easily than the appositive relative clause and parenthetical in (64)c-d. We take this to suggest that post-posed gestures do not have an at-issue semantics.

An alternative was suggested by Manfred Krifka (p.c.), and independently by Rob Pasternak (p.c.). Krifka's proposal is that post-speech gestures have a cosuppositional semantics, but come with an anaphoric element that must be resolved – hence the deviance of (61)b. The behavior of (64)a can now be explained in terms of properties of presupposition projection. Focusing on (64)a, we can take the post-speech gesture *SLAP* modifying *punish* to trigger a cosupposition of the form *punish(e) => slap(e),* where *e* is an event variable. We can take its denotation to be resolved in the same way as that of the pronoun *this* in (64)d, which certainly makes reference to punishments satisfying the antecedent of the conditional. The cosupposition will then yield the inference that such events involve slapping, as is desired.

In order to compare this cosuppositional analysis of post-speech gestures to the supplemental analysis, we would need to be a bit more precise about the semantics and pragmatics of supplements. Some analysts take them, following Potts 2005, to be radically different from presupposition triggers in that supplements fail to interact scopally with logical operators. By contrast, Schlenker 2010c, 2013 takes supplements to give rise to *bona fide* projection phenomena reminiscent of presuppositions, but with one important proviso: syntactically, appositive relative clauses tend to attach high, with the result that it is only in the rare cases in which they are in the scope of logical operators that supplement projection can be observed. Due to this potential similarity between supplement projection and presupposition projection, more research would be needed to compare the cosuppositional and the supplemental analysis of post-speech gestures.[15] Still, it should be mentioned that one further property distinguishes presuppositions from supplements: as emphasized by Potts 2005, the latter but not the former come with a requirement that they should be non-trivial, as shown by (65).

(65) Lance Armstrong survived cancer. #When reporters interview Lance, a cancer survivor / who survived cancer, he often talks about the disease. (after Potts 2005)

In that respect, it would seem that post-speech gestures pattern with supplements rather with presuppositions. Consider (66)a, which has a post-speech gesture following a modifier, namely *like SLAP this*, which already provides the same information. Our impression is that if the two gestures are realized identically, the result is rather sharply deviant.

(66) a. #John punished his son like SLAP_  this – SLAP_  .

b. ? John SLAP_  punished his son – SLAP_  .

Facts are more subtle in (66)b, where the first occurrence of *SLAP* contributes cosuppositional rather than assertive information. Our impression is that the post-speech gesture can be made acceptable if it is realized differently from the first gesture – in which case the first occurrence seems to us to make clear *that* the punishment was a slapping, whereas the post-speech gesture more concretely demonstrates *how* the slapping was realized. If so, we will of course have to refine our understanding of the precise contribution of co- and post-speech gestures (in order to understand why the post-speech gesture has a more precise demonstrative contribution), but our point will remain that post-speech gestures obey a version of Potts's non-triviality condition. This would go against a cosuppositional analysis of post-speech gestures, since cosuppositions are species of presuppositions, and thus should not be subject to a non-triviality condition.

Still, this argument wouldn't be complete without an assessment of the non-triviality condition for *co*-speech gestures. As it stands, our cosuppositional theory predicts that in this case violations of non-triviality could be acceptable. But judgments on (67)a do not bear this out, or at least not clearly: speakers we have consulted find the version with two occurrences of the same co-speech gesture redundant. The relevant point of comparison is (67)b, which is predicted to be deviant because the appositive contributes no information; in this case the prediction seem to be correct.[16]

[15] Schlenker 2010b, 2013 argues that in some limited cases an appositive relative clause may take scope under an operator – notably when the appositive contains a tense or mood which must be licensed by the operator in question. The availability of such 'low scope' readings with post-speech gestures remains to be investigated. A closer analysis of examples such as (64)a would be of direct relevance. In this connection, Pasternak (p.c.) suggests that this example might have a 'locally accommodated' reading, which could be explained if the post-posed gesture triggers a (weak) cosupposition. An alternative is that this is in fact a supplement with a low reading.

[16] J. Kuhn (p.c.) notes that if one uses an insistent intonation that makes it clear that the repetition is intentional, the sentence becomes acceptable.

(67) Yesterday John bought (i) LARGE_  [a bottle of beer]. / (ii) a bottle of beer, which was LARGE_  this large. I thought he'd drink it over dinner last night. But this morning, he brought

a. (#) LARGE_  [his bottle of beer] to the workshop!

b. (#) his bottle of beer, which was LARGE_  this large, to the workshop!

More detailed work would be needed to compare judgments on (67)a and on (67)b. But we should be open to the possibility that some non-redundancy condition should in the end be added to the analysis of gestural cosuppositions – which would at a minimum require a refinement of the present theory.[17]

5 Conclusion

We have suggested that a very simple analysis can account for complex patterns of 'gesture projection'. There were two parts to our proposal. Our main hypothesis was that the content of a co-speech gesture should be entailed by the 'contextual meaning' of the expression it modifies – in effect, the intuition was that a co-speech gesture serves to illustrate (and thus make more precise) the meaning of the expression if modifies. The second part consisted in a completely standard explication of 'contextual meaning' as the meaning that an expression has relative to its local context, as defined in dynamic semantics (Heim 1983) or in reconstructions of it (Schlenker 2009). Putting both parts together, we arrived at a cosuppositional analysis in which the content of a co-speech gesture is presupposed to follow from the content of the expression it modifies, and interacts with the logical structure of a sentence by way of local context computation.[18] We saw that these cosuppositions are often easy to accommodate locally as well as globally, which of course raises the question why this should be so – a question we leave for future research.[19]

We argued against a supervaluationist alternative to our analysis, although we do not claim to have exhausted the space of possible supervaluationist theories. On the other hand, we did not so much *refute* the supplemental analysis of Ebert and Ebert 2014 as *displace* it: we argued that it is not correct for co-speech gestures, but might well capture essential properties of post-speech gestures. If this typology is on the right track, one should of course ask how the same primitive objects – speech-accompanying gestures – can have a cosuppositional behavior in some cases and a supplementary behavior in others. Thus the analysis of gestures leads to new questions about some foundational issues in semantics – in particular about the connection between presuppositions and supplements.[20]

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[17] An interesting point of comparison can be found in 'redundant' modifiers in the scope of a definite description, as in (i)a and (i)c:

(i) a. ??John's blond father has arrived
b. John's blond brother has arrived.
c. John's idiotic father has arrived. (Schlenker 2005)

Like co-speech gestures on the cosuppositional analysis, these redundant modifiers make a purely presuppositional contribution at the clausal level, and they can be removed without affecting the grammaticality of the relevant clause. They arguably come with a requirement that they should be non-trivial, or at least remind the addressee of relevant information (see Schlenker 2005, 2007a for further data, and for a mechanism that guarantees that the relevant presuppositions end up being informative; see also Leffel 2014 for a discussion of related examples). When this is not the case, as in (i)a, these modifiers are deviant. These facts could be used to argue on Gricean grounds that separable elements that make a purely presuppositional contribution should still be informative in some way (or else they would violate a maxim of brevity). But the issue is complex, since anaphoric presupposition triggers such as *too* and *again* would also seem to make a purely presuppositional contribution, and yet they do not come with a non-triviality requirement. Furthermore, a principled analysis will have to be embedded in a theory of alternatives and implicatures which takes into account presuppositions – not a trivial matter (but see Katzir 2007).

[18] See Schlenker 2015d for an alternative derivation of the formal behavior of cosuppositions within the 'Transparency Theory' developed in Schlenker 2008a. This alternative leads one to expect that non-gestural expressions could also trigger cosuppositions, a prediction that has yet to be appropriately tested.

[19] As announced in fn. 4, Rob Pasternak (p.c.) remarked that for gestural cosuppositions as well as for weak presupposition triggers, contrastive focus makes it particularly easy to obtain readings with local accommodation (see Simons et al., to appear, for related remarks). A comparative analysis of weak triggers and gestural cosuppositions (and of the role of focus) would thus be particularly interesting.

[20] This dual behavior is surprising if presuppositions and supplements are entirely distinct semantic phenomena. On the other hand, this dual behavior is less surprising if presuppositions and supplements have a common core,

Finally, the analysis of the semantics of co-speech gestures matters for a broader debate about the expressive power of spoken and sign language. Due to the presence of a rich iconic component at the logical core of sign language, some researchers have argued that the latter is in some respects more expressive than spoken language (e.g. Schlenker et al. 2013, Schlenker 2015b). Others have countered that both sign and spoken language have a gestural component, and that some instances of iconicity in sign language should really be compared to co-speech gestures in sign language (Davidson, to appear; Goldin-Meadow and Brentari 2015). The present piece indirectly contributes to this debate by sharpening our understanding of the 'co-speech gesture' side of the comparison – and by suggesting that co-speech gestures often have a presuppositional/cosuppositional status. Importantly, although the iconic effects in sign language discussed in Schlenker et al. 2013 were presuppositional in nature, many others are assertive (Schlenker 2015b).

Schlenker, to appear tentatively proposes that there is a principled reason for this difference. Briefly, the idea is that an iconic enrichment of an expression that comes from a different sign ('allosematic enrichment') always starts out as non-assertive, whereas an iconic enrichment of an expression obtained by modulating that very expression ('autosematic enrichment') can have any status. Many iconic effects in sign language are autosematic, as it is easy to modulate signs in rich iconic ways; they may thus be assertive. But by their very nature, co- and post-speech gestures are always allosematic, and thus one might expect that they are never assertive.[21] A systematic comparative investigation would be needed to confirm or refute this potential generalization.

In sum, we hope to have shown (following Ebert and Ebert's (2014) lead) that gesture projection offers a fertile ground for formal semantics and pragmatics, with a non-trivial interaction between gestural enrichments and logical operators, and an interesting role played by timing considerations. On a *theoretical level*, the cosuppositional analysis of co-speech gestures and the supplemental analysis of post-speech gestures further enriches the typology of 'projective content' (see Tonhauser et al. 2013) – and highlights the need for theoretical attempts to derive it on principled grounds. Besides its specific intrinsic interest for semantics and pragmatics, gesture projection also

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as argued in Schlenker 2010b, 2013. In that framework, presuppositions must be trivial or 'transparent' in their local context (as is also the case in dynamic semantics). Supplements should not be trivial (as emphasized by Potts 2005), but they should be 'translucent', in the sense that it should be easy to add to the context of the conversation uncontroversial assumptions that would make them trivial in their local context. The underlying intuition is that material that is 'syntactically parasitic' should also be 'semantically parasitic'. An appositive is *syntactically parasitic* on the rest of the sentence because it is attached into fully-formed syntactic constituents, and could be omitted without leading to ill-formedness. It is also *semantically parasitic*, in the sense that its informational contribution is less important than that of the rest of the sentence. Still, an appositive occupies a dedicated time slot, and for this reason it should not make an entirely trivial contribution, or else considerations of brevity should exclude it; this explains the non-triviality requirement on supplements. These ideas could be extended to the analysis of gestural enrichments. Co-speech gestures are syntactically parasitic on the expressions they modify, since they come from a different modality and could thus be omitted without yielding ill-formedness. Furthermore, nothing in their timing requires that they should be non-trivial since they do not occupy a separate time slot. Post-speech gestures are also syntactically parasitic, but unlike co-speech gestures they have their own time slot and thus should obey a non-triviality requirement, just like appositives. (Of course the analysis would have to change a bit if there is in the end some kind of non-triviality requirement on cosuppositions, as mentioned at the end of Section 4.2.3. In addition, as noted in fn. 17, anaphoric triggers such as *too* and *again* have their own time slot but do not come with a requirement of non-triviality, which complicates the picture.)

[21] Schlenker, to appear tentatively argues that cosuppositions can be triggered in sign language when allosematic enrichments are used. In addition, supplementary-like inferences can arguably be triggered with post-speech gestures. Both points are illustrated with the preliminary data in (i) (data elicited in work with Jonathan Lamberton using the 'playback method', described for instance in Schlenker et al. 2013).

(i) a. [7] BABY-a IX-arc-a NONE LOOK-a SELF-CL-a.
'No baby looks at itself.'
b. [7] BABY-a IX-arc-a NONE LOOK-a SELF-CL-a - :-(
=> it's disgusting that no baby looks at itself
c. [7] BABY-a IX-arc-a :-([NONE LOOK-a SELF-CL-a]
=> it's disgusting that no baby looks at itself
d. [5]BABY-a IX-arc-a NONE **:-(**[LOOK-a SELF-CL-a]
=> it would be disgusting for babies to look at themselves
(ASL, 33, 0544, 2 trials)

(i)a is the baseline, assessed for acceptability on a 7-point scale, with 7 = best. (i)b adds to (i)a a disgusted post-speech facial expression, transcribed as *:-(* . It can be seen to target the entire proposition, hence the inference that it is disgusting that no baby looks at itself. (i)c and (i)d involve co-speech facial expressions, which target either the quantified sentence (for (i)c) or just the complex predicate (for (i)d). While the latter is somewhat degraded, it does give rise to an inference that is characteristic of cosuppositions embedded under *none*, namely the universal inference that for any baby it would be disgusting to look at itself.

has an important role to play in the comparison between the expressive possibilities of spoken and sign languages. On an *empirical level*, the data we explored could fruitfully be investigated with experimental means in the future – especially in cases that are unclear or controversial. In addition, it is likely that the typology of projective behaviors we sketched in this piece will be refined and enriched in the future, especially when further types of gestural enrichments are taken into account.

Appendix I. Local Contexts (Schlenker 2009, 2010)[22]

❑ *Fragment*

The reconstruction of local contexts proposed in Schlenker 2009, 2010 is defined for a fragment that includes propositional connectives, unary predicates and generalized quantifiers.

(68) **Syntax**
-Generalized Quantifiers: Q ::= Q_i
-Predicates: P ::= P_i | $\underline{P}_i P_k$ (Type: <s, <e, t>>)
-Propositions: p ::= p_i | $\underline{p}_i p_k$ (Type: <s, t>)
-Formulas F ::= p | (not F) | (F and F) | (F or F) | (if F. F) | (Q_i P . P)

(69) **Classical Semantics**
w |= p iff $\mathbf{p}^w = 1$
w |= $\underline{p}p'$ iff $\mathbf{p}^w = \mathbf{p'}^w = 1$
w |= (not F) iff w |≠ F
w |= (F and G) iff w |= F and w |= G
w |= (F or G) iff w |= F or w |= G
w |= (if F. G) iff w |≠ F or w |= G
w |= (Q_i<$\underline{P}$>P'.<$\underline{Q}$>Q') iff $f_i(a_w, b_w)=1$ with a_w={d∈D: <$\mathbf{P}^w$(d) = 1 and> $\mathbf{P'}^w$(d) = 1 and (<$\mathbf{Q}^w$(d) = 0 or> $\mathbf{Q'}^w$(d) = 0)}, b_w={d∈D: <$\mathbf{P}^w$(d) = 1 and> $\mathbf{P'}^w$(d) = 1 and <$\mathbf{Q}^w$(d) = 1 and> $\mathbf{Q'}^w$(d) = 1}

The following dynamic semantics corresponds to Heim's analysis (Heim 1983), except that (i) it applies to all generalized quantifiers, (ii) it does not include variables, (iii) it applies to disjunction, which Heim does not discuss (here we follow Beaver 2001).

(70) **Dynamic Semantics**
C[p] = {w ∈ C: $\mathbf{p}^w = 1$}
C[$\underline{p}p'$] = # iff for some w ∈ C, $\mathbf{p}^w = 0$; if ≠ #, C[$\underline{p}p'$] = {w ∈ C: $\mathbf{p'}^w = 1$}
C[(not F)] = # iff C[F] = #; if ≠ #, C[(not F)] = C - C[F]
C[(F and G)] = # iff C[F] = # or (C[F] ≠ # and C[F][G] = #); if ≠ #, C[(F and G)] = C[F][G]
C[(F or G)] = # iff C[F] = # or (C[F] ≠ # and C[not F][G] = #); if ≠ #, C[(F or G)] = C[F] ∪ C[not F][G]
C[(if F. G)] = # iff C[F] = # or (C[F] ≠ # and C[F][G] = #); if ≠ #, C[(if F.G)] = C-C[F][not G]
C[(Q_i <$\underline{P}$>P'.<$\underline{R}$>R')] = # iff <for some w ∈ C, for some d ∈ D, $\mathbf{P}^w$(d) = 0> or <for some w ∈ C, for some d ∈ D, <$\mathbf{P}^w$(d) = 1 and> $\mathbf{P'}^w$(d) = 1 and $\mathbf{R}^w$(d) = 0>. If ≠ #, C[(Q_i<P>P'.<R>R')] = {w ∈ C: $f_i(a^w, b^w) = 1$} with a^w = {d ∈ D: $\mathbf{P'}^w$(d) = 1 and $\mathbf{R'}^w$(d) = 0}, b^w = {d ∈ D: $\mathbf{P'}^w$(d) = 1 and $\mathbf{R'}^w$(d) = 1}

❑ *Local contexts and presupposition satisfaction*

Local contexts are then defined as follows for the fragment in (68) with the classical semantics in(69):

(71) **Local Contexts**
The local context of an expression *d* of propositional or predicative type which occurs in a syntactic environment *a* _ *b* in a context C is the strongest proposition or property x which guarantees that for any expression *d'* of the same type as *d*, for all strings *b'* for which *a d' b'* is a well-formed sentence,

$C \models^{c' \to x}$ a (c' and d') b' ⇔ a d' b'

(If no strongest proposition or property x with the desired characteristics exists, the local context of *d* does not exist[23]).

Presupposition satisfaction is then defined by reference to local contexts:

(72) **Presupposition Satisfaction**
An elementary presuppositional expression *E* is acceptable in a sentence *S* uttered in a context C just in case the presupposition of *E* is entailed by the local context of *E* (if it exists).

❑ *Relation to dynamic semantics*

Schlenker 2009 proves some general results about the relation between this reconstruction of local contexts and a Heimian dynamic semantics in which generalized quantifiers trigger universal presuppositions (see Schlenker 2009 Section 2.4. and Appendix A; these, in turn, build on technical results of Schlenker 2007b)

[22] This Appendix borrows from Schlenker 2009 and Schlenker 2010 (especially Section 2.4. of Schlenker 2009).
[23] See Schlenker 2009 for a discussion of the case in which local contexts do not exist.

In the propositional case, we obtain full equivalence with the system outlined in Heim 1983, enriched with the asymmetric dynamic disjunction of Beaver 2001. Specifically, it can be shown that for any propositional formula *F* and for any Context Set C, the local contexts as we have defined them always exist. Furthermore, if we write as C[F] the Heimian update of C with *F*, C[F] ≠ # just in case for each presupposition trigger of the form *d* that occurs in *F*, *d* is entailed by its local context as reconstructed here (we write this as *Sat(C, F)*; *lc(C, d', a_b)* refers to the local context of *d'* in the sentence *a d' b*, as obtained by (71)). This result is summarized in (73).

(73) Let C ⊆ W be a context set and let *F* be a propositional formula. Then:
(i) for all expressions *a, b, d'* , if F = a d' b, lc(C, d', a_b) ≠ #. Furthermore,
(ii) Sat(C, F) iff C[F] ≠ #.

In the quantificational case, things are more complicated. In a nutshell, when all the relevant local contexts exist, (73) also holds for all generalized quantifiers that can be defined by way of the 'tree of numbers', but only when two technical conditions are met:
-*Non-Triviality:* quantificational clauses should not be 'trivial', i.e. replaceable with a tautology or a contradiction – as stated in

(74) **Non-Triviality**
Let C be a Context Set and let *F* be a formula. <C, F> satisfies Non-Triviality just in case for any initial string of the form αA, where *A* is a quantificational clause (i.e. a formula of the form $(Q_i G. H)$), there is a sentence completion β such that:
C ⊭ α A β ⇔ α T β
C ⊭ α A β ⇔ α F β
where *T* is a tautology and *F* is a contradiction.

-*Constancy:* the domain of individuals should be finite, and in addition restrictors should hold true of a constant number of individuals throughout the context set, as is stated in (75).

(75) **Constancy**
Let C be a Context Set and let *F* be a formula. <C, F> satisfies Constancy if each restrictor that appears in *F* holds of the same number of individuals throughout the world of C (in other words, the size of its extension is constant throughout C).

(In case local contexts fail to exist, a modified version of the approach of Schlenker 2009 guarantees full equivalence with Heim's result when Non-Triviality and Constancy are satisfied; see C.19 in Appendix C of Schlenker 2009.)

Note that an extension of the theory must be countenanced to compute the local context of expressions embedded under attitude reports, as is discussed in Appendix II.

❑ *Two versions of cosuppositions*

In (39), we explained that (a) in a Heimian dynamic semantics … *[e => g]e* … and … *[e & g]* … generate the same presuppositions, and (b) the result extends to the *propositional* version of the system of Schlenker 2009 due to the presuppositional equivalence with a Heimian dynamic semantics (as in the main text, we use *&* to abbreviate *and*). In the quantificational case, the fragment in (68) does not make it possible to define expressions *[a & e]* when *a* or *e* are predicative expressions or contain variables (since this fragment has no variables, and also has no complex predicates).

Still, one can ask what would happen if we extended the framework of Schlenker 2009 to this more complex case. Rather than doing things in two steps by computing a local context and checking that it satisfies a presupposition, we will use the equivalent formulation of the 'Transparency Theory' of Schlenker 2008 (the two formulations are equivalent when local contexts exist; see Schlenker 2009, Appendix C, C. 21).

(76) **Principle of Transparency (after Schlenker 2007b, 2008)**
A predicative or propositional presupposition trigger *d** which occurs in a syntactic environment *a _ b* is infelicitous unless for every *d'* of the same type as *d*, for every string *b'* for which *a d' b'* is a well-formed sentence,
C ⊨ a (d & d') b' ⇔ a d' b'

We show that in extensions of the fragment of Schlenker 2007b, 2008, 2009 which countenance complex predicates, (i) if the sentence *a (e⇒g)e* b* satisfies (76) (with non-presuppositional *a* and *b*), then this is also the case of the sentence *a (e & g) b*, but (ii) in general the converse does not hold, even when Non-Trivality and Constancy are satisfied.
(i) Let us prove the first result.

(77) If *a (e⇒g)e* b* satisfies (76) (with non-presuppositional *a* and *b*), then this is also the case of the sentence *a (e & g) b*

Proof: By assumption, for each *c'* of the same type as *g* (as well as *e* and *e**), for each acceptable sentence completion *b'*, the following holds:

(78) C |= a ((e⇒g) & c') b' ⇔ a c' b'

Now for every *c"* of the same type as *g*, take *c' = (e & c")* and derive from (77) that for each acceptable sentence completion *b'*,

C |= a ((e ⇒g) & (e & c")) b' ⇔ a (e & c") b', hence
C |= a (e & (g & c")) b' ⇔ a (e & c") b'

This shows that *a (e & g) b* satisfies (76).

(ii) Let us turn to the second result.

(79) In general, the converse of (77) does not hold, even under the hypotheses of Non-Triviality and Constancy: there are cases in which *a (e & g) b* satisfies (76) but *a (e⇒g)e* b* does not.

Counterexample: Consider the sentence *(Q T. (e & g))*, where *Q* is a generalized quantifier meaning *at most k,* with k ≥ 1, and *T* is a tautological predicate (so that *Q T* means *at most k objects*). To simplify notations, boldfaced expressions refer to the semantic values of these expressions.

(80) **Partial specification of a model**
a. Worlds: {w, w'}
b. Domain of objects: D, with k+1 ≤ |D| ≤ 2k
b. |**e**(w)| = k
c. |**e**(w')| = 0

(76) applied to *(Q T. (e & g))* is given in (81), which is trivially true: both sides of the equivalence are true because both complex predicates hold of at most k objects, thus satisfying *Q T*.

(81) For al *c'* of the same type as *e*, C |= (Q T. (e & (g & c'))) ⇔ (Q T. (e & c'))

But (76) applied to *(Q T. ((e⇒g)e*))* as in (82)a will fail to hold in case *c'* is a tautologous predicate and *g* is, as before, a contradictory predicate. This is because (82)a is equivalent in this case to (82)b. The right-hand side is false because |D| ≥ k+1, but the left-hand side is true because there are |D|-k not-e objects, and |D| ≤ 2k, whence |D|-k ≤ k, with the result that *(not e)* satisfies *Q T*.

(82) a. C |= (Q T. ((e⇒g) & c')) ⇔ (Q T . c')
b. C |= (Q T. (not e)) ⇔ (Q T . T)

It can also be checked that this counterexample is still compatible with the conditions of Non-Triviality and Constancy (defined in (74) and (75) above), under which Schlenker 2007b proved for his quantificational fragment a complete equivalence between the Transparency theory and Heim 1983. Our target formula is *(Q T. ((e⇒g)e*))* (interpreted in a bivalent system), where we take *g* to be a contradictory predicate (as before) and *e** to be a tautologous predicate, with the result that *(Q T. ((e⇒g)e*))* is equivalent to *(Q T. (not e))*. With *e* defined as in (80), *(Q T. (not e))* has different values in w and w', which shows that Non-Trivality as defined in (74) is satisfied.

Importantly, this result does not extend to the quantifier *No*. In fact, Transparency predicts the same presuppositions for *(No P . (e & g))* and for *(No P. ((e⇒g)e*))*, as shown in (83)

(83) **Transparency predicts the same presuppositions for *(No P. ((e⇒g)e*)) and (No P . (e & g))***
a. (77) shows that if *(No P. ((e⇒g)e*))* and C satisfy (76), so do *(No P . (e & g))* and C.
b. Suppose, for contradiction, that *(No P . (e & g))* and C satisfy (76) but *(No P. ((e⇒g)e*))* and C don't. So we have:
(i) for all *c'* of the same type as *e*, C |= (No P. (e & (g & c'))) ⇔ (No P. (e & c'))
(ii) for some *c'* of the same type as *e,* for some w in C, w |≠ (No P. ((e⇒g) & c')) ⇔ (No P . c'), hence since the right-to-left direction of th equivalence is always true,
(iii) w |= (No P. ((e⇒g) & c')) but
(iv) w |≠ (No P . c')
If in w no P-object satisfies *e* and *c'*, then for every P-object d either *c'* is false of d, in which case *((e⇒g) & c'))* is as well; or *c'* is true of d, in which case *e* is false of d, and *((e⇒g) & c'))* is true of d. In other words, relative to P-objects *((e⇒g) & c'))* and *c'* should have the very same extension, which contradicts (iii)-(iv). Hence
(v) w |≠ (No P. (e & c')).
But if in w some P-object satisfies *e* and *g* and *c',* (iii) would be refuted, hence

(vi) w |= (No P. (e & (g & c')))
(v) and (vi) show that *(No P . (e & g))* and C don't satisfy (76), *contra* hypothesis.

One last remark is in order. If the equivalence between Transparency and a Heimian system extended, subject to Non-Triviality and Constancy, to a fragment with complex predicates or propositions with variables bound by quantifiers, then we would expect *a (e⇒g)e* b* and *a (e & g) b* to yield the same presuppositions, contrary to fact. Thus Non-Triviality and Constancy are insufficient to guarantee an equivalence between Transparency and a Heimian system.[24]

[24] It should be noted that our counterexample was based on a violation of a more subtle version of Non-Triviality, since in *(Q T. (e & g))* the restrictor was trivial, and more importantly *g* couldn't affect the truth-conditions, which were already guaranteed to be satisfied in view of the beginning of the formula (since *e* had such a small extension that *(e & d')* was guaranteed to satisfy the quantifier *Q T* for any *d'*). Thus one could ask whether strengthenings of Non-Triviality could yield a presuppositional equivalence between *a (e⇒g)e* b* and *a (e & g) b*.

Appendix II. Computing the local context of the embedded clause under factive verbs

We assume the general framework of Schlenker 2009, Section 3.1.2 ('Adding Belief Reports'), and in particular the device of double indexing (hence the double abstraction over *w** and over *w*), which is necessary to compute local contexts in intensional cases. As before, we write *lc(F)* to refer to the local context of an expression *F*, and we write **F** for the semantic value of an expression *F*.

Schlenker 2009 shows that for non-factive formulas such as *Believe_s F,* the value of the local context of the embedded clause is lc(F) = λw* λw (w* ∈ C and **w ∈ Dox$_s$(w*)**). *Modulo* some technical assumptions, we show that in the factive case the boldfaced formula must be replaced with the disjunction **(w ∈ Dox$_s$(w*) or w = w*)**, which guarantees that an expression entailed by the local context must hold in the actual world.

Notation: If w* is a world, we write w* ⊨ F just in case **F**(w*)(w*) = 1. If C is a set of worlds, we write C ⊨ F just in case for each world w* in C, w* ⊨ F.

(84) **Local context of *F* in *(Un)aware_s F***
Assume that *(Un)Aware_s F* is equivalent to *F & (not) Bel_s F,* where the *not* in parentheses is present for *Unaware* and absent for *Aware*.

Claim: lc(F) = λw* λw (w* ∈ C and (w ∈ Dox$_s$(w*) or w = w*))

By definition, lc(F) is the most restrictive c' of type <s, <s, t>> such that for all d'

C ⊨ (Un)Aware_s (c' & d') <=> (Un)Aware_s d', or in other words, or in other words

(E) C ⊨ [(c' & d') & (not) Bel_s (c' & d')] <=> [d' & (not) Bel_s d']

We need to show that (i) this value of lc(F) satisfies equivalence (E), and that (ii) no more restrictive value does.

(i) Clearly, equivalence (E) holds if c' denotes lc(F) as defined above.

(ii) Now suppose that for w* and w that satisfy (w* ∈ C and (w ∈ Dox$_s$(w*) or w = w*)), **c'**(w*)(w) = 0. We show that such a value for *c'* is overly restrictive, in the sense that it may fail to satisfy equivalence (E).

Aware

Take d' to be a tautology. In order to refute equivalence (E), we show that
a. w* ⊭ (c' and d') & Bel_s(c' & d')
but
b. w* ⊨ d' & Bel_s d'
b. is immediate since d' is a tautology.
a. follows by cases.
If **c'**(w*)(w*) = 0, w* ⊭ c' and the result is immediate.
If **c'**(w*)(w*) = 1, then for some for some w ∈ Dox$_s$(w*), **c'**(w*)(w) = 0, and thus w* ⊭ Bel_s (c' & d'), from which the result follows.

Unaware

Assumption: for each w* ∈ C, for some $w_s \neq w^*$, Dox$_s$(w*)(w_s) = 1.[25]

Case 1. **c'**(w*)(w*) = 0. Take d' to be defined by **d'**(w*) = {w*}. Since w* ⊭ c', we also have that
a. w* ⊭ (c' & d') & not Bel_s (c' & d'). However,
b. w* ⊨ d' & not Bel_s d', since **d'**(w*) = {w*} and Dox$_s$(w*)(w_s) = 1, whence w* ⊨ d' and w* ⊨ not Bel_s d'.

[25] This assumption is minimal, in the sense that if (i) below is satisfied, equivalence (E), taking the form in (ii), won't be refuted.

(i) for each w* ∈ C, for each w_s, Dox$_s$(w*)(w_s) = 1 => w_s = w*
(ii) C ⊨ [(c' & d') & not Bel_s (c' & d')] <=> [d' & not Bel_s d']

Assuming (i), both sides of (ii) will be false throughout C. For assume, for contradiction, that for some w* ∈ C, one of the two sides, of the form *F and not Bel_s F,* satisfies w* ⊨ F and not Bel_s F. This entails that w* ⊭ Bel_s F, hence by (i) **F**(w*)(w*) = 0 – but then w* ⊭ F, *contra* hypothesis.

Case 2. **c'**(w*)(w*) = 1, hence for some for some w ∈ Dox_s(w*), **c'**(w*)(w) = 0. Take d' to be a tautology. Then:
a. w* ⊨ (c' & d') & not Bel_s(c' & d') because **c'**(w*)(w*) = 1 and d' is a tautology, whence w* ⊨ (c' & d'); and w ∈ Dox_s(w*) and **c'**(w*)(w) = 0, whence w* ⊨ not Bel_s(c' & d'). However,
b. w* ⊭ d' & not Bel_s d' because d' is a tautology, whence w* ⊨ Bel_s d'.

Appendix III. More on Supervaluationist Accounts

This Appendix discusses in greater detail the supervaluationist accounts of co-speech gestures that were sketched in Section 4.1.

❑ *The cosuppositional approach predicts stronger inferences than the Basic Supervaluationist Account*

As we saw in Section 4.1, in cases of embedding under *unaware* and *exactly one*, the supervaluationist approach generates presuppositions that are weaker than those of the presuppositional approach. This is an entirely general fact: the supervaluationist approach predicts inferences that are entailed – sometimes asymmetrically entailed – by those derived by the presuppositional approach. To put it informally, the key is that the presuppositional approach derives conditions on the Context Set C that are so strong that that they guarantee that, relative to C, the sentence with the co-speech gesture is *equivalent* to the bare sentence without the co-speech gesture; as a result, if one of them is true, *both* are – and thus whenever the presuppositional condition is satisfied, so is the supervaluationist condition. This is explained in greater detail in (85).

(85) The presuppositional account predicts stronger inferences than the supervaluationist account
a. Suppose that a sentence … Ge … with a gesture *G* modifying an expression *e* is true and felicitous according to the presuppositional approach. Then it is true and felicitous according to the supervaluationist approach.

Proof: If … *Ge* … is felicitous in a Context Set C, then relative to the local context of e, e => g (if g is an expression with the same content as G). This guarantees that

C ⊨ … e … <=> … (e & g) …

If … *Ge* … is felicitous and true, then both … *e* … and … *(e & g)* … are felicitous and true, which shows that … *Ge* … is felicitous and true on the supervaluationist account.

b. There are cases in which the presuppositional account predicts stronger inferences than the supervaluationist account.
A case in point, pertaining to gestures embedded under *exactly one,* is given in (44) and (57)

An additional remark will be useful below. In our Basic Supervaluationist Account, we only required that two versions of the sentence be true, one with and one without the gestural enrichment. But one could investigate a supervaluationist approach that makes stronger predictions, and requires that a sentence … *Ge* … with a predicate *e* enriched by a gesture *G* with content *g* should be true on all the possible *point-wise* resolutions of the uncertainty about the presence of the enrichment *g*. In other words, we consider all the values of the predicate *e* obtained by requiring that arbitrary objects satisfying *e* also satisfy the gestural enrichment *g*. Technically, this amounts to a requirement that the original sentence … *Ge* … should be true just in case … *e* … is true on all interpretation on which *e* takes values within the set R(e, g) defined as in (86):

(86) $R(e, g) = \{[\lambda w \lambda x \,.\, \mathbf{e}(w)(x) = 1 \;\&\; \langle x, w\rangle \in F \Rightarrow \mathbf{g}(w)(x) = 1]:\; F \subseteq D \times W\}$

This yields a stronger requirement than our 'official' supervaluationist approach, since on the latter which we only require that … *e* … should be true when *e* takes the two values $\{\lambda w \lambda x \,.\, \mathbf{e}(w)(x) = 1$, $\lambda w \lambda x \,.\, \mathbf{e}(w)(x) = 1 \;\&\; \mathbf{g}(w)(x) = 1\}$; by contrast, the point-wise definition using (86) requires that the sentence should be true for many other values of the predicate.

❑ *The problem of downward-monotonic environments*

At this point, it might seem that the supervaluationist analysis has an advantage over the presuppositional one. But when we consider downward-monotonic environments, the situation changes. We saw that under the quantifier *no* one intuitively obtains a non-trivial conditional inference; thus for *None of these 10 guys SLAP punished his son,* we obtain the inference that for each of these 10 guys, if he had punished his son, he would have done so by slapping him. The presuppositional approach derives this result. But the supervaluationist approach derives nothing at all: the problem is that in downward-monotonic environments, the enriched version of the sentence is *weaker* than the original version, with the result that only the latter makes its truth-conditional effects felt.

(87) a. None of these 10 guys SLAP punished his son.
a'. [No g] Sp

b. (a') is true and felicitous iff *[No g] p* and *[No g](p and e)* are both true and felicitous, iff *[No g] p* is true and felicitous.

Importantly, the very same problem extends to the stronger supervaluationist account we considered at the end of the preceding section. In that approach, the sentence *[No g] Sp* is true just in case *[No g] p* under al interpretations on which *p* takes values within the set R(p, s) = {[λwλx . **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1]: F ⊆ D ×W}, since each of these values is at least as restrictive as the original value **p**; as a result, the truth conditions of *[No g] Sp* end up being the same as those of the bare sentence *[No g] p*.

❑ *A mixed approach*

We could try to fix the problem by combining the advantages of the supervaluationist and of the presuppositional approach, along the following lines:

(88) Mixed Supervaliationist Account: supervaluations and presuppositions
(i) One first tries to interpret a co-speech gesture according to a supervaluationist analysis.
(ii) However, if the result makes the co-speech gesture vacuous, we interpret it according to the presuppositional approach.

While this approach is obviously complicated, it has the possible advantage of predicting conditional presuppositions under the quantifier *no*, but not under non-monotonic quantifiers such as *exactly one*. Still, as we will now see, it suffers from further deficiencies.

❑ *Remaining problems for the supervaluationist accounts*

Even the mixed solution envisaged in (88) ('first try a supervaluationist analysis; and if this still makes the gesture vacuous, go for a presuppositional treatment') encounters problems. Consider the sentences in (89):

(89) a. An odd number of guys SLAP punished their son.
=> an odd number of guys punished their son, and they did so by slapping them
b. Three or five guys SLAP punished their son.
=> three or five guys punished their son, and they did so by slapping them

I believe we get a fairly strong inference that all the guys who punished their son did so by slapping him. But this is not predicted by the supervaluationist account, even in its mixed version. The predictions of our Basic Supervaluationist Account are laid out in (90) and (91).

(90) Predictions of the Basic Supervaluationist Account: *an odd number*
a. An odd number of guys SLAP punished their son.
a'. [Odd g] Sp
b. (a') is true iff *[Odd g] p* and *[Odd g] (p and s)* are both true.
Thus (a') is true in particular if exactly five guys punished their son, and exactly three guys punished their son by slapping him.

(91) Predictions of the Basic Supervaluationist Account: *three or five*
a. Three or five guys SLAP punished their son.
a'. [=3 or =5 g] Sp
b. (a') is true iff *[=3 or =5 g] p* and *[=3 or =5 g] (p and s)* are both true.
Thus (a') is true in particular if exactly five guys punished their son, and exactly three guys punished their son by slapping him.

In both cases, the Basic Supervaluationist Account predicts that the gesture is non-vacuous. To see this, notice that without the gesture, the sentences would end up meaning that *an odd number of guys punished their son* or that *three or five guys punished their son*. With the gesture, the Basic Supervaluationist Account imposes the additional requirement that *an odd number of guys punished their son by slapping him*, or that *three or five guys punished their son by slapping him* – a non-trivial condition that doesn't follow from the meaning of the bare sentence. So even the mixed theory predicts that we should stick to the supervaluationist analysis of these sentences. But the readings we obtain are too weak: we do not get the intuitively desirable inference that *all* the guys who punished their son did so by slapping him, as the supervaluationist truth conditions allow for the possibility that only a strict subset of the guys who punished their son did so by slapping him. In particular, as mentioned in (90) and (91), both sentences are predicted to be true if exactly five guys punished their son, and exactly three guys punished their son by slapping him – a dubious result. (We note for future reference that the same situation shows that a similar problem arises for the sentence *Between three and five of these guys SLAP punished their son*.)

❑ *Solution within the Point-wise Supervaluationist Account*

On our Point-wise Supervaluationist Account, the initial problem gets solved. Recall that on this approach *[Odd g] Sp* is true just in case *[Odd g] p* is true on all interpretations on which *p* takes values within the set: R(e, g) = {[λwλx . **e**(w)(x) = 1 & <x, w> ∈ F => **g**(w)(x) = 1]: F ⊆ D ×W}. Clearly, this interpretation is stronger than the bare sentence without a co-speech gesture, and thus it entails that an odd number of guys punished their son. Furthermore, relative to the Context Set it is equivalent to: *An odd number of guys punished their son, and all these guys did so by slapping them.* The argument is in two steps.

(i) Clearly, if an odd number of guys punished their son, and all did so by slapping him, the sentence will be true on the relevant supervaluationist analysis, because relative to the Context Set the underlined condition will be vacuous for all w, x for which **p**(w)(x) = 1.

(ii) To establish the converse, we show that if an odd number of guys punished their son in a world w* of the Context Set, and if at least one guy g* didn't do so by slapping him, then the target sentence will not be true on the relevant supervaluationist interpretation. To see this, take W' = {w*} and D' = {g*}. It is clear that if for w = w* an odd number of guys punished their son in w, then in w an even number of guys x satisfy the condition **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1 – since the underlined condition is vacuously satisfied by all guys except g*, and g* falsifies it.

Furthermore, on the Point-wise Supervaluationist Account, we still preserve the positive features of our analysis of embedding under *exactly one,* as shown in (92).

(92) a. Exactly one of these guys SLAP punished his son.
a'. [=1 g] Sp

b. Predictions of the Basic Supervaluationist Account
(a') is true and felicitous iff *[=1 g] p* and *[=1 g] (p & s)* are both true and felicitous. It follows that exactly one guy punished his son, and furthermore he did so by slapping them.

b'. Predictions of the Pointwise Supervaluationist Account
(a') is true iff *[=1 g] p* is true at a certain world w* on all interpretations on which *p* takes values within the set: R(p, s) = {[λwλx . **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1]: F ⊆ D×W}.
As in b., at a world w* this requires that exactlyl one guy g* punished his son, and g* did so by slapping him (if g* didn't punish his son by slapping him, by taking F = {w*} × {g*}, we could find an interpretation of *p* on which zero guy satisfies the interpretation of *p*).

Still, in cases the Pointwise Supervaluationist Account yields potentially unintuitive results – although judgments are somewhat subtle. In particular, in the case of the quantifier *between three and five of these guys*, we *fail* to derive the inference that all the guys who punished their son did to by slapping him (this problem does not arise for the sentence *Three or five of these guys SLAP punished their so* [26]). This is shown for both versions of the supervaluationist account in (93), symbolizing the relevant quantifier as *[3 ≤ • ≤ 5 g]*.

(93) a. Between 3 and 5 guys SLAP punished their son.
a'. [3 ≤ • ≤ 5 g] Sp

b. Predictions of the Basic Supervaluationist Account
(a') is true iff *[3 ≤ • ≤ 5 g] p* and *[3 ≤ • ≤ 5 g] (p and s)* are both true.
Thus (a') is true in particular if exactly 5 guys punished their son, and exactly 3 guys punished their son by slapping him.

b'. Predictions of the Pointwise Supervaluationist Accountt
(a') is true iff *[3 ≤ • ≤ 5 g] p* is true at a certain world w* on all interpretation on which *p* takes values

[26] Specifically, in this case the Pointwise Supervaluationist Account derives an inference that all the guys who punished their son did so by slapping him. To see this, assume that three or five of the relevant guys punished their son in a world w* of the Context Set, and but that one of them, g*, didn't do so by slapping g*'s son. Take W' = {w*} and D' = {g*}. Assume that for w = w* three or five guys punished their son in w.
Case 1. In w = w*, exactly three guys (including g*) punished their son. But due to g*, exactly two guys satisfy the condition **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1 – since the underlined condition is vacuously satisfied by all guys except g*, and g* falsifies it.
Case 2. In w = w*, exactly five guys (including g*) punished their son. But due to g*, exactly four guys satisfy the condition **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1 – since the underlined condition is vacuously satisfied by all guys except g*, and g* falsifies it.
The upshot is that *Three or five guys SLAP punished their son* couldn't be true on the Pointwise Supervaluationist account if at least one of the guys who punished their son did so without slapping him. (It is immediate that if all did slap, the sentence is true.)

within the set: R(p, s) = {[λwλx . **p**(w)(x) = 1 & <x, w> ∈ F => **s**(w)(x) = 1]: F ⊆ D×W}.
We still have the result that (a') is true in particular if exactly 5 guys punished their son, and exactly 3 guys punished their son by slapping him.

- *Tentative conclusions*

Our current conclusions are as follows.
(i) In upward-monotonic and some non-monotonic environment (e.g. embedding under *be unaware, exactly one*), supervaluationist accounts make good predictions.
(ii) In downward-monotonic environments, the supervaluationist accounts we have discussed make the incorrect prediction that the gestural enrichment doesn't affect the meaning. They could be supplemented with a presuppositional treatment for such cases, but at the cost of making the analysis quite a bit more complicated.
(iii) On the most intuitive supervaluationist treatment (which takes the presence of the gesture to be somehow vague), incorrect predictions are made even with the modification in (ii), especially for the case of embedding under *an odd number* and *between 3 and 4*. The less natural point-wise supervaluationist account makes better predictions for the first case, but still makes somewhat unintuitive predictions for the second – although these would need to be tested.

- *A cautionary note: supervaluationist accounts of gestures vs. supervaluationist accounts of presuppositions*

In the foregoing, our use of supervaluations was motivated by the idea that the presence of a gestural enrichment makes it 'vague' whether it should be taken into account or not. In our Basic Account, we thus provided truth conditions on which a sentence with a co-speech gesture is true just in case it is true both in its bare form and in its enriched version. In our Pointwise Account, we extended this approach 'point-wise' to predicates. These vagueness-inspired approaches should be compared to supervaluation-based analyses of presuppositions, which were discussed (and sometimes advocated) in George 2008a, b, Fox 2008, and Schlenker 2008b, among others (see also Beaver and Krahmer 2001 for related approaches using modified versions of Strong Kleene logic). These analyses work in two steps.
(i) They start from the idea that an expression *dd'* whose presupposition *d* is not satisfied by objects or parameters o_1, ... , o_n is neither true nor false of these objects – hence a value # when evaluated with respect to them.
(ii) However, if no matter how the value # is resolved the entire sentence has one and the same value, it can 'recover' from the failure and be evaluated as true or false, as the case may be.

There are some similarities and some differences between the supervaluationist approach to presuppositions and that based on local contexts.
(a) In upward-monotonic environments, the supervaluationist approach often predicts weaker and possibly more adequate inferences than the approach based on local contexts. For instance, for *At least one of these 10 students knows that he is incompetent,* the supervaluationist approach just predicts an inference that at least one of these 10 students is incompetent (and knows it), whereas approaches based on local contexts typically predict an inference that each of these ten students is incompetent.
(b) For *None of these 10 students knows that he is incompetent,* the supervaluationist approach to presuppositions yields an entailment that each of these 10 students is incompetent (because if at least one isn't, the value of the predicate evaluated at that student would yield the value #, and if this value is resolved as 'true', this would falsify the statement). In this simple case, the inference is comparable (though not quite of the same nature) as the one we derive from an approach based on local contexts, which yields a presupposition that each of these 10 students is incompetent.
(c) For *Exactly 1 of these 10 students knows that he is incompetent*, the supervaluationist approach to presuppositions also predicts a universal entailment that each of these 10 students is incompetent. This is again because if any one of them isn't, the predicate evaluated at that student would yield the value #; and resolving this value as 'true' or as 'false' would affect the number of students that satisfy the predicate, hence the impossibility of getting a true 'exactly one' statement no matter how the value is resolved.

In two of these three cases, we would get different results from our vagueness-inspired account if we treated gestures as simple presupposition triggers within a supervaluationist treatment of presuppositions – with the assumption that *x SLAP punished his son* triggers a presupposition that x slapped his son.
(a') For *At least one of these 10 guys SLAP punished his son,* we get the same result, namely an inference that at least one of these 10 guys punished his son by slapping him.
(b') For *None of these 10 guys SLAP punished his son,* the two accounts make entirely different predictions, since we saw that vagueness-inspired accounts predict that the co-speech gesture should

be vacuous (which in turn argues for an enrichment of the theory), whereas the presuppositional supervaluationist analysis will yield an inference that each of these 10 guys slapped his son. This is of course an inference which is far too strong.
(c') For *Exactly one of these 10 guys SLAP punished his son*, the two accounts make different predictions again. Vagueness-inspired accounts predict that exactly one of these 10 guys punished his son, and he did so by slapping him. By contrast, if we treat *SLAP* as a simple presupposition resolved by supervaluationist means, we obtain an inference that each of these ten guys slapped his son – which is again far too strong.

Interestingly, the vagueness-inspired Pointwise Supervaluationist Account turns out to converge with the supervaluationist sccount of presuppositions if within the latter we treat the gestural contribution as a cosupposition rather than as a simple presupposition (this is what we call the Supervaluationist Account of Cosuppositions). This result is sketched in a special case in (94) and (95).

(94) **Vagueness-inspired Pointwise Supervaluationist Account vs. Supervaluationist Account of Cosuppositions (special case)**
Consider a sentence … *Ge* … which only contains bivalent material except for *Ge*, where *G* is a co-speech gesture and *e* is a predicative expression.

a. Predictions of the vagueness-inspired Pointwise Supervaluationist Account

The sentence is true (resp. false) just in case … *e* … is true (resp. false) on all interpretations on which *e* takes values within the set R(e, g) defined as:

$\mathbf{R(e, g)} = \{[\lambda w \lambda x \,.\, \mathbf{e}(w)(x) = 1 \,\&\, (\langle x, w\rangle \in F \Rightarrow \mathbf{g}(w)(x) = 1)]\colon\ F \subseteq D \times W\}$

(In effect, interpretations for *Ge* are obtained by selecting arbitrary members of D×W that satisfy *e*, and requiring that they also satisfy *g*.)

b. Predictions of the Supervaluationist Account of Cosuppositions (= supervaluationist treatment of presuppositions combined with a cosuppositional treatment of gestural enrichments)

If *Ge* is analyzed as *e & g* within a supervaluationist account of presupposition,

for all $w \in W, x \in D$, $\mathbf{Ge}(w)(x)$ = 1 iff $\mathbf{e}(w)(x) = \mathbf{g}(w)(x) = 1$
= 0 iff $\mathbf{e}(w)(x) = 0$ and
= # iff $\mathbf{e}(w)(x) = 1$ and $\mathbf{g}(w)(x) = 0$

Given standard supervaluationist rules,

… *Ge* … is true (resp. false) just in case it is true (resp. false) for all possible ways of resolving the values # yielded by *Ge*, i.e. just in case … *e* … is true (resp. false) on all interpretation on which *e* takes values within the set R'(e, g) defined as:

$\mathbf{R'(e, g)} = \{P \in D_{\langle s, \langle e, t\rangle\rangle}$: P is bivalent and for every $\langle x, w\rangle \in D \times W$, **(1)** if $\mathbf{e}(w)(x) = \mathbf{g}(w)(x) = 1$, $P(w)(x) = 1$, and **(2)** if $\mathbf{e}(w)(x) = 0$, $P(w)(x) = 0\}$

Thus if $P \in R'(e, g)$, P is fully defined by **(3)** its behavior on $\{\langle x, w\rangle \in D \times W$: $\mathbf{e}(w)(x) = 1$ and $\mathbf{g}(w)(x) = 0\}$.

(95) **Equivalence of (94)a and (94)b**
With the definition in (94), R(e, g) = R'(e, g), and as a result (94)a and (94)b make the same predictions.

(i) First, we show that if $P \in R'(e, g)$, $P \in R(e, g)$. We define $F' = \{\langle x, w\rangle$: $\mathbf{e}(w)(x) = 1$ and $\mathbf{g}(w)(x) = 0$ and $P(w)(x) = 0\}$. And we note that $P = \lambda w \lambda x \,.\, [\mathbf{e}(w)(x) = 1 \,\&\, \langle x, w\rangle \in F' \Rightarrow \mathbf{g}(w)(x) = 1]$, which shows that $P \in R(p, s)$.[27]

[27] In greater detail, let us write abbreviate $\lambda w \lambda x \,.\, [\mathbf{e}(w)(x) = 1 \,\&\, \langle x, w\rangle \in F' \Rightarrow \mathbf{g}(w)(x) = 1]$ as $R_{F'}$, and show that $P = R_{F'}$. Clearly, for all $\langle x, w\rangle \in D \times W$,
(i) if $\mathbf{e}(w)(x) = \mathbf{g}(w)(x) = 1$, $R_{F'}(w)(x) = 1$;
(ii) if $\mathbf{e}(w)(x) = 0$, $R_{F'}(w)(x) = 0$;
(iii) if $\mathbf{e}(w)(x) = 1$ and $\mathbf{g}(w)(x) = 0$, $R_{F'}(w)(x) = 0$ if $P(w)(x) = 0$ and $R_{F'}(w)(x) = 1$ otherwise.
(i) and (ii) guarantee that $R_{F'}$ satisfies the general requires on P ((**1**) and (**2**) above in the definition of R'(e, g)), and line (iii) shows that $R_{F'}$ agrees with P on its characteristic behavior ((**3**) above in the line following the definition of R'(e, g)).

(ii) Second, we show that if $P \in R(e, g)$, $P \in R'(e, g)$. So let $F \subseteq D \times W$ and let $P = \lambda w \lambda x$. $\mathbf{e}(w)(x) = 1$ & $\langle x, w \rangle \in F \Rightarrow \mathbf{g}(w)(x) = 1$. Then:
if $\mathbf{e}(w)(x) = \mathbf{g}(w)(x) = 1$, then $P(w)(x) = 1$ (since the consequent of $\langle x, w \rangle \in F \Rightarrow \mathbf{g}(w)(x) = 1$ will be true);
if $\mathbf{e}(w)(x) = 0$, $P(w)(x) = 0$.

We leave a more detailed discussion of supervaluationist approaches for future research.

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