Gesture Projection and Cosuppositions[*]

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Abstract: In dynamic theories of presupposition, a trigger *pp'* (e.g. *it stopped raining*) with presupposition *p* (*it rained*) and at-issue 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 earlier accounts of local contexts (e.g. Heim 1983, 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.

1   Introduction

1.1   *Main goals*

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.

Notation: here and throughout, a co-speech gesture is notated in capital letters *before* the expression it co-occurs with. This expression is boldfaced for clarity, with square brackets if it contains several words. Whenever convenient, we illustrate the gesture with a picture following the capitalized gloss.[1]

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). 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.[2] It should be emphasized that we will not seek to explain how a gesture such as *UP* in (1) comes to have the content that it does, but just ask how this content interacts 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;[3] 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 – hence what we call a 'supplemental analysis', since the contribution of appositives is standardly called a 'supplemental' (Potts 2005).

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 at-issue 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 p 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 at-

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[1] Two notes might be useful at the outset. First, the capitalized gloss should not suggest that the 'lexical' contribution of these gestures is conventional: a given gesture might give rise to slightly different interpretations across individuals (as we explain in Section 1.3, this won't matter for our study because we seek to explain how gestural inferences interact with logical operators ('gesture projection'), rather than how they arise in the first place). Second, for greater clarity one might want to notate co-speech gestures *above* the modified expressions, borrowing notational conventions used in sign language research for non-manual markers. But this notation doubles the space occupied by examples, and makes it hard to cite examples in the main text, so we do not adopt it here.

[2] McNeill 2005 (chapter 2) distinguishes between four types of gestures: *iconic*, *metaphoric*, *deictic* and *beat*, defined as follows.

(i) "*Iconic:* such gestures present images of concrete entites and/or actions. They are gestures in which the form of the gesture and/or its manner of execution embodies picturable aspects of semantic content."

(ii) "*Metaphoric:* Gestures can also present *images of the abstract*."

(iii) "*Deictic:* Although the prototypical deictic gesture is the hand with an extended index finger, almost any extensible body part or held object can be used for pointing."

(iv) "*Beats:* Levy and I called gestures 'beats' when they took the form of the hand beating time."

Some authors, such as Giorgolo 2010 (pp. 4-5) have a subcategory of 'emblems', which 'are "typically culture specific gestures, associated with a fixed meaning" – for instance the 'thumb up' 👍 gesture used in Western culture. We will not make use of emblems *per se*, but it will be useful to keep in mind that some gestures have a general, non-iconic interpretation; and as we discuss in fn. 6, the iconic component of gestures may be interpreted more or less literally depending on the gesture.

[3] 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 at-issue and presuppositional contributions of their component parts.

issue component p'. We show that this 'cosuppositional' analysis can be combined with standard analyses of presupposition projection to account for complex patterns of gesture projection in quantified contexts and in attitudinal reports (in some cases in which standard analyses of presupposition projection are insufficiently predictive, we will appeal to the theory of local contexts of Schlenker 2009 to derive precise predictions). 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 main intuition we pursue can be described rather simply by inserting the example in (1) in various contexts, as in (2) (we notate under the examples the relevant inferences we take them to trigger, preceded by =>; in some cases, we will use the symbol ≠> if a certain inference fails to arise).

(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

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

As noted, (2)a triggers the inference that John helped his son by lifting him. Now in (2)b we infer that John didn't help his son, but that *if* he had this would lifting would have been involved. 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 we develop is that the context should 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 can posit that the relevant inference must follow from the context of the conversation. But in embedded cases a more sophisticated notion is needed, that of a *local context*. To see why it is needed, consider the example in (3).

(3)   If little Johnny takes part in the competition, will his mother UP_ help him?
       => if little Johnny takes part in the competition, if his mother helps him, lifting will be involved

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 derived is narrower: besides the fact that it only applies to Johnny and his mother, it is relative to the hypothesis that Johnny will take part in a competition; and we thus infer that this kind of competition involves some kind of upward movement.

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 combined with the context of the conversation. In most cases, we will take for granted the value of the relevant local contexts, as it can be established on the basis of standard presuppositional data, and derived using standard tools of dynamic semantics. 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.[4]

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[4] 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.

1.2 Projection

In agreement with Ebert and Ebert 2014, we will claim that co-speech gestures make meaning contributions that are not typically at-issue (or 'assertive', as one also says), and thus give rise to projection phenomena. Unlike Ebert and Ebert 2014, we will take the correct point of comparison for co-speech enrichments to be given by presupposition triggers rather than by appositive relative clauses. So we should say a word about the typology of these inferences, which are illustrated in (4)-(6).

(4) **At-issue entailment**
    a. John ensured that he had competent students.
    => John had competent students
    b. John didn't ensure that he had competent students.
    ≠> John had competent students
    c. None of my colleagues ensured that he had competent students.
    ≠> some/all of my colleagues had competent students

(5) **Presupposition**
    a. John knew that he had competent students.
    => John had competent students
    b. John didn't know that he had competent students.
    => John had competent students
    c. None of my colleages knew that he had competent students.
    => each of my colleagues had competent students

(6) **Supplement**
    a. John had students, who (by the way) were competent.
    b. #John didn't have students, who (by the way) were competent
    c. #None of my colleagues had students, who (by the way) were competent.

• In (4), the property $\lambda x.\ x$ *ensured that x had competent students* has the at-issue entailment $\lambda x.\ x$ *had competent students*, hence the positive inference we obtain in (4)a, which disappears in the negative environments in (4)b and (4)c.

• By contrast, in (5), the property $\lambda x.\ x$ *knew that x had competent students* triggers a presupposition $\lambda x.\ x$ *had competent students*. A hallmark of presuppositions is that they 'project' out of the scope of negation, as seen in (5)b, and yield universal positive inferences when they are triggered in the scope of *none*-type quantifiers, as seen in (5)c (see Chemla 2009 for experimental data). More generally, presuppositions have a characteristic projection behavior that sets them apart from other inferences, although there are debates about how unified the class of presupposition triggers really is (Tonhauser et al. 2013), and why presuppositions display the projection behavior they do (see for instance Beaver and Geurts 2011 and Schlenker to appear a for surveys). In addition, presuppositions are often taken to have a particular epistemic status: they must follow from what the speaker and addressee take for granted, i.e. from the 'Context Set'. (In the accounts of Heim 1983 and Schlenker 2009, it makes no difference whether a presupposition is *also* part of the at-issue component of an expression, as rules of presupposition projection would make this component redundant.[5] This is also the view will take in this piece, although there are theories in which this is not the case, e.g. Sudo 2012, 2014.)

• Finally, in (6)a, the appositive relative clause triggers the inference that John had competent students. But the appositive is degraded in the negative environments in (6)b-c. Why this is so is debated. One standard view (due to Potts 2005) is that the meanings of appositive relative clauses, called 'supplements', cannot interact scopally with logical operators. Since in our examples the appositive clause modifies a narrow scope indefinite, this yields deviance. An alternative view is that, in some cases at least, appositive relative clauses attach to the matrix level, and that the relative pronoun *who* has in this case the semantics of (E-type) *they* – with the result that the appositive is deviant for the same reason as the second clauses are in the discourses in (7) (see for instance Schlenker 2010b, 2013).

(7)   a. John didn't have students$_i$. #They$_i$ were competent.
       b. None of my colleagues had students$_i$. #They$_i$ were competent.

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[5] In the theories developed in Schlenker 2008, 2009, a presupposition 'starts out' as part of the at-issue component and gets strengthened by mechanisms that guarantee that its contribution should be trivial (and limited equivalence results extend this result to the theory of Heim 1983, modulo some technical conditions).

These properties will matter below. We will argue that co-speech gestures trigger a variety of presuppositions, while post-speech gestures (which come *after* they expressions they modify) display the behavior of appositive relative clauses.

1.3   Cautionary notes

Some cautionary remarks should be made 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. We are not concerned with how a particular gesture, such as *UP* in (1), comes to be interpreted as it is. Some gestures have a general, emblematic meaning; others have a highly iconic meaning. Our only concern is how the gestural enrichment projects.[6]

　　　Another question we will only be tangentially addressing pertains to the *epistemic status* of gestural enrichments. As noted, presuppositions are usually taken to follow from the Context Set, and thus to be uninformative. Arguably, gestural enrichments are often 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 (see for instance Stalnaker 2002, von Fintel 2008, Schlenker 2012; we revisit this question in Section 3.3.3).

• Second, presuppositional phenomena notoriously give rise to patterns of local accommodation, whereby a presupposition essentially gets incorporated into the at-issue 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 (if it projected, a contradiction would ensue). In this respect, some presupposition triggers are thought to be weaker than others, in the sense that they more readily allow for local accommodation. For instance, *stop* is typically thought to be weak (as is *realize*) which explains why in the discourse in (8), it does not lead to the inference that the interlocutor used to smoke (see also Beaver 2010).

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

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[7]. While we will primarily discuss 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 (Esipova 2016).[8] We will often compare gestural cosuppositions to the weak presuppositional inferences triggered by the verb *realize,* which is a rather weak trigger (see e.g. Stalnaker 1974).

• 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 crucial to investigate patterns of gesture

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[6] The example in (i), suggested by an anonymous referee, involves a gesture whose iconic component need not be interpreted precisely or literally.

(i)   a. John OPEN-DOOR **[opened the window]**.
　　　b. Will John OPEN-DOOR **[open the window]**?

Here *OPEN-DOOR* refers to an iconic gesture in which the actor grasps an imaginary handle and pulls it. As the referee observes, (i) can be uttered in a situation in which the window under discussion slides to the side or must be pushed, or in situation in which the way the window opens is not common knowledge. We take such a gesture to have a relatively general meaning, to the effect that a door is involved, as is suggested by (ii)a: without the gesture, we cannot exclude the possibility that the object refers to a box, or to a book, but with the gesture these possibilities are excluded, *although more precise information is not conveyed*. Our concern is not to explain how this inference arises in (ii)a, but to understand why it is preserved in the question in (ii)b, or in the conditional in (ii)c.

(ii)   a. John OPEN-DOOR **[opened the damn thing]**.
　　　b. Will John OPEN-DOOR **[open the damn thing]**?
　　　c. If John OPEN-DOOR **[open the damn thing]**, I'll be relieved.

[7] We owe this observation to Rob Pasternak (p.c.).

[8] Esipova 2016 argues that even strong triggers can give rise to local accommodation is this is necessary to make focus felicitous.

projection. But we are convinced that they will prove particularly useful *after* one has explored the initial space of possible theories – which is a primary goal in the present study.

• Fourth, as briefly mentioned above, the timing of co-speech gestures greatly matters. There is a rich literature analyzing where co-speech gestures naturally occur, in particular in connection with intonation (see for instance Loehr 2004, Ebert et al. 2011).[9] Here we will only be concerned with two types of cases, which are sharply distinct in terms of realization (so that confusion between them is unlikely): co-speech gestures which co-occur with syntactically well-defined constituents; and post-speech gestures that are sharply separated from the expressions they modify by pause. We come back to this distinction in Section 4.2.1, and use the contrast between co- and post-speech gestures as an argument against Ebert and Ebert's analysis of the former (we take the timing to be sharply different in the two cases, with post-speech gestures starting only the end of the modified expression).

• 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[10]), 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 presuppositional 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 with the unembedded examples in (9).

(9)   a. John UP_ **helped** his son.
       => John helped his son by way of an upwards movement of his hands

       b. John SLAP_ **punished** his son.[11]
       => John punished his son by slapping him

In (9)a, the gesture contributes the inference that the helping event involved some lifting; and in (9)b, that the punishment was by slapping – or possibly just physical (the difference won't matter, as long as we assess the same inference in elementary clauses and in complex sentences).
       Each example could easily be modified so as to involve minimally different co-speech gestures. For instance, *UP* could be replaced with a forward motion, and *SLAP* could be replaced with

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[9] Some terminology is useful to introduce the findings. In Loehr's (2004) terminology, following Kendon 1972, 1980, 'the smallest unit of motion is the *stroke* of the gesture', which is the 'short, dynamic peak of the movement'. Together with an optional 'preparatory phase' and an optional 'retraction phase', it forms a 'gestural phrase'. Loehr 2004 makes two relevant claims about timing. First, 'apexes of strokes align with pitch accents' (p. 111). Second, 'g-phrases [= gestural phrase] align with intermediate phrases' (p. 114), where the 'intermediate phrase' is a hierarchical level below the intonational phrase (Bekman and Pierrehumbert 1986). For their part, Ebert et al. 2011 find 'a clear, but shifted alignment for the onsets of gesture phrases and (new information) foci'. They conclude that 'gestures are a means of marking information structure next to intonational and syntactic means, i.e. speech-accompanying gestures can indicate focus domains'.

[10] Lascarides and Stone 2009 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 at-issue, presuppositional or supplemental status of co-speech enrichments does not arise in their article.

[11] Some of our examples refer to objectionable situations, which is occasionally useful to make projection facts particularly striking. For instance, the negation *John didn't SLAP* **punish** *his son* still suggests something highly objectionable about John (and possibly the speaker), namely that he takes punishment to be physical.

a punching motion. The associated inferences would be modified accordingly (e.g. *John helped his son by pushing him, John punished his son by punching him).*[12]

      Now let us embed each co-speech gesture under a *none*-type quantifier, using as at-issue controls sentences in which the co-speech is replaced with the modifier *like this,* accompanied with the appropriate gesture. (We take the semantics of the control sentence to be unsurprising: *this* is a deictic expression whose denotation must be provided by the context, the gesture serves to make a certain manner of action salient in the context, and *like this* is an at-issue modifier.)

(10) a. None of these 10 guys UP_ **helped** his son.
      => for each of these 10 guys, if he had helped his son, this would have involved some lifting

     b. None of these 10 guys helped his son like UP_ **this**.
      => for each of these 10 guys, if he helped his son, it was *not* by lifting him

(11) a. None of these 10 guys SLAP_ **punished** his son.
      => for each of these 10 guys, if he had punished his son, this would have involved some slapping.

     b. None of these 10 guys punished his son like SLAP_ **this**.
      => for each of these 10 guys, if he punished his son, it was *not* by slapping him

In (10)a and (11)a, we obtain a universal positive inference, of the form: for each of the relevant individuals x, if x had satisfied the *VP*, this would have involved an action that satisfied the content of the gesture. This universal positive inference is reminiscent of the behavior of presuppositions under *none*-type quantifiers, as we saw in (5)c, but with a twist: the presupposition is conditionalized on the at-issue component of the modified expression. Specifically, (10)a and (11)a do not yield the inference that some or all of the relevant guys lifted or slapped their sons. But they do seem to yield the inference that, in each relevant case, *if a guy x had helped/punished his son*, x's action would have involved lifting/slapping: the presupposition involves a conditional of the form: *if x had satisfied VP*, where VP is the modified Verb Phrase.

      By contrast, the control examples in (10)b and (11)b display an unsurprising behavior (on the assumption that *like this* is an at-issue modifier): given the meaning of *none,* we understand that none of the relevant guys helped his son by lifting him or punished him by slapping him. Hence *a guy x helped/punished his son*, x's action did *not* involve lifting/slapping. In other words, this is the *opposite* from the inferences triggered by the target sentences.[13] It is also notable that, unlike the supplements in (6)c, the co-speech gestures are entirely acceptable in the scope of *none*-type quantifiers, which will provide an argument against a supplemental treatment (as we will see, post-speech gestures display a very different behavior and can be analyzed in supplemental terms).

      In simple cases, related inferences can be obtained with co-speech gestures modifying NPs, as in (12). However these involve empirical and theoretical difficulties, and thus unless we specifically need them we will focus on co-speech gestures that co-occur with a verbal (or sometimes propositional) element.

(12) a. None of these 10 philosophers found LARGE_ **[a bottle he liked]**.
      => for each of these 10 philosophers, if he had found a bottle he liked, it would have been a large one

     b. None of these 10 philososphers found a bottle like LARGE_ **this** that he liked.
      => for each of these 10 philosophers, if he found a bottle he liked, it was *not* a large one

      We now turn to propositional, quantificational and attitudinal examples to strengthen the parallel with presuppositions.

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[12] Some gestures are of course cultural. For instance, replacing *SLAP* with an ear pulling gesture is readily understood in France, and can be taken to be emblematic or metaphorical, so that one need not literally understand the punishment to have involved some ear pulling. By contrast, an American audience may not readily understand this gesture.

[13] Here and throughout, the at-issue controls with *like this* modifiers may trigger some implicatures, which we disregard for simplicity. Specifically, it is very plausible (in particular in view of Katzir 2007) that (10)b evokes a more informative alternative of the form: *None of these 10 guys helped his son*. The implicature that this alternative is false leads to the inference that *at least one of the 10 guys helped his son*.

2.2 Propositional examples

While inferences in unembedded clauses are clear, as in (13), they are not particularly helpful to distinguish the presuppositional component from the at-issue component of a construction, as can be seen by the fact that the same inferences are derived in the at-issue controls in (14).

(13) a. John will UP_____ **help** his son.
=> John will help his son by lifting him

b. John will SLAP_____ **punish** his son.
=> John will punish his son by slapping him

c. John will realize that his son is losing.
=> John's son is/will be losing

(14) a. John will help his son like UP_____ **this**.
=> John will help his son by lifting him

b. John will punish his son SLAP_____ **this**.
=> John will punish his son by slapping him

c. John will correctly believe that his son is losing.
=> John's son is/will be losing

Thus in order to test the specific presuppositional component of a construction, we must appeal to systematic presupposition tests that tease apart at-issue from presuppositional contributions (keeping in mind that in most theories a presupposition might also contribute to the at-issue component, although in standard cases this effect wouldn't be felt because the presuppositional contribution is stronger).

In questions and under negation, our co-speech gestures trigger conditional inferences, as is illustrated in (15)-(16), where we have included as a control a (weak) presupposition trigger, the verb *realize*. Of course *realize* triggers a simple factive presupposition, whereas co-speech gestures trigger conditionalized ones – but this is precisely the difference we wish to argue for. We also include controls with *like this*; unless noted otherwise, they clearly *fail* to trigger the relevant inferences.[14]

(15) a. John won't (i) UP_____ **help** his son. (ii) help his son like UP_____ **this**.
(i) => If John helped his son, he would do so by lifting him

b. John won't (i) SLAP_____ **punish** his son. (ii) punish his son like SLAP_____ **this**.
(i) => If John punished his son, he would do so by slapping him

c. John won't realize that his son is losing.
=> John's son is losing

(16) a. Will John (i) UP_____ **help** his son? (ii) help his son like UP_____ **this**?
(i) => If John helps his son, he will do so by lifting him

b. Will John SLAP_____ **punish** his son? (ii) punish his son like SLAP_____ **this**?
(i) => If John punishes his son, he will do so by slapping him

c. Will John realize that his son is losing?
(i) => John is helping/helps his son

To study gesture projection in upward-monotonic environments, it is sometimes useful to embed some of the examples in questions, as in (17), so as to distinguish the presuppositional component (which is preserved or 'projects' under questions) from the at-issue component (which doesn't project).

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[14] As mentioned in fn. 13, the implicatures triggered by *like this* modifiers should be taken into account in a more complete treatment. For reasons of simplicity, we disregard this point in the rest of this discussion.

(17) a. If little Johnny takes part in the competition, will (i) his mother UP_[gesture] **help** him? (ii) his mother help

him like UP_[gesture] **this**?
(i) => if little Johnny takes part in the competition, if his mother helps him, lifting will be involved

b. If little Johnny cheats on the exam, will (i) his mother SLAP_[gesture] **punish** him? (ii) his mother punish

him like SLAP_[gesture] **this**?
(i) => if little Johnny cheats on the exam, if his mother punishes him, slapping will be involved

c. If little Johnny cheats on the exam, will his mother realize that he committed an extremely serious offense?
=> if little Johnny cheats on the exam, he will have committed an extremely serious offense

As mentioned at the outset, examples such as (17)a-b 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, which do not yield the general inference that if Johnny's mother helps/punishes him, lifting/slapping will be involved, but rather the narrower inference that this should hold *when the antecedent clause is satisfied*.

The same point can be made more forcefully by including a discourse that makes reference to a variety of situations that satisfy the relevant predicate. Thus in (18) the first occurrence of *help* is used to indicate (by way of a presupposition) that Johnny's mother helps him 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 Johnny takes part in the competition*, any help his mother will provide will involve lifting.[15] 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.

(18) Since Johnny's mother helps him no matter what, if he takes part in the competition, will she (i) UP_[gesture]

help him? (ii) help him like UP_[gesture] **this**?
(i) => if Johnny takes part in the competition, if his mother helps him, lifting will be involved
(i) ≠> Johnny's mother always helps him by lifting him

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: the cosupposition projects.

(19) a. If Johnny takes part in the competition and his mother (i) UP_[gesture] **helps** him, (ii) helps him like

UP_[gesture] **this,** people will talk about it.
(i) => if Johnny takes part in the competition, if his mother helps him, lifting will be involved

b. If Johnny cheats on the exam and his mother (i) SLAP_[gesture] **punishes** him, (ii) punishes him like

SLAP_[gesture] **this**, people will talk about it.
(i) => if Johnny cheats on the exam, if his mother punishes him, slapping will be involved

c. If Johnny cheats on the exam and his mother realizes that he committed a serious offense, she will take

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[15] By contrast, some native speakers 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?

appropriate measures.
=> if Johnny cheats on the exam, he will have committed a serious offense

Finally, under existential modals, we are not certain of the facts, but believe that a weak conditional inference is triggered about the actual world – something that should be further investigate. It might also be that with weak presupposition triggers such as *realize* the facts are the same unclear status.[16]

(20) a. Johnny's mother might (i) UP_ **help** him. (ii) help him like UP_ **this**.
=>? if Johnny's mother helps him, lifting will be involved

b. Johnny's mother might (i) SLAP_ **punish** him. (ii) punish him like this SLAP_ **this**.
=>? if Johnny's mother punishes him, slapping will be involved

c. Johnny's mother might realize that he cheated on the exam.
=>? Johnn cheated on the exam

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 at-issue contribution (we henceforth omit pictures from the transcription of the gestures, unless these have not been exemplified before). We start with cases involving a quantificational adverb, as this makes for particularly minimal pairs with the propositional examples discussed earlier. As before, we include in each paradigm a point of comparison involving the weak presupposition trigger *realize*.

(21) a. On Mondays, did John always (i) UP **help** his son? (ii) help his son like UP **this**?
(i) => on Mondays, when John helped his son, he did so by lifting him
b. On Mondays, did John always (i) SLAP **punish** his son? (ii) punish his son like SLAP **this**?
(i) => on Mondays, when John punished his son, he did so by slapping him
c. On Mondays, did John always realize that his son needed help?
(i) => on Mondays, John's son needed help

Similar generalizations hold for nominal quantifiers:

(22) a. Did each of these 10 guys (i) UP **help** his son? (ii) help his son like UP **this**?
(i) => for each of these 10 guys, if he helped his son, he did so by lifting him
b. Did each of these 10 guys (i) SLAP **punish** his son? (ii) punish his son like SLAP **this**?
(i) => for each of these 10 guys, if he punished his son, he did so by slapping him
c. Did each of these 10 guys realize that his son needed help?
(i) => for each of these 10 guys, his son needed help.

Under negative quantifiers such as *never* and *none*, we obtain universal conditional presuppositions, as was already shown for nominal quantifiers in (10)a-(11)a, which we repeat with a presuppositional control in (23).

(23) a. On Mondays, John never (i) UP **helped** his son. (ii) helped his son like UP **this**.
(i) => on Mondays, John never helped his son, but if had done so, it would have been by lifting him
b. On Mondays, John never (i) SLAP **punished** his son. (ii) punished his son like SLAP **this**.
(i) => on Mondays, John never punished his son, but if had done so, it would have been by slapping him
c. On Mondays, John never realized that his son needed help.
=>? on Mondays, John's son needed help[17]

(24) a. None of these 10 guys (i) UP **helped** his son. (ii) helped his son like UP **this**.
(i) => 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
b. None of these 10 guys (i) SLAP **punished** his son. (ii) punished his son like SLAP **this**.
=> 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

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[16] We do not include questions in the paradigm because *might* is an existential modal, and thus any inference due to the at-issue component of the embedded clause would be weaker than the purported presupposition. For instance, in (20)a an at-issue contribution of *UP* in the scope of *might* would only yield the modal inference that Johnny's mother *might* help by lifting him, which still does not imply that if Johnny's mother helps him, lifting will be involved.

[17] To our ear, the inference is a bit weaker than in other examples (it might become stronger if *realized* is replaced with *was aware*).

c. None of these 10 guys realized that his son needed help.
=> for each for each of these 10 guys, his son needed help

Embedding under *exactly n* numerals is more difficult to assess, and as we will see the theoretical situation is complicated as well. We have tried to separate inferences that are clear from ones that are not, adding a question mark or two to the symbol => in order to indicate degree of uncertainty. Here the controls with *like this* do give rise to some inferences of interest, in which case (ii) appears before the => sign. We note that in all cases involving modified numerals, the strong conditional inferences noted for embedding under *none*-type quantifiers are highly unclear, which will be topic of theoretical discussion below.

(25) a. On exactly 1 of the last 4 competitions, John (i) UP **helped** his son. (ii) helped his son like UP **this**.
    (i), (ii) => on exactly one of the last 4 competitions, John helped his son by lifting him
    (i) =>? on none other did John help his son
    b. After exactly 1 of the last 4 competitions, John (i) SLAP **punished** his son (ii) punished his son like SLAP **this**.
    (i), (ii) => after exactly 1 of the last 4 competitions, John punished his son by slapping him
    (i) =>? after none other did John punish his son
    c. On exactly 1 of the last 4 competitions, John realized that his son needed help.
    => on exactly 1 of the last 4 competitions, John came to correctly believe that his son needed help
    =>?? on none other did John come to believe that his son needed help

(26) a. Exactly 1 of these 10 guys (i) UP **helped** his son. (ii) helped his son like UP **this**.
    (i), (ii) => exactly 1 of these 10 guys helped his son by lifting him
    (i) =>? none other helped his son
    b. Exactly 1 of these 10 guys (i) SLAP **punished** his son. (ii) helped his son like SLAP **this**.
    (i), (ii) => exactly 1 of these 10 guys punished his son by slapping him
    (i) =>? none other punished his son
    c. Exactly 1 of these 10 guys realized that his son needed help
    => exactly 1 of these 10 guys came to correctly believe that his son needed help
    =>?? each of these 10 guy's son needed help

We note for future reference that in each case the clearest inference is obtained by taking the purported presupposition to contribute to the at-issue meaning, and therefore this inference is also triggered by the at-issue controls (the difficult question is to know whether other inferences, due to projection, are also found in the co-speech case). This is transparent in the case of (25)c and (26)c, since *John came to correctly believe that p* is the conjunction of the at-issue component of *John realized that p* and of its factive presupposition *p*. In (25)a-b and (26)a-b, *John helped his son by lifting him* is in fact obtained from the at-issue component *John helped his son* and the purported cosupposition *if John helped his son, lifting was involved;* and similarly for *John punished his son by slapping him*.

The same distinctions must be drawn for the non-monotonic quantifier *between 3 and 5*, which gives rise to some clear and some unclear inferences.

(27) a. Between 3 and 5 of these 10 guys (i) UP **helped** their son. (ii) helped their son like UP **this**.
    (i), (ii) => between 3 and 5 of these 10 guys helped their son by lifting him
    (i) =>? none other helped their son
    b. Between 3 and 5 of these 10 guys (i) SLAP **punished** their son. (ii) punished their son like SLAP **this**.
    (i), (ii) => between 3 and 5 of these 10 guys punished their son by slapping him
    =>? none other punished their son
    c. Between 3 and 5 of these 10 guys realized that their son needed help
    => between 3 and 5 of these 10 guys came to correctly believe that their son needed help
    =>?? for each of these 10 guys, their son needed help

2.4 Attitude reports

We turn to gesture projection in attitude reports. In possible worlds semantics, *x believes that F* is analyzed 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. But some aspects of the discussion are more complicated due to additional inferences that can also arise with standard presupposition triggers under *believe*. Let us start with the paradigm in (28).

(28) a. Does Samantha believe that John (i) UP **helped** his son? (ii) helped his son like **UP** this?
    (i) =>? Samantha believes that if John helped his son, lifting was involved
    (i) =>?? if John helped his son, lifting was involved
    b. Does Samantha believe that John (i) SLAP **punished** his son? (ii) punished his son like SLAP **this**?
    (i) =>? Samantha believes that if John punished his son, slapping was involved
    (i) =>?? if John punished his son, slapping was involved

c. Does Samantha believe that John realized that his son needed help?
=> Samantha believes that John's son needed help
=>? John's son needed help

The presuppositional control in (28)c yields an expected presuppositional inference, to the effect that the worlds compatible with what Samantha believes satisfy the presupposition of the embedded clause – hence: she thinks that John's son needed help. But researchers noted that when this type of sentence is uttered out of the blue, we often derive an inference to the effect that John's son did *in fact* need help – this is called the 'Proviso Problem' because dynamic theories failed to predict this inference. [18] Thus in this case the presupposition of the clause embedded under *believes* is to some extent inherited by the matrix sentence (we may call it a 'matrix presupposition'). There is a debate in a literature to determine how this matrix presupposition should be obtained: for proponents of DRT, it should be immediately derivable by presupposition projection mechanisms (e.g. Geurts 1999); for dynamic theories (e.g. Heim 1983) and for the analyses of Schlenker 2008, 2009, additional mechanisms of pragmatic enrichment are needed to derive the inference. But regardless of how they should be derived, the facts seem to be relatively well established.

Turning to the gestural examples in (28)a-b(i), the data are not entirely clear; pending further work, it would seem that to some extent the co-speech gestures give rise to conditional inferences relativized to Samantha's belief states – which the at-issue controls in (ii) certainly do not trigger. But in addition we might well obtain a matrix presupposition as well. [19]

Be that as it may, competing theories of presupposition agree that when the preceding discourse contradicts the relevant matrix presupposition, the discourse is still acceptable and the presupposition is *not* inherited by the matrix clause, as can be seen in (29)c. Importantly for our purposes, this observation extends to gestural cosuppositions, as shown in (29)a-b.

(29) a. Samantha is convinced, incorrectly, that John's son was trying to climb up, and she also believes that John UP **helped** him.
   ≠> if John helped his son, lifting was involved
   b. Samantha wrongly thinks that John is violent, and she believes that he just SLAP **punished** his son.
   ≠> if John punished his son, slapping was involved
   c. Samantha wrongly thinks that John's son had difficulties, but she feels reassured: she also believes that John realized that his son needed help
   ≠> John's son needed help

We should also mention striking patterns of projection 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. [20] Strikingly, the co-speech inference makes itself felt in the positive but not (or not clearly) in the negative component of the meaning, as is illustrated in (30) (the at-issue modifier makes itself felt in both components, as one would expect). As we will see below, the cosuppositional come close to explaining these facts, albeit not perfectly.

(30) a. Sam is unaware that John (i) UP **helped** his son. (ii) helped his son like UP **this**.
   (i) [but not (ii)] => Sam doesn't believe that John helped his son
   (i), (ii) => John helped his son by lifting him
   b. Sam is unaware that John (i) SLAP **punished** his son. (ii) punished his son like SLAP **this**.
   (i) [but not (ii)] => Sam doesn't believe that John punished his son
   (i), (ii) => John punished his son by slapping him

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[18] The problem is more general, and arises in other modal constructions. For simplicity, we tried to discuss conditional examples that did not have this feature (in (17)). But it is easy to modify them in such a way that the presupposition is inherited by the entire sentence:

(i)   a. If little Johnny encounters difficulties, will his mother UP **help** him?
         => if little Johnny's mother helps him, lifting will be involved
         b. If little Johnny comes home, will his mother SLAP **punish** him?
         => if little Johnny's mother punishes him, slapping will be involved
         c. If little Johnny comes home, will his mother realize that he committed a serious offense?
         => little Johnny committed a serious offense

[19] An anonymous referee is of the opinion that a sentence such as (28)b cannot be continued with (i), indicating that the cosupposition is inherited by the matrix sentence.

(i) However, I know that he just did not get ice cream for dessert.

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

Similar data can be obtained with *x doesn't realize that F* as with *x is unaware that F*, as can be seen in (31).

(31) a. Sam doesn't realize that John (i) UP **helped** his son. (ii) helped his son like UP **this**.
(i) [but not (ii)] => Sam doesn't believe that John helped his son
(i), (ii) => John helped his son by lifting him
b. Sam doesn't realize that John (i) SLAP **punished** his son. (ii) punished his son like SLAP **this**.
=> 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 (32)a. Importantly, the disgust might be attributed to the speaker or to Sam in (32)a; but what matters for present purposes is that whatever inference is obtained in the simple case is inherited by the complex sentences in the paradigm.

(32) **Propositional examples**

a. Sam went :-(_____ **[skiing with his parents]**.
=> for Sam to go skiing with Sam's parents would be disgusting (from Sam's / from the speaker's standpoint)
b. Sam won't go :-(**[skiing with his parents]**.
=> for Sam to go skiing with Sam's parents would be disgusting (from Sam's / from the speaker's standpoint)
c. Did Sam go :-(**[skiing with his parents]**?
=> for Sam to go skiing with Sam's parents would be disgusting (from Sam's / from the speaker's standpoint)
d. If Sam goes :-(**[skiing with his parents]**, I'll hear about it.
=> for Sam to go skiing with Sam's parents would be disgusting (from Sam's / from the speaker's standpoint)

We can also obtain examples in which the disgusted facial expression appears in the consequent of a conditional, and the disgust can be relativized to the content of the antecedent, as shown in (33).[21]

(33) Sam loves skiing, but if the snow is as terrible as it is today, he won't go :-(**skiing** tomorrow
=> if the snow is as terrible as it is today, skiing will be disgusting tomorrow (from Sam's / from the speaker's standpoint)

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.[22] (Data pertaining to facial expressions in attitude reports are complex; we leave an investigation for another occasion.)

(34) **Quantificational examples**
a. Each of my friends goes :-(**[skiing with his parents]**.
=> for each of my friends, to go skiing with his/her parents would be disgusting (from the friend's / from the speaker's standpoint)
b. Does each of your friends go :-(**[skiing with his parents]**?
=> for each of my friends, to go skiing with his/her parents would be disgusting (from the friend's / from the speaker's standpoint)
c. None of my friends goes :-(**[skiing with his parents]**
=> for each of my friends, to go skiing with his/her parents would be disgusting (from the friend's / from the speaker's standpoint)

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[21] For reasons discussed above in connection with the 'Proviso Problem', some care is needed to construct examples in which a conditional rather than unconditional inference is obtained; see fn. 18.
[22] See Schlenker, to appear c for initial data that suggest that similar inferences can be replicated with some non-grammatical (disgusted) facial expressions in ASL.

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. For most of our discussion, we will rely on standard results of dynamic semantics, which offers an articulated account of local contexts and dynamic updates. But because dynamic semantics is intrinsically lexicalist (in the sense that the update behavior of connectives and operators is stipulated on a case-by-case basis), it sometimes fails to make predictions for cases that are of interest here. In such cases, we will follow the framework of Schlenker 2009, which in simple cases almost entirely agrees with the results of dynamic semantics, but 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 (35): a co-speech gesture triggers a presupposition that its content is entailed by that of the expression it modifies. We provide a definition for cosuppositions that affect expressions whose type 'ends in t', but in practice we will restrict attention to the propositional and the predicative case (as is also the case in Schlenker 2008, 2009).

(35) **Cosuppositions triggered by co-speech gestures**
Let G be a co-speech gesture co-occurring with an expression d' whose type 'ends in t'[23], 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').[24]

To put things differently, a co-speech gesture triggers a presupposition of a particular sort, namely one that is conditionalized on the at-issue content of the expression it modifies, as specified in (36).

(36) **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 at-issue 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 by 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 (37)a, and the special case of cosuppositions in (37)b, with the notation in (37)c.

(37) **Presupposition Satisfaction (dynamic approach)**
Let E be an expression with an at-issue 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

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[23] See for instance Rooth and Partee 1982. The definition of types 'that end in t' (= 'conjoinable types') can be given as in (i):

(i)   a. t is a conjoinable type
         b. If b is a conjoinable type, then for any type a, <a, b> is a conjoinable type.

[24] 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 $x'(y_1) ... (y_n) = 1$. (When x and x' are of type t, the standard notion of entailment applies.)

context and *F* is a formula of the appropriate type, we write lc ⊨ F in case lc entails F by generalized entailment.[25]

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.

(38) a. If little Johnny takes part in the competition, his mother will UP **help** him
      b. if t, U**h**

We analyze this sentence as having the Logical Form in (38)b, where *t* stands for *little Johnny takes part in the competition, h* for *his mother will help him*, and *U* for the gesture. When we come to quantified examples, we will take the content of the gestures to impose a predicative presupposition, of the same type of the modified VP. This approach will extend to non-quantified cases, but to see how the system works it is convenient to pretend that the co-speech gesture is propositional in nature, with the rough content *g = lifting was involved*.

We now apply the satisfaction condition in (37) to (38)b.

• First, we need to compute the local context of *Uh* in *if t, Uh* given C; we call this local context lc(U**h**).[26] Standard dynamic analyses as well as the reconstruction of local contexts of Schlenker 2009 take lc(t) to correspond to the set of worlds in C that also satisfy *t*, as is written in (39).

(39) Local context of *Uh* in (38)b given a Context Set C

      lc(U**h**) = λw_s w is in C and w satisfies *t*

• Second, the licensing condition in (37)b specifies that relative to lc(h), *h* should entail the content *g* of *G*, i.e. *lifting was involved*. We obtain the result in (40).

(40) **Licensing condition on *G* in (38)b given a Context Set C**
      a. lc(U**h**) as computed in (39) should guarantee that lc(U**h**) ⊨ h => u, where *u* is the content of *U*.
      b. [λw_s w is in C and w satisfies *t*] ⊨ [h => u]
      and thus we get the result that every world w in C that satisfies *t* should satisfy *h => u*.
      In words, every world in C in which little Johnny takes part in the competition is one in which help provided by his mother would involve lifting

This seems appropriate.

Finally, we must make provisions for local accommodation of the presupposition (Heim 1983). The condition is standard; one version is defined in (41)a for the general case, and applied in (41)b to the case of cosuppositions (in either one of versions defined in (42)).

(41) **Local Accommodation**
      a. General case
      A presupposition which is 'locally accommodated' is treated as part of the at-issue component of the expression it belongs to.

      b. Application to cosuppositions
      A cosuppositional expression with at-issue component *a* and presupposition *a => g* acquires an at-issue component *(a & (a => g))*, i.e. *a & g*, after local accommodation (the same result is obtained for the 'official' condition in (42)a and for the equivalent condition in (42)b: it is immediate in the latter case that *a & g* gets locally accommodated to *a & g*).

In the case of gestural enrichments, the effect of local accommodation will simply be to turn the gestural enrichment into part of the at-issue component. A systematic comparison between the accommodation properties of co-speech gestures and of standard presupposition triggers is beyond the scope of this study, but as noted we conjecture that co-speech gestures are often weak triggers, which easily give rise to local accommodation (this was the reason we compared cosuppositions to the presuppositions triggered by the weak trigger *realize*).[27]

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[25] More precisely, we can define the relevant notion of generalized entailment (between a set-theoretic object and a formula) as follows:
If o is a type-theoretic object of a type that 'ends in t', and can take at most n arguments, and if *F* is a formula of the same type, with meaning **F**, then o ⊨ *F* just in case for all objects $x_1, \ldots, x_n$ of appropriate types, if $o(x_1)\ldots(x_n) = 1$, then $\mathbf{F}(x_1)\ldots(x_n) = 1$. (When o and *F* are of type t, the standard notion of entailment applies.)
[26] Since the local context of an expression is computed without regard for the content of that expression, the local context of *Uh* in *if t, Uh* is the same as the local contest of *h* in *if t, h*.
[27] An anonymous referee objects that co-speech inferences, unlike presuppositions, can sometimes be cancelled.

(i) Our house has SQUARE **[5 windows]**. Well, in fact they are round.

Clearly, local accommodation won't help here. We believe this example should be analyzed in terms of correction, as suggested by the expression 'in fact', rather than in terms of cancellation. First, the pattern is not general; to our ear (and eye), it is hard to make sense of (ii):

3.2   Near-equivalent condition

Having illustrated the licensing condition in (37)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 at-issue component *e** and a presupposition *e => g*. As a result, … *e => g e** … and … *(e & g)* … trigger the same presupposition, as is stated in (42)a (if *e* = e*, the result of the dynamic update is also the same).

(42)   **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 at-issue component with content *e**, and let *(e & g)* be the conjunction of an expression with content *e* with an expression with a presuppositional content *g* and a trivial at-issue 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] = #. Furthermore, 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 (42)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. For simplicity, we pretend that the co-speech gestures we consider have a propositional contribution. In fact, the co-speech gestures we considered (with the

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(ii) John SLAP **punished** his son. ?But it wasn't a physical punishment.

(i) could be a simple case of correction, of the kind exemplified in (ii) – where one term is more common than another and tends to be used with a broader meaning, although this need not be technically correct:

(ii) I used a drone to spy on my neighbor today. Well actually it was a quadcopter. The names are so interchangeable and yet they aren't exactly the same. (retrieved online on 08/04/2016 at https://scriggler.com/SharePost/Story?cash=4b667c0a6bbbd0b6286a803789971059#sthash.n4ZDGzSd.dpuf).

The case in (i) might also be related to a remark (originating with the same referee) we made in fn. 6: some gestures need not be interpreted strictly iconically, or may be ambiguous between a strict iconic reading and a broader one. The gesture SQUARE in (i) might be taken to represent windows in general, although on a strict iconic reading it is not appropriate, which might justify the correction in the second sentence.

exception of some facial expressions) made a *predicative* contribution, but nothing hinges on this simplification: in all standard systems including dynamic semantics, when a predicative presupposition trigger is applied to one or several referential expressions, the effect is the same as if a (properly adapted) propositional presupposition trigger had been applied.[28]

   As before, co-speech gestures appear in capital letters, e.g. *U* (for *UP*); and their content appears in normal letters, e.g. *u*. 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".) includes 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 (43), we consider cases in which the local context of the enriched expression is identical to the global context of the conversation. In case the sentence is a question, as in (43)a, we obtain the desired cosupposition: if Johnny's mother helped him, this involved some lifting, or with our notation (introduced in (37)c): $C \vDash h \Rightarrow u$. If instead of a question we have an assertion, as in (43)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.

(43)   a. Johnny's mother UP **helped** him.
       a'. Did Johnny's UP **help** him?
       a". U**h** (?)
       b. Licensing condition:
       $lc(U\mathbf{h}) \vDash h \Rightarrow u$
       hence
       $C \vDash h \Rightarrow u$
       and when h is asserted, we thus infer: h and u.

In (44), we obtain a further relativization to the antecedent of the conditional, as is desired as well. And in (45), the same cosupposition is obtained as in (43), simply because negation does not affect the computation of local contexts.

(44)   a. If Johnny takes part in the competition, will his mother UP **help** him?
       a'. if t, U**h**?
       b. Licensing condition:
       $lc(U\mathbf{h}) \vDash h \Rightarrow u$
       hence
       $C \vDash t \Rightarrow (h \Rightarrow u)$
       hence an inference (which survives under questions) that
       if Johnny takes part in the competition, then if his mother helps him, lifting will be involved.

(45)   a. Johnny's mother didn't UP help him.
       a'. not U**h**
       b. Licensing condition:
       $lc(U\mathbf{h}) \vDash h \Rightarrow u$
       But in a'. $lc(U\mathbf{h}) = C$, the global context, hence
       $C \vDash h \Rightarrow u$
       In the end, we have two inferences:

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[28] For instance, in trivalent systems. *stop smoking* evaluated in a world w and at a time t (with respect to a context c and an assignment function s) denotes the partial property in (i) (using the notation of Heim and Kratzer 1998, where the lambda-term $\lambda x: F . G$ yields a failure on x unless F is true of x; in this piece, we write this failure as #).

(i) $[[\text{stop-smoking}]]^{c, s, t, w} = \lambda x.$ x smoked before t in w . x smoked before t but doesn't smoke at t in w

As a result, *John stops smoking* evaluated in a world w and at a time t has the truth and failure conditions in (ii):

(ii) $[[\text{John stop-smoking}]]^{c, s, t, w}$ is defined only if John smoked before t in w; if so, = 1 iff John smoked before t but doesn't smoke at t in w

This is the very result that would be obtained if *John-stopped-smoking* were treated as a propositional presupposition trigger, with the presupposition that *John used to smoke* and the at-issue component that *John doesn't smoke*.

relative to the Context Set, if Johnny's mother helps him, lifting will be involved;
relative to the (more specific) speaker's beliefs, Johnny's mother didn help him.

3.3.2 Quantified examples

Let us turn to quantified examples. Now it becomes essential that the gestures associate with the VP rather than with an entire clause, since the presuppositions must be predicative in nature. We assume for simplicity that the gesture associates with the entire VP even if it just co-occurs with the verb.[29]

❑ *Basic results*

As desired, we derive a universal conditional presupposition in the case of embedding under *none of these 10 guys*. The 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).

(46) a. None of these 10 guys UP helped his son.
　　　a'. [No g] U**h**
　　　b. Licensing condition:
　　　lc(U**h**) ⊨ h => u
　　　Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:
　　　$C \vDash [\forall x: g(x)](h(x) => u(x))$
　　　In the end, we have two inferences:
　　　relative to the Context Set, if any of the 10 guys helped his son, lifting was involved;
　　　relative to the speaker's beliefs, none of these 10 guys helped 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 (47)-(48). 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 at-issue component to yield the inference that the individuals that did in fact punish their sons did so by slapping them.

(47) a. Exactly one of these 10 guys UP **helped** his son.
　　　a'. [=1 g] U**h**
　　　b. Licensing condition:
　　　lc(U**h**) ⊨ h => u

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[29] There are two reasons for this simplification.
• First, the equivalence between Heim's dynamic semantics (Heim 1983) and the reconstruction of local contexts in Schlenker 2009 holds for a fragment with 1-place predicates, hence it is expedient to treat VPs as atomic units.
• Second, in standard trivalent systems nothing hinges on this simplification as long as the object is referential, for the same reasons that were outlined in fn. 28. Specifically, in a trivalent system we can posit that the co-speech gesture triggers a presupposition on the value of a transitive verb as in (i) (of type <e, <e, t>>), which ends up constraining the value of a complex predicate as in (ii). But this yields the same effects as if we took the co-speech gestures to directly constrain the value of the VP, as in (iii). (For illustrative purposes, we simplify the derivation of the truth conditions by assuming that for every relevant individual x, time t and world w, x has exactly one son, son(x), at t in w. We also illustrate the point within a static trivalent system; this should be extended to a dynamic trivalent system to fit the system used in the text.)

(i) $[[\text{UP-help}]]^{f, s, t, w} = \lambda y. \lambda x$: if x helps y at t in w, lifting is involved . x helps y at t in w and lifting is involved

(ii) $[[\lambda_i \, t_i \, \text{UP-help [his}_i \, \text{son]}]]^{f, s, t, w} = \lambda x' . [[t_i \, \text{UP-help [his}_i \, \text{son]}]]^{f, s[i->x'], t, w}$
$= \lambda x' . [[\text{UP-help}]]^{f, s[i->x'], t, w}(\text{son}(x'))(x') = \lambda x'$: if x' helps son(x') at t in w, lifting is involved . x' helps son(x') at t in w and lifting is involved

(iii) $[[\text{UP-help-his-son}]]^{f, s, t, w} = \lambda x$: if x helps son(x) at t in w, lifting is involved . x helps x's son at t in w and lifting is involved

Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:

C ⊨ [∀x: g(x)](h(x) => u(x))

In the end, we have two inferences:

relative to the Context Set, if any of the 10 guys helped his son, lifting was involved;

relative to the speaker's beliefs, exactly one of the 10 guys helped his son; by the first inference, he did so by slapping him, and the others didn't help their son (whether by helping him or not).

It is worth noting that the predicted inferences are rather different from those obtained for *Exactly one of these 10 guys helped his son by lifting him.* Specifically, in our analysis, the sentence in (47) doesn't just yield the inference that exactly one guy helped his son by lifting him, but also that the other relevant guys didn't help their son (whether by lifting them or in some other way). The latter inference is not triggered by the at-issue control with the modifier *by lifting him*. Still, as we noted in (26)a, this inference ('no other guy helped his son, whether by lifting him or not') is not entirely clear. Furthermore, we derive this inference by way of a universal conditional presupposition to the effect that *for each each of these 10 guys, if he helped his son, lifting was involved.* But as we noted in our empirical discussion in Section 2.3, this universal conditional inference is far less clear for modified indefinites than it is for *none*-type quantifiers.

This difficulty might be related to an independent problem in the theory of presupposition: in fact, the experimental results of Chemla 2009 suggest that there are clear differences in terms of universal projection between *none*-type quantifiers (clear universal projection) and modified numerals (no clear universal projection). Thus the data might well be closer than is predicted for the target sentence in (47)a and for the at-issue control with the modifier *by lifting him*, but this need not show that the presuppositional analysis of co-speech gestures is incorrect; it might be that our theory of presupposition projection just makes overly strong predictions (an alternative way of weakening our predictions is discussed in Section 3.3.3).

For future reference, we also note that, on the assumption that presuppositions project universally in this case as well, we obtain related results for the quantifier *between 3 and 5*, as shown in (48). Again, one of the inferences predicted ('no other guy helped his son') might be too strong, but possibly for reasons having to do with inadequacies of the theory of presuppositions rather than with the cosuppositional analysis of co-speech gestures.

(48) a. Between 3 and 5 of these 10 guys UP **helped** their sons.
   a'. [3 ≤ • ≤ 5 g] U**h**
   b. Licensing condition:
   lc(U**h**) ⊨ h => u
   Given standard results about the local contexts of the restrictor in quantified statements, this derives the following result:
   C ⊨ [∀x: g(x)](h(x) => u(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, and the others didn't help their son (whether by helping him or not).

❑ *Extension to NP-modifying co-speech gestures*

Before we consider attitude reports, we should say a word about some cases in which co-speech gestures modify quantified NPs. Consider again the example in (12)a, repeated in simplified form (without he bound variable *he*) in (49).

(49) None of these 10 philosophers found LARGE_ [**a bottle he liked**].
   => for each of these 10 philosophers, if he had found a bottle he liked, it would have been a large one

Our analysis allows co-speech gestures to trigger presuppositions on the value of a variety of elements whose type 'ends in t'. In this case it is simplest to take the co-speech gesture to modify the NP *bottle he liked* (rather than the entire DP with the determiner – the precise phonological difference would be hard to perceive since the determiner is so short). Without going in to formal details, the present account could be extended to such cases as follows:

• with the gesture, the NP *a bottle of beer* triggers a presupposition, to the effect that if something satisfies that description, it is large;

• the subject quantifier gives rise to universal presupposition projection, whereby each individual *i* who is of the 10 philosophers must satisfy the presupposition of *i found a LARGE [bottle he$_i$ liked]*. This propositional expression includes a presupposition trigger in the restrictor of an existential quantifier. In the theory of Heim 1983, this should give rise to universal projection as well, hence in

the end the result that for every individual *i* who is one of the 10 philosophers, if something is a bottle *i* likes, it should be something large.

This seems appropriate, although a more rigorous analysis should be given in the future.[30]

3.3.3 A note on Context Set vs. Speaker's Context

From the perspective of a theory with universal presupposition projection under quantifiers, there might be another way of solving the empirical problems we encountered with *exactly one*. In a nutshell, we could posit that gestural cosuppositions can be assessed relative to the speaker's beliefs (the 'Speaker's Context') rather than with respect to the Context Set of the conversation, with one proviso: the gestural cosupposition should not be assessed relative to the Speaker's Context if this makes 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 in (50).[31]

(50) **Gestural cosuppositions evaluated relative to the Speaker's Context** (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).

As we will now see, the proposed modification will keep the strong universal presupposition (with respect to the Context Set) for embedding under *none*-type quantifiers, while weakening the inferences triggered by some problematic examples.

• Let us first consider (46)a, and suppose we evaluate its various contributions relative to the Speaker's Context, which we write as *B* (for 'belief state'). First, we obtain the universalized cosupposition (boldfaced) in (51)a, evaluated with respect to the Speaker's Context rather than with respect to the Context Set. Second, the at-issue component of the sentence also contributes information about the speaker's belies, hence the contribution in (51)b. (Note that due to the universal projection of the cosupposition, it would be redundant to add the cosupposition as part of the at-issue component.)

(51) Contribution of (46)a with evaluation relative to the Speaker's Context
a. Globally accommodated presupposition: $B \vDash [\forall x: g(x)](\mathbf{h(x) => u(x)})$
b. At-issue component: $B \vDash [\forall x: g(x)]$ not h(x)

It is immediate that the conjunction of (51)a and (51)b is equivalent to (51)b, since it makes the boldfaced material conditional in (51)a vacuously satisfied. But this is also the meaning we would obtain for the sentence without the co-speech gesture, hence (50)b mandates that we *not* evaluate the cosupposition relative to the Speaker's Context, and but evaluate it instead with respect to the Context Set. We thus preserve the universal cosupposition of our initial theory, which seems to be a good thing.

• Predictions are different in the case of quantifiers that have a positive component, for instance those in (47) and (48): in such cases, the universal conditional presupposition yields inferences that the gesture-less sentence wouldn't. This is illustrated for (47) (involving *exactly one*) in (52).

(52) Contribution of (47)a with evaluation relative to the Speaker's Context
a. Globally accommodated presupposition: $B \vDash [\forall x\ x: g(x)](\mathbf{h(x) => u(x)})$
b. At-issue component: $B \vDash [= 1x: g(x)]$ h(x)

The conjunction of (52)a and (52)b an be seen to be equivalent to (53): the speaker believes that exactly one guy helped his son, and that every guy who did used lifting. In other words: the speaker believes that exactly one guy helped his son, and that he did so by lifting him. It is immediate that this is stronger than the meaning of the gesture-free sentence, so evaluation with respect to the Speaker's Context does not make it vacuous and can be applied.

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[30] One of the difficulties is that universal projection of presuppositions under existential quantifiers is too strong, as has been noted repeatedly in the literature, and as was shown with experimental means in Chemla 2009.
[31] Two remarks should be added. First, evaluation with respect to the Speaker's Context might come very close to an analysis in which Global Accommodation is automatic and without cost; but this would raise a question about the *difference* obtained between gestural embedding under *none*-type quantifiers vs. modified indefinites in cases in which Global Accommodation must be applied to the first case. Second, as pointed out by an anonymous referee, there are treatments of specific indefinites on which they too impose pragmatic conditions on the Speaker's Context; see for instance Saebø 2013.

(53) Restatement of the conjunction of (52)a and (52)b
  The speaker believes that exactly one guy helped his son, and that he did so by way of lifting.

Furthermore, due to evaluation with respect to the Speaker's Context, the Context Set does not have to satisfy the universal cosupposition any more – possibly a good thing.

   Related results are obtained for (48) (involving *between 3 and 5*), as shown in (54): we obtain the inference that the speaker believes that between 3 and 5 of guys punished their son, and that all the guys who helped their son did so by way of lifting. In other words, the speaker believes that between 3 and 5 guys helped their son, and that they did so by way of lifting (as in (55)) – which is stronger than what the gesture-free sentence would deliver, hence global accommodation can be applied. Again, the Context Set does not have to satisfy the universal cosupposition any more.

(54) Contribution of (48)a with evaluation relative to the Speaker's Context
  a. Globally accommodated presupposition: $B \vDash [\forall x\ x: g(x)](\mathbf{h(x)} => \mathbf{u(x)})$
  b. At-issue component: $B \vDash [3 \leq \bullet \leq 5x: g(x)]\ h(x)$

(55) Restatement of the conjunction of (54)a and (54)b
  The speaker believes that between 3 and 5 guys helped their son, and that they did so by way of lifting.

   It is worth pausing to reflect on the strategy explored here. Since the Speaker's Context is always more specific than the Context Set, it is *easier* for a cosupposition to be entailed by the former than by the latter. This is one reason why the inferences predicted for gestural embedding under modified indefinites are now weaker than for *none*-type quantifiers. In addition, part of these inferences will now be redundant with the at-issue component of the sentence, and hence harder to detect unless further projection tests are used. Importantly, when we embed the target sentences in questions, we should still see evidence for projection since the at-issue component won't be entailed any more; the judgments should be investigated.

   This is of course a tentative proposal, whose empirical and theoretical ramifications should be explored in greater depth in future research.

3.4 Attitude reports

3.4.1 Simple attitude reports

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 (56). This seems adequate to derive the attitudinal inference we discussed in (28)a; the additional inference that might be obtained when the sentence is uttered out of the blue (to the effect that the *speaker* believes that the helping event involved lifting) would require a strengthening mechanism, but as we noted the same issue arises with standard presuppositions.

(56) a. Samantha believes that John UP **helped** his son.
  a'. $Bel_s\ U\mathbf{h}$
  b. Licensing condition:
  $C \vDash Bel_s\ (h => u)$

  Heim 1983, 1992 and Schlenker 2009 derive the result that for a presupposition trigger *qq'* with presupposition *q*, $Bel_s\ qq'$ presupposes $Bel_s\ q$. In a'. the presupposition is of the form *h => u,* hence the result.[32]

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

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

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) $C \vDash Bel_s\ p => s$

The at-issue component yields $Bel_s\,h$, hence also an inference that $Bel_s\,h$: Samantha believes that John helped his son and that lifting was involved.

The data are more subtle and harder to assess in the negative example in (57). The predicted cosupposition is the same as in (56), but given the negative nature of the at-issue component, the overall inferences obtained are of course different. Here we predict a presupposition that is probably too strong, namely that the Samantha believes that if John had helped his son, lifting would have been involved. We leave this problem for future research.

(57)   a. Samantha doesn't believe that John UP **helped** his son.
  a'. not Bel_s U**h**
  b. Licensing condition:
  $C \vDash Bel_s\,(h => u)$
  The presuppositional result is the same as in (56), but the at-issue component is negative and thus we do not obtain the inference that Samantha believes that John helped his son and that lifting was involved.

3.4.2   *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 expedient to make use of the reconstruction of local contexts in Schlenker 2009 (presented more concisely in Schlenker 2010).

By way of motivation, let us explain what would go wrong if we simply assumed that the gestural inference is conjoined with the embedded clause, so that *John UP helped his son* means *h & (h => u): John helped his son, and if he helped him, lifting was involved*. This is immediately equivalent to: *h & u*, i.e. *John helped his son and lifting was involved*. Under *be aware, be unaware, realize* and *not realize*, this conjunction becomes presupposed, which is compatible with the observed inferential facts (e.g. *Samantha realizes that John UP **helped** his son* does give rise to the inference that John did in fact help his son, and lifting was involved). But under *be unaware* and *not realize*, the at-issue component derived for the entire sentence is now too weak: we infer that *Samantha doesn't believe that John helped his son by lifting him*, whereas the correct result is arguably that *Samantha doesn't believe that John helped his son*.

We will now show that this stronger result does follow from the mechanism of local context computation of Schlenker 2009 (although we might also obtain a result that is in some respects *too* strong). The key intuition can be summarized as follows. The local context of a clause *John UP helped his son* embedded under *Samantha is unaware that___* is in essence the smallest set of worlds that one can restrict attention to when assessing the embedded clause. For this reason, the local context will turn out to include the worlds compatible with the agent's beliefs, but also the actual world – due to the factive component of these constructions. Since the local context should entail that if John helped his son, lifting was involved, this conditional will hold both in the actual world and in the worlds compatible with Samantha's beliefs. And since *be unaware* is factive, we will get the inference that in the actual world John helped his son, and that lifting was involved; but we will still preserve the at-issue inference that Samantha doesn't believe that John helped his son (together with a conditional inference – possibly too strong – that she believes any such help would have involved lifting).

Let us see this in greater detail. We start by assuming that the bivalent meaning of a formula *Unaware_s F* (used as the Logical Form of *s is unaware that 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: $lc(F) = \lambda w^* \lambda w\ (w^* \in C$ and $(w \in Dox_s(w^*)$ or $w = w^*))$. This result is stated in (58) and proven in Appendix II. But a word of explanation might be useful. In the framework of Schlenker 2009, one should think of 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, setting $w^* = c$, the local context of F is $lc(F)(c) = \lambda w\ .\ (w \in Dox_s(c)$ or $w = c)$, which can be thought of as

the set $\text{Dox}_s(c) \cup \{c\}$. 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), hence $\text{Dox}_s(c)$, augmented with itself, $\{c\}$.

(58) **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:
$\text{lc}(F) = \lambda w^* \, \lambda w \, (w^* \in C \text{ and } (w \in \text{Dox}_s(w^*) \text{ or } w = w^*))$

We are now in a position to consider the case of *Samantha is aware that John UP **helped** his son*, analyzed in (59).

(59) a. Samantha is aware that John UP **helped** his son.
a'. Aware$_s$ U**h**
b. Licensing condition:
$\text{lc}(U\mathbf{h}) \vDash \mathbf{h} \Rightarrow u$
By (58), $\text{lc}(U\mathbf{h}) = \lambda w^* \, \lambda w \, (w^* \in C \text{ and } (w \in \text{Dox}_s(w^*) \text{ or } w = w^*))$, where $\text{Dox}_s(w^*)$ is the set of worlds compatible with what individual s believes in world w^*. As a result, we obtain the presupposition that

(i) $C \vDash (h \Rightarrow u) \ \& \ \text{Bel}_s \, (h \Rightarrow s)$

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) $C \vDash h \ \& \ (h \Rightarrow u)$, hence $C \vDash h \ \& \ u$

Since *Aware$_s$ U**h*** 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) $B \vDash \text{Bel}_s(h \ \& \ u)$

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

(60) a. Samantha is unaware that John UP **helped** his son.
a'. Unaware$_s$ U**h**
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) $C \vDash (h \Rightarrow u) \ \& \ \text{Bel}_s \, (h \Rightarrow u)$

(ii) $C \vDash h \ \& \ u$

The at-issue component gives us in the present case:

(iii) $B \vDash \text{not} \ \text{Bel}_s(h \ \& \ u)$

and by (i) and (iii)

(iv) $B \vDash \text{not} \ \text{Bel}_s \, h$

since for $w \in B$, if $w \vDash \text{Bel}_s \, h$, by (i) $w \vDash \text{Bel}_s \, (h \Rightarrow u)$ [because $C \vDash F$ implies $B \vDash F$], hence $w \vDash \text{Bel}_s \, (u \ \& \ h)$, which contradicts (iii).

Importantly, it might seem that *Bel_s(h => u)* in (i) is still too strong. This is directly related to the difficulty we already encountered in (57), and we also leave this problem for future research.
Since the local context of the embedded clause is the same under *aware* and *unaware*, we also get the result that *Samantha is not aware that John UP helped his son* in (61)a is predicted to behave like (60)a.

(61) a. Samantha is not aware that John UP **helped** his son.
a'. not Aware$_s$ U**h**
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) $C \vDash (h \Rightarrow u) \ \& \ \text{Bel}_s \, (h \Rightarrow u)$

(ii) C ⊨ h & u

The at-issue component gives us in the present case:

(iii) B ⊨ not Bel$_s$(h & u)

and by (i) and (iii)

(iv) B ⊨ not Bel$_s$ h

since if B ⊨ Bel$_s$ h, by (i) B ⊨ Bel$_s$ (h => u) [because C ⊨ F implies B ⊨ F], hence B ⊨ Bel$_s$ (h & u), 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 UP **helped** his son* or *Did John UP **help** his son?* We predict a presupposition to the effect that *if John helped his son, lifting was involved* – but our framework does not specify what kind of connection, if any, there should be between the help and the lifting. We clearly want something stronger, namely: *if John helped his son, lifting was involved in the helping event in question*. As Krifka points out, this more adequate inference can be obtained by integrating cosuppositions to an event semantics, one in which *help* 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 (62)a: *help* will compose with two individual arguments y (corresponding to the patient) and x (corresponding to the agent) to yield an event predicate true of helpings events involving x and y as an agent and as a patient respectively. For concreteness, we adopt a trivalent framework in which *UP **help*** yields a failure unless the helping event (relative to certain arguments) entails a lifting motion, as is encoded in (62)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).[33]

(62) a. Lexical entry of *help* (where *help'* is a meta-linguistic predicate true of helping events, and *up'* is a meta-linguistic predicate true of lifting events)

[[help]] = λy λx λe [help'(e) and agent(e) = x and patient(e) = y]

b. Cosupposition triggered by *UP* co-occurring with *help*

[[UP **help**]] = λy λx λe: [help'(e) and agent(e) = x and patient(e) = y] => up'(e) . [help'(e) and agent(e) = x and patient(e) = y]

c. [[John UP **help** his son]]

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

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

For *John UP **help** his son,* we obtain in (62)c a predicate that is true of events in which John helped his son, with a cosupposition that such events are lifting events. To obtain final 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 (63).

(63) [∃e: De] John UP help his son

The final result depends on presupposition projection in existentially quantified structures – a controversial topic. Assuming (as in Heim 1983 and Schlenker 2009) that 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 helps his son, e is a lifting*. 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.

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[33] For notational simplicity, we do not repeat the presupposition as part of the at-issue component. As mentioned in fn. 5 and in the corresponding main text, in standard theories this makes no difference, but there are exceptions.

3.6   Summary and further issues

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. This accounts for the analogies we described in Section 2 between presupposition projection and gestures projection. As a consequence, barring local accommodation, co-speech gestures strengthen the meaning of sentences because their contribution is presuppositional (in the special, cosuppositional form they take).

One issue we did not address is under what conditions local accommodation of a cosupposition is possible – but in fairness this is a complex question in the context of standard presuppositions as well. As mentioned by several colleagues, including an anonymous referee, examples such as (64)a, with contrastive focus, make such readings easy to obtain; we believe they extend to operators besides negation, as in (64)b, which makes it unlikely that mere meta-linguistic readings are at stake. Related remarks are made about the interaction of focus with presuppositions in Simons et al., to appear, and we refer the reader to Esipova 2016 for a comparative discussion of the role of focus in triggering local accommodation of standard presuppositions and of gestural cosuppositions[34].

(64)   a. I did not bring LARGE **[a bottle]**, I brought SMALL **[a bottle]**.
    b. If you bring SMALL **[a bottle]**, I'll be disappointed, but if you bring LARGE **[a bottle]**, I won't be.

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, although they could be combined with our main account to yield a more sophisticated (but conceptually odd) theory. 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 above, our initial cosuppositional analysis predicted some inferences that were somewhat too strong. This was in particular the case in (47)a (*Exactly one of these 10 guys UP **helped** his son*), for which we initially predicted a universal conditional presupposition to the effect that for each of these 10 guys, if he helped his son, lifting was involved. The same potential problem arose in (60)a (*Samantha is unaware that John UP **helped** his son*), for which we initially predicted a presupposition that Samantha believes that either John didn't help his son, or he did so by lifting him. 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. The intuition behind this treatment is that the gesture, being somehow parasitic, should only *enrich* the gesture-free meaning of the sentence. The enrichment is not obtained in a presuppositional fashion, but by conjoining to the gesture-free meaning of the sentence the meaning it has if the gesture is taken to be part of its at-issue component.

The intuitive motivation for this analysis is to treat the meaning of the sentence as being in a sense indeterminate: one can take it to have its literal meaning without the accompanying gesture; or one can take it to have its meaning with the gesture incorporated to its normal at-issue meaning (by way of the conjunction with the expression it modifies). For instance, *John UP **helped** his son* is indeterminate between two meanings: one akin to *John helped his son,* and one to *John helped his son by lifting him*. On the supervaluationist treatment of indeterminacy/vagueness, a sentence is clearly true (or 'super true') only if each resolution of its meaning is true. This is a standard idea in the analysis of vagueness: for *John is bald* to be clearly true, the sentence should be true on all resolutions

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[34] Esipova's current view analysis is broadly compatible with the view that local accommodation is used as a 'last resort'

of the predicate *bald*, whose extension is vague because it isn't not clear how many hairs one may have while still counting as bald (if different resolutions yield different truth values, the sentence is neither true nor false). In the gestural case, the idea is that the sentence is clearly true only if two versions of the sentence are true: one without the gesture, and one in which the gesture makes an at-issue contribution, hence the conjunction of *John helped his son* and *John helped his son by lifting him*. In this simple case, this just yields the same meaning as the strongest of the two conjuncts, but in more complex logical environments the predictions are quite interesting.

As we will see, some are excellent, and some are flawed. But in any event it is worth briefly exploring this analysis in view of the resurgence of interest in (diverse versions of) supervaluationist approaches, which have been applied to (i) presuppositions (see van Fraassen 1969, George 2008, Fox 2008, Schlenker 2008), (ii) semantic paradoxes (e.g. McGee 1991), (iii) vagueness (e.g. Keefe 2008), and (iv) and 'homogeneity' inferences triggered by plural definites and other constructions (Spector 2013).[35] It is thus of interest to explore whether co-speech gestures might be an additional domain of application for supervaluations. In addition, we will see that one might be able to *combine* the supervaluationist and the cosuppositional approaches to yield subtle and interesting predictions.

Let us give an initial statement of a Basic Supervaluationist Account:

(65) **Basic Supervaluationis Account**
A sentence of 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 *Samantha is unaware that John UP **helped** his son*. As shown in (66), this ends up yielding the strongest of the presuppositions of *Unaware$_s$ h* and *Unaware$_s$ (h & u)*, hence a presupposition that John helped his son by lifting him; while this also yields the strongest of the two at-issue components, and hence (since the at-issue component is negative) an assertion that Samantha doesn't believe that John helped his son – irrespective of whether this was by lifting him or by other means.

(66) a. Samantha is unaware that John UP **helped** his son.
a'. Unaware$_s$ U**h**
b. (a') is true iff *Unaware$_s$ h* and *Unaware$_s$ (h & u)* are both true,
iff it is presupposed that h, and (it is asserted that) s doesn't believe that h, and it is presupposed that (h & u), and (it is asserted that) s doesn't believe that (h & u)
iff it is presupposed that h and u, and s doesn't believe that h. In other words, it is presupposed that John helped his son by lifting him, and (it is asserted that) Samantha doesn't believe that John helped his son.

Importantly, we do not derive in this way the questionable inference that Samantha believes that if John helped his son, lifting was involved (or more precisely: Samantha believes that John didn't help his son, or that lifting was involved). Thus we have solved one of the problems encountered by the cosuppositional approach.

This initial success of the Basic Supervaluationist Account extends to other non-monotonic environments such as *exactly one*, as shown in (67).

(67) a. Exactly one of these 10 guys UP **helped** his son.
a'. [=1 g] U**h**
b. (a') is true and felicitous iff *[=1 g] h* and *[=1 g] (h & u)* are both true and felicitous. It follows that exactly one guy helped his son, and furthermore he did so by lifting him.

This result can be compared to the stronger inference we obtained in our presuppositional approach in (47). As will be recalled, we had derived two relevant inferences:
• relative to the Context Set, if any of the 10 guys helped his son, slapping was involved.
• relative to the (more specific) speaker's beliefs, exactly one of the 10 guys helped his son; by the first inference, lifting was involved.
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 UP **helped** 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 (68).

(68) **Mixed Supervaluationist Account**
A co-speech gesture
(i) is treated in terms of the Basic Supervaluationist Account in (65)...
(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 it is 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 UP **helped** their son*. In essence, the Basic Supervaluationist Account treats this as a the conjunction of *Between 3 and 5 guys helped their son*, and *Between 3 and 5 guys helped their son by lifting him*. This turns out to be true in case exactly 5 guys helped their son, and exactly 3 guys helped their son by lifting him – which seems to us to be a counterintuitive result. We believe the desired inference is closer to: *Between 3 and 5 helped their son, and those that did lifted 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?

Pioneering work on gesture projection originated in work by Ebert and Ebert (2014). They argued that co-speech gestures have the same kind of semantic contribution of appositive relative clauses – they are thus 'supplements'. We submit that this analysis of co-speech gestures is in error, but that post-speech gestures indeed contribute supplements. The contrast between these two provides an important argument against Ebert and Ebert's analysis.

Importantly, there should be a clear temporal distinction between the co-speech gestures and the post-speech gestures; the latter should only start the end of the production of the spoken expressions they modify. As we mentioned in Section 1.3 (and especially in fn. 9), there is a rich literature on the alignment between gestures and speech, particularly in connection with intonation. But for our purposes the distinction between co- and post-speech gestures does not require such a fine-grained distinction: a co-speech gesture does not have its own time slot and co-occurs with the entire expression that it modifies, as encoded in our notation; by contrast, a post-speech gesture has its own time slot and starts after the expression it modifies.

4.2.1   Co-speech gestures as cosuppositions vs. Post-speech gestures as supplements

Schlenker 2015e provides initial arguments against a supplemental analysis by focusing on negative environments in which supplements are degraded. But in order to understand the full typology, we need to consider a broader range of examples, with positive and negative environments, co-speech and post-speech gestures, as well as appositive relative clauses. Here we focus on size-denoting gestures that modify NPs, as these make a comparison with appositives particularly easy. It is immediate that the distribution of indicative appositive relative clauses does *not* mirror that of co-speech gestures, but rather that of post-speech gestures. It is of course important to pronounce the appositives as is appropriate for non-restrictive clauses; the relevant reading can be brought out by

adding *by the way* right after the relativizer.[36] Overall, and with a possible exception in (74), the acceptability of post-speech gestures tracks that of appositive relative clauses. Since at this point we are interested in the distribution of these expressions rather than in the inferences they give rise to, we omit the latter from the present discussion.

(69) a. Some/No philosopher brought LARGE **[a bottle of beer]**.
b. Some/#No philosopher brought a bottle of beer, which (by the way) was LARGE **this** large. (Schlenker 2015e)
c. Some/#No philosopher brought a bottle of beer – LARGE.

(70) a. It's likely/It's unlikely that the previous speaker brought LARGE **[a bottle of beer]** to his talk.
b. It's likely/#It's unlikely that the previous speaker brought a bottle of beer, which (by the way) was LARGE **this** large.[37]
c. It's likely/# It's unlikely that the previous speaker brought a bottle of beer – LARGE.

(71) a. One/None of these 10 guys UP **helped** his son.
b. One/#None of these 10 guys helped his son, which (by the way) he did by lifting him.
c. One/#None of these 10 guys helped his son – UP.

(72) a. It's likely/It's unlikely that John UP **helped** his son.
b. It's likely/#It's unlikely that John helped his son, which (by the way) he did by lifting him.
c. It's likely/#It's unlikely that John helped his son – UP.

(73) a. One/None of these 10 guys SLAP **punished** his son.
b. One/#None of these 10 guys punished his son, which (by the way) he did by slapping him.
c. One/#None of these 10 guys punished his son – SLAP.

(74) a. It's likely/It's unlikely that John SLAP **punished** his son.
b. It's likely/#It's unlikely that John punished son, which (by the way) he did by slapping him
c. It's likely/(?) It's unlikely that John punished his son – SLAP.

As mentioned in Schlenker 2015e, a supplementary approach could deal with (69)a-(70)a by taking the gestures to behave like the appositives in (69)b-(70)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. But the crucial problem is that *this approach does not explain why such a strategy* fails *to be available in the case of post-speech gestures* (we come back below to a potential explanation). A more natural account is afforded by positing that post-speech gestures are supplements and that they cannot involve a covert counterfactual mood.

We note for completeness that related contrasts can be obtained on the basis of facial expressions. (75)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 (75)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.

(75) 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].

4.2.2 *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 is 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

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[36] Thanks to Miloje Despić for making this suggestion.
[37] Note that here and in the other b-examples one might expect a slight pragmatic oddity with *likely* due to the fact that this expression implicates that it's not established that the relevant event took place, whereas the *which*-clause presupposes its existence. But in any vent the version of the sentence with *unlikely* is far worse.

particular, one could argue instead (i) that they make an at-issue contribution; or (ii) that they have a cosuppositional semantics. We discuss each theory in turn.

❑ *An at-issue semantics for post-speech gestures?*

First, could post-posed gestures have an at-issue semantics?[38] If so, they should be able to take scope under operators. The deviance of the negative version of the c-examples in (69)-(73) already suggests that under the negative quantifier *No NP* this 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 with full-fledged clauses. This, however, would fail to account for the cases of embedding under *unlikely*. Similarly, to the extent that (76)a is interpretable, it seems to us that its differs sharply from the controls with at-issue modifiers in (76)b-c: the latter are interpreted in the scope of *deny*, but the post-speech gesture *SLAP* isn't.

(76) a. ?? I deny that John punished his son – SLAP.
      b. I deny that John punished his son (and [that he] did so) like SLAP **this**.
      c. I deny that John punished his son (and [that he] did so) by slapping him.

Similar remarks hold for (77)a: to the extent that it is acceptable, it seems to us that it does not raise the question but rather assumes that punishment would involve slapping – unlike the at-issue controls in (77)b-c.

(77) a.?(?) Do you think that John punished his son – SLAP?
      b. Do you think that John punished his son (and [that he] did so) like SLAP **this**?
      c. Do you think that John punished his son (and [that he] did so) by slapping him?

It also useful to consider the paradigm in (78), where all sentences seem to be acceptable.[39] The question is whether (78)a resembles (78)c-d rather than (78)b in triggering an inference that *if John punishes his daughter, slapping will be involved*. It seems to us that the post-speech gesture in (78)a does not take scope within the *if*-clause.

(78) a. If John punishes his son – SLAP, I'll scream.
      => if John punishes his son, slapping will be involved
      b. If John punishes his son by slapping him, I'll scream.
      ≠> if John punishes his son, slapping will be involved
      c. If John punishes his son, which will/would involve some slapping, I'll scream.
      => if John punishes his son, slapping will be involved
      d. If John punishes his son (this would involve some slapping), I'll scream.
      => if John punishes his daughter, slapping will be involved

Similar issues arise with less clearly acceptable sentences in (79). To the extent that (79)a is acceptable, it appears to assume rather than deny that for John to punish his son would involve some slapping. This is sharply different from the reading we get with the at-issue control in (79)b.

(79) a. ?(?) Never in a thousand years will John punish his son – SLAP.
      b. Never in a thousand years will John punish his son like SLAP **this**.

Although the data would need to be investigated much more thoroughly (and possibly with experimental means), we take them to suggest that post-posed gestures do not have an at-issue semantics.

❑ *A cosuppositional semantics for post-speech gestures (Krifka, p.c.; Pasternak, p.c.)*

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 the negative version of the c-examples in (69)-(73). The behavior of (78)a can now be explained in terms of properties of presupposition projection. Focusing on (78)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 (78)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.

Without fully implementing the proposal, it could be made concrete along the lines of (80):

(80) Cosuppositional analysis of post-speech gestures and facial expressions (informal statement)
      a. A post-speech gesture or facial expression *G* takes a null anaphoric expression, hence has the form:

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[38] Thanks to Cornelia Ebert (p.c.) and to an anonymous reviewer for suggesting that we discuss this possibility.
[39] From the present perspective, we would need to say that the post-speech supplement involves indicative mood, possibly because its is generic (≈ if John punishes his son, *which normally involves some slapping*, etc.).

G pro$_i$
b. It yields a semantic failure unless, relative to the local context of *G pro$_i$*, *pro$_i$* entails the (bivalent) content of *G* ('generalized entailment' must be used if these expressions
c. If it does not yield a failure as in b., *G pro$_i$* makes a trivial (tautologous) contribution: it has a purely cosuppositional meaning.

As an example, consider again the example in (34)c, repeated in (81).

(81) None of my friends goes skiing with his parents – :-(_⏺.

There are at least two conceivable ways to resolve the anaphoric element *pro$_i$* introduced by the post-speech gesture.
• If *pro$_i$* has is a proposition-denoting pronoun, it is natural to take it to be coindexed with the entire proposition that *none of my friends goes skiing with his parents*. This should yield a cosupposition to the effect that this fact is disgusting – hence it would be good for my friends to go skiing with their parents.
• If *pro$_i$* is a property-denoting pronoun, it is natural to take it to corefer with the property of going skiing with one's parents. There is a technical issue involved at this point: one must determine (i) what the local context of the post-speech gesture is, and (ii) what it means for the property of going skiing with one's parents to entail disgust. We leave this open at this point, but it is plausible that the local context of the post-speech gesture is the initial context updated with the propositional content of the main sentence. And that the predicted inference is thus that skiing with one's parents in general should be disgusting (an alternative would be that it is only the case for each of my friends x, x's skiing with x's parents is disgusting; it' isn't quite clear how this could be derived).
To the extent that (81) is ambiguous, the cosuppositional analysis of post-speech gestures could be maintained. But it encounters difficulties in several cases. In a nutshell, the problem is that post-speech gestures have a more restricted distribution than one might expect on a cosuppositional analysis.
(i) Our initial argument against Ebert and Ebert's (2014) supplement-based analysis of co-speech gestures was that these are less constrained that appositive relative clauses. But as we saw in Section 4.2.1, post-speech gestures are constrained in exactly this way. The cosuppositional analysis of post-speech gestures would have to posit that the antecedent of the covert pronoun is constrained to be propositional in nature. However this measure won't be enough for examples (70) and (72) above, where a full clause is embedded under *it is unlikely/it is likely that*, but can apparently not be targeted by the post-speech gesture. So one would need to posit there is a general preference for resolving the null pronoun to a matrix proposition. We leave such explorations for future research.

(ii) In order to compare this cosuppositional analysis of post-speech gestures with the supplemental analysis, we would need to be 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.[40]
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 (82).[41]

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

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[40] The availability of such 'low scope' readings with post-speech gestures remains to be investigated. A closer analysis of examples such as (78)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.
[41] An anonymous referee suggests that presupposition are a heterogeneous class and could thus differ along this dimension, with some having a non-triviality requirement. But we don't know of *other* presupposition triggers, and if none can be found this parameter of variation would have to be stipulated for the analysis of cosuppositions.

In that respect, it would seem that post-speech gestures pattern with supplements rather with presuppositions. Consider (83)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.

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

   b. ? John SLAP_ punished his son – SLAP_.

Facts are more subtle in (83)b, where the first occurrence of *SLAP* contributes cosuppositional rather than at-issue 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 (84)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 (84)b, which is predicted to be deviant because the appositive contributes no information; in this case the prediction seem to be correct.[42]

(84) 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 (84)a and on (84)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.[43]

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[42] 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.

[43] 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).

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.[44] 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.

     We argued against a supervaluationist alternative to our analysis, although we do not claim to have exhausted the space of possible supervaluationist theories; and a supervaluationist analysis could be combined with our main theory to yield a sophisticated but conceptually odd account. 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.[45]

     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 2015; 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 at-issue (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 (= external enrichment) always starts out as non-at-issue, whereas an iconic enrichment of an expression obtained by modulating that very expression (=internal enrichment) can have any status. Many iconic effects in sign language are internal, as it is easy to modulate signs in rich iconic ways; they may thus

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[44] 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.

[45]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, 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 somewhat if there is in the end some kind of non-triviality requirement on cosuppositions, as mentioned at the end of Section 4.2.2. In addition, as noted in fn. 43, 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.)

be at-issue. But by their very nature, co- and post-speech gestures always yield external enrichments, and thus one might expect that they are never at-issue. 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 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)__[46]

❑ *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.

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

(86) **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).

(87) **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<$\underline{P}$>P'.<$\underline{R}$>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 (85) with the classical semantics in(86):

(88) **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 $\vDash^{c'-x}$ 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[47]).

Presupposition satisfaction is then defined by reference to local contexts:

(89) **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)

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[46] This Appendix borrows from Schlenker 2009 and Schlenker 2010 (especially Section 2.4. of Schlenker 2009).
[47] 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 *dd'* that occurs in *F*, *d* is entailed by its local context as reconstructed here (we write this as *Sat(C, F)*; *lc(C, dd', a_b)* refers to the local context of *dd'* in the sentence *a dd' b*, as obtained by (88)). This result is summarized in (90).

(90)   Let C ⊆ W be a context set and let *F* be a propositional formula. Then:
    (i) for all expressions *a, b, dd'* , if F = a *dd'* b, lc(C, *dd'*, 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, (90) 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

(91)   **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 α A, 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 (92).

(92)   **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 (42), 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 (85) 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).

(93)   **Principle of Transparency (after Schlenker 2007b, 2008)**
    A predicative or propositional presupposition trigger *dd** 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 (93) (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.

(94)   If *a (e⇒g)e* b* satisfies (93) (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:

(95) 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 (94) 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 (93).

(ii) Let us turn to the second result.

(96) In general, the converse of (94) does not hold, even under the hypotheses of Non-Triviality and Constancy: there are cases in which *a (e & g) b* satisfies (93) 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.

(97) **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

(93) applied to *(Q T. (e & g))* is given in (98), 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*.

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

But (93) applied to *(Q T. ((e⇒g)e*))* as in (99)a will fail to hold in case *c'* is a tautologous predicate and *g* is, as before, a contradictory predicate. This is because (99)a is equivalent in this case to (99)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*.

(99) 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 (91) and (92) 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 (97), *(Q T. (not e))* has different values in w and w', which shows that Non-Trivality as defined in (91) 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 (100)

(100) **Transparency predicts the same presuppositions for** *(No P. ((e⇒g)e*))* **and** *(No P . (e & g))*
    a. (94) shows that if *(No P. ((e⇒g)e*))* and C satisfy (93), so do *(No P . (e & g))* and C.
    b. Suppose, for contradiction, that *(No P . (e & g))* and C satisfy (93) 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 (93), *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.[48]

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[48] 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.

(101) **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*.

<u>Claim</u>: 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$_s$ ≠ w*, Dox$_s$(w*)(w$_s$) = 1.[49]

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'.

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[49] 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. $\mathbf{c'}(w^*)(w^*) = 1$, hence for some for some $w \in Dox_s(w^*)$, $\mathbf{c'}(w^*)(w) = 0$. Take d' to be a tautology. Then:

a. $w^* \vDash (c'~\&~d')~\&$ not Bel_s(c' & d') because $\mathbf{c'}(w^*)(w^*) = 1$ and d' is a tautology, whence $w^* \vDash (c'~\&~d')$;

and $w \in Dox_s(w^*)$ and $\mathbf{c'}(w^*)(w) = 0$, whence $w^* \vDash$ not Bel_s(c' & d'). However,

b. $w^* \nvDash d'~\&$ not Bel_s d' because d' is a tautology, whence $w^* \vDash$ 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 (102).

(102) The presuppositional account predicts stronger inferences than the supervaluationist account
    a. Suppose that a sentence … G*e* … 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 … G*e* … 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 … G*e* … is felicitous and true, then both … *e* … and … *(e & g)* … are felicitous and true, which shows that … G*e* … 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 (47) and (67)

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 … G*e* … 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 … G*e* … 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 (103):

(103) R(e, g) = {[λwλx . **e**(w)(x) = 1 & <x, w> ∈ F => **g**(w)(x) = 1]: F ⊆ D ×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 {λwλx . **e**(w)(x) = 1, λwλx . **e**(w)(x) = 1 & **g**(w)(x) = 1}; by contrast, the point-wise definition using (103) 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.

(104) 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 $R(p, s) = \{[\lambda w \lambda x \ . \ \mathbf{p}(w)(x) = 1 \ \& \ <x, w> \in F => \mathbf{s}(w)(x) = 1]: \ F \subseteq D \times W\}$, 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:

(105) 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 (105) ('first try a supervaluationist analysis; and if this still makes the gesture vacuous, go for a presuppositional treatment') encounters problems. Consider the sentences in (106):

(106) 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 (107) and (108).

(107) 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.

(108) 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 (107) and (108), 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 . $\mathbf{e}$(w)(x) = 1 & <u><x, w> ∈ F => $\mathbf{g}$(w)(x) = 1</u>]: 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 $\mathbf{p}$(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 $\mathbf{p}$(w)(x) = 1 & <u><x, w> ∈ F => $\mathbf{s}$(w)(x) = 1</u> – 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 (109).

(109) 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 . $\mathbf{p}$(w)(x) = 1 & <x, w> ∈ F => $\mathbf{s}$(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* [50]). This is shown for both versions of the supervaluationist account in (110), symbolizing the relevant quantifier as *[3 ≤ • ≤ 5 g]*.

(110) 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

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[50] 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 $\mathbf{p}$(w)(x) = 1 & <u><x, w> ∈ F => $\mathbf{s}$(w)(x) = 1</u> – 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 $\mathbf{p}$(w)(x) = 1 & <u><x, w> ∈ F => $\mathbf{s}$(w)(x) = 1</u> – 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 10 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 (111) and (112).

(111) **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:

R(e, g) = {[λwλx . $\mathbf{e}(w)(x) = 1$ & ($<x, w> \in F => \mathbf{g}(w)(x) = 1$)]: $F \subseteq D \times W$}

(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∈W, x∈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:

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

(112) **Equivalence of (111)a and (111)b**
With the definition in (111), R(e, g) = R'(e, g), and as a result (111)a and (111)b make the same predictions.

(i) First, we show that if $P \in R'(e, g)$, $P \in R(e, g)$. We define F' = {$<x, w>$: $\mathbf{e}(w)(x) = 1$ and $\mathbf{g}(w)(x) = 0$ and P(w)(x) = 0}. And we note that P = λwλx . [$\mathbf{e}(w)(x) = 1$ & $<x, w> \in F' => \mathbf{g}(w)(x) = 1$], which shows that $P \in R(p, s)$.[51]

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[51] In greater detail, let us write abbreviate λwλx . [$\mathbf{e}(w)(x) = 1$ & $<x, w> \in F' => \mathbf{g}(w)(x) = 1$] as $R_{F'}$, and show that $P = R_{F'}$. Clearly, for all $<x, w> \in D \times W$,
(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)),

(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 $\langle x, w \rangle \in F \Rightarrow g(w)(x) = 1$ 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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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)).

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