CrossMark

Gestural semantics

Replicating the typology of linguistic inferences with pro- and post-speech gestures

Philippe Schlenker[1,2,3]

© Springer Nature B.V. 2018

Abstract We argue that a large part of the typology of linguistic inferences can be replicated with gestures, including some that one might not have seen before. While gesture research often focuses on *co-speech gestures*, which co-occur with spoken words, our study is based on *pro-speech* gestures (which fully replace spoken words) and *post-speech gestures* (which follow expressions they modify). We argue that pro-speech gestures can trigger several types of inferences besides entailments: presuppositions and anti-presuppositions (derived from *Maximize Presupposition*), scalar implicatures and 'Blind Implicatures,' homogeneity inferences that are characteristic of definite plurals, and some expressive inferences that are characteristic of pejorative terms. We further argue that post-speech gestures trigger inferences that are very close to the supplements contributed by appositive relative clauses. We show in each case that we are not dealing with a translation into spoken language because the fine-grained meanings obtained are tied to the iconic properties of the gestures. Our results argue for a generative mechanism that assigns new meanings a specific place in a rich inferential typology, which might have consequences for the structure of semantic theory and the nature of acquisition algorithms.

✉ P. Schlenker
philippe.schlenker@gmail.com

1   Institut Jean-Nicod (ENS – EHESS – CNRS), Département d'Etudes Cognitives, Ecole Normale Supérieure, Paris, France

2   PSL Research University, Paris, France

3   New York University, New York, USA

🖄 Springer

1 Introduction

1.1 Goals

While there has been considerable work on the interaction between language and gestures, only recently has linguistics attempted to study the role of gestures in the typology of meaning operations in language. Traditionally, linguists have focused on *co-speech gestures*, which are produced simultaneously with the spoken words they modify. But recent research has brought two further categories to prominence: *post-speech gestures*, which follow the expressions they modify; and *pro-speech gestures*,[1] which fully replace some spoken words (Slama-Cazacu 1976; Clark 1996; Fricke 2008; Ladewig 2011; Schlenker 2017, to appear b). A natural question is how gestures fit in the typology of linguistic inferences uncovered by contemporary semantics.

Some coarse-grained gestural typologies were proposed in recent work. First, pro-speech gestures (as in (1)a) usually make an assertive contribution. Second, while there is general agreement that co-speech gestures (as in (1)b) are non-assertive, theorists differ as to their nature: some believe that they display the behavior of appositive relative clauses in contributing supplements (Ebert and Ebert 2014), while others take them to trigger presuppositions of a particular sort (Schlenker 2015, 2017, to appear a, to appear b). However proponents of the latter claim have argued that *post*-speech gestures (as in (1)c) display the behavior of appositive relative clauses (see Sect. 1.2 for full transcription conventions).

(1)   a. **Pro-speech gesture:**   Her enemy, Mary will _<phhh>.

       b. **Co-speech gesture:**   Mary will **punish** her enemy.

       c. **Post-speech gesture:**   Mary will punish her enemy – _<phhh>.

In this piece, we argue that a large part of the typology of linguistic inferences found in language can be replicated with gestures, including some that one has not encountered before. Besides standard entailments, we argue that pro-speech gestures can trigger scalar implicatures and associated phenomena (Blind Implicatures), pre-

---

[1]A note about the terminology: a *pro-speech gesture* replaces a spoken word, just as a *pronoun* replaces a noun and a *proconsul* replaces a consul.

suppositions and associated phenomena (namely anti-presuppositions due to *Maximize Presupposition*), homogeneity inferences that are characteristic of definite plurals, as well as some expressive inferences that are characteristic of some pejorative terms. We further argue that post-speech gestures trigger inferences that are very close to the supplemental inferences obtained with appositive relative clauses. We show in each case that we are not dealing with a translation into words because the fine-grained meanings obtained are tied to the iconic properties of the gestures. Nonetheless, new gestures are easily assigned a specific place in a sophisticated inferential typology.

If correct, these results might have broader consequences. An important achievement of contemporary semantics was to uncover an exquisitely detailed typology of linguistic inferences. But a key question pertains to their source: are they encoded in rich lexical entries that might be relatively arbitrary and require rich input to be acquired? Or are they generated by a productive procedure that takes as input the form and simple (i.e. bivalent, non-multidimensional) semantic contribution of an expression and returns its fine-grained meaning within the inferential typology?

1.2 Transcription conventions and methods

For legibility, we use a non-standard font to transcribe gestures. A gesture that co-occurs with a spoken word (= a co-speech gesture) is written in capital letters or as a picture (or both) *preceding* the expression it modifies. The modified spoken expression will be boldfaced, and enclosed in square brackets if it contains several words, as illustrated in (2).

(2)   Mary $\mathbb{SLAP}$ **punished** her enemy.

        Mary $\mathbb{SLAP}\_$ **punished** her enemy.

        Mary **punished** her enemy.

A gesture that follows a spoken word (= a post-speech gesture) is written in capital letters or as a picture *following* the expression it modifies, and preceded by a dash: –, as illustrated in (3).

(3)   Mary punished her enemy – $\mathbb{SLAP}$.

        Mary punished her enemy – $\mathbb{SLAP}\_$.

        Mary punished her enemy – .

A gesture that replaces a spoken word (i.e. a 'pro-speech gesture') is written in capital letters, if necessary with an onomatopoeic sound following it (with an 'un-

derscore' connection _ between the sound and the gesture, as for words modified by co-speech gestures); this is illustrated in (4).

(4)   Your brother, I will $LAP_<phhh>.

      Your brother, I will $LAP__<phhh>.

      Your brother, I will _<phhh>.
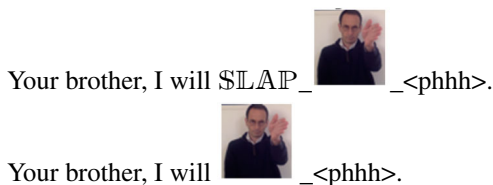
Gestural data reflect the author's judgments and those of linguists that were consulted (native speakers of American English who are not signers).[2] While experimental methods will be useful to establish the facts more rigorously, we believe that it is reasonable to adopt standard linguistic methodology and establish fine-grained generalizations on the basis of rich introspective judgments, before testing them more systematically when quantitative data become relevant (see Tieu et al. 2018 for an experimental confirmation of our results pertaining to scalar implicatures, presuppositions, homogeneity inferences and supplements).

One general point is worth making about methods. The interpretation of gestural inferences depends on discourse, context and world knowledge, but this is true of non-gestural inferences as well, especially when it comes to pragmatic inferences. Whenever possible, we will try to provide minimal pairs as well as precise tests that suggest that the target inferences are specifically produced by the target gestures (sometimes combined with explicit contextual conditions), and that they fall within well-understood categories of the inferential typology. This will help make our findings relatively theory-neutral: whatever accounts for the standard inferential typology might have to be extended to the gestural case as well.

1.3 Structure

The rest of this article is organized as follows. In Sect. 2, we provide some background on the inferential typology uncovered by recent semantics, and on the typology of gestures. We then show that each cell of the inferential typology can be filled with gestures. In each case, we seek to (i) zero in on telltale properties of the relevant inferences and then (ii) to replicate them with gestures; we also (iii) highlight sophisticated iconic/gradient properties of gestural inferences, which make it implausible that they are codes for simple, gesture-free words. We show in Sect. 3 that standard and 'blind' implicatures arise with gestures—which is unsurprising given standard theories. We turn to presuppositions and anti-presuppositions in Sect. 4, with more surprising results: they too seem to be the result of productive processes. Homogeneity inferences are discussed in Sect. 5, followed by expressives and supplements in Sect. 6. Theoretical consequences and conclusions are drawn in Sect. 7.

---

[2]Some related French data were discussed with French-speaking colleagues but are not reported here.

2 Background: Inferential typology and gestural typology

2.1 Inferential typology

2.1.1 General picture

One of the great achievements of contemporary semantics has been to uncover an articulated typology of semantic and pragmatic inferences, and to describe and sometimes explain on principled grounds their interaction with logical operators. We will remind the reader of the main properties of each inferential type as we consider it in connection with gestures below. But before we plunge into this detailed discussion, we should sketch the general picture and its theoretical significance. One key question is whether the relevant inferences are encoded in some lexical entries,[3] or are taken to be derived by productive semantic or pragmatic processes.

Any semantics has of course a notion of 'entailment': *Mary is an American student* entails *Mary is a student* because any situation that makes the first sentence true makes the second sentence true as well. Here the entailment follows from the meaning of the words alone, and does not rely on additional assumptions. In other cases, an entailment is *contextually* valid. *Mary is in Paris* entails *Mary is in France* because any situation *compatible with our knowledge* that satisfies the first sentence satisfies the second as well. Contemporary semantics has gone far beyond entailments to offer the typology illustrated in (5).

(5) **Typology of linguistic inferences**

Type	Lexical?	Examples
Standard scalar implicatures	No (Horn 1972), except possibly for the existence of lexical scales	Some group members attended. ⇒ not all group members attended
Blind scalar implicatures	No, just like standard scalar implicatures (Magri 2009)	#Some Italians come from a warm country.
Presuppositions	Yes (Heim 1983)	None of my students knows that he is incompetent. (⇒ all of my students are incompetent)
Anti-presuppositions	Like standard presuppositions, possibly with lexical scales in addition	#John is incompetent and he believes it.
Homogeneity inferences	[not entirely clear yet, but probably not lexical]	Mary will/won't find her presents. ⇒ she will find all / she will find none
Supplements	Yes, through the comma intonation (Potts 2005)[4]	One/#None of these women helped her son, which saved him.
Expressives	Yes (Potts 2005)	(#) If I were really prejudiced against the French, I wouldn't hire a Frog.

Let us briefly discuss each case in turn.

---

[3]Lexical entries may be rather abstract, as when one posits a special lexical entry for a 'comma intonation' in appositive relative clauses (Potts 2005).

[4]We write 'yes' in this cell because, on Potts's analysis, a special lexical entry is needed to handle appositive relative clauses, namely what he calls the 'comma intonation.' As hinted in the text, although the phonological realization of this lexical entry is rather abstract (possibly involving just a pause), it involves a semantic specification that does not follow from independent principles and is thus lexical in nature.

2.1.2 Scalar implicatures

Historically, scalar implicatures were taken to be derived rather than lexically encoded. In a variety of neo-Gricean theories (from Horn 1972 to Chierchia et al. 2012), (6)a yields the inference that not all group members attended because it competes with (6)b, which is more informative.[5]

(6)   a. Some group members attended.
            ⇒ not all group members attended
        b. All group members attended.

There may be something lexical, however, in the ways in which alternatives are generated. Horn (1972) posited 'lexical scales' to determine which expressions a word competes with; as a result, his theory of implicature generation had a lexical component. More recent accounts have sometimes tried to eschew lexical stipulations. In particular, Katzir (2007) and Katzir and Fox (2011) take alternatives to be either provided by the context, or by syntactic manipulations that consist, in essence, in replacing or simplifying parts of the target sentence. In the example in (6)a, the replacement of *some* with *all* suffices to generate the desired alternative (see Geurts 2011 for a different view).

   Scalar implicatures were taken by Grice and his followers (Grice 1981; Horn 1972) to follow from principles of cooperative communication. As result, the relevant notion of informativity was taken to be based on contextual entailment, because what matters for the speech act participants is the information provided by a sentence *relative to the context*. From this perspective, data discussed by Magri (2009) raised new issues. (7)a is deviant, and it is tempting to explain this fact because it triggers the implicature that the alternative in (7)b is false. On this tempting theory, we then observe that, taken together, the sentence and its implicature yield the inference that 'some but not all Italians come from a warm country.'[6] But in the world as we know it, this is not possible: the predicate was chosen in such a way that *some Italians come from a warm country* is true just in case *all Italians come from a warm country*, and thus one could not assert the first sentence while implicating that the second is false.

(7)   a. #Some Italians come from a warm country.
        b. All Italians come from a warm country.

The difficulty, however, is that Gricean and neo-Gricean theories cannot explain why (7)a should trigger an implicature to begin with: precisely because (7)a and (7)b are equivalent relative to contextual knowledge, the Gricean or neo-Gricean reasoning, based on differences in informativity, cannot get off the ground.

---

[5]In several recent theories (e.g. Spector 2006), an alternative S' to a sentence S can be negated in case it is non-weaker than S, or in other words if S and not S' is not contradictory. For instance, *The first group member attended* may evoke the sentence *The second group member attended*, which is not more informative, but which can be denied without contradicting the first sentence. The second sentence can thus be negated on this revised view, yielding the inference that the second group member didn't attend. See for instance Schlenker (2016) for a survey that discusses this issue.

[6]A contradiction is obtained on the assumption, made by Magri and others, that it is presupposed that there are Italians (or more generally that the NP restrictor of *some* and *all* has a non-empty denotation).

Magri's solution (2009) is to propose, against the Gricean tradition, that implicatures should be computed *without access* to contextual information. On this assumption the second sentence is in fact stronger than the former; this suffices to trigger an implicature, which then yields a contradiction when contextual knowledge is finally taken into account. While this analysis is debated (e.g. Schlenker 2012; Spector 2014; and Magri 2017), the term 'Blind Implicatures' has been used to characterize cases of deviance such as (7)a. It goes without saying that Blind Implicatures are a direct product of general mechanisms of implicature generation, and are thus no more lexically based than 'standard' implicatures.

To foreshadow our enterprise, we will show that pro-speech gestures (including some that one may never have encountered before) trigger implicatures, and that these may, depending on the case, be generated by way of contextual or non-contextual alternatives. Furthermore, we will show that Blind Implicatures too can be replicated with gestures. These results will help us establish our methodology, and they will also serve as a 'sanity test,' as these results are expected on theoretical grounds given current theories of implicatures.

2.1.3 Presuppositions

By contrast with implicatures, presuppositions are usually taken to be lexically encoded: a sentence such as *John knows that he is incompetent* is taken to presuppose (rather than to entail or implicate) that John is incompetent, due to lexical properties of *know* (e.g. Heim 1983). Presuppositions are usually taken to be characterized by two key properties. First, they impose constraints on what is taken for granted by the speech act participants rather than just on what the speaker believes; in technical parlance, they are evaluated with respect to the 'context set' (Stalnaker 1974, 2002) rather than to the speaker's belief state. As a result, the above sentence would be slightly odd in a conversation in which the addressee initially thinks that John is in fact competent.[7] Second, and more robustly, presuppositions interact in characteristic ways with logical operators. Whereas the negation of a sentence removes its entailments, presuppositions 'project' out of negation, as illustrated in (8)a. And strikingly, a presupposition trigger that appears under a *none*-type quantifier gives rise to a universal positive inference, as in (8)b.

(8)   a. John doesn't know that he is incompetent.
        ⇒ John is incompetent
    b. None of my students knows that he is incompetent.
        ⇒ all of my students are incompetent

It has been suggested that some presuppositions are triggered by general (non-lexical) algorithms, possibly on pragmatic grounds (e.g. Grice 1981; Stalnaker 1974; Abbott 2000; Simons 2001; Abusch 2010; Schlenker 2010; Chemla 2010; Simons et al. 2010; Abrusán 2011; Romoli 2015; Tonhauser et al. 2013). This debate—are

---

[7]There are exceptions to this observation, as presuppositions may in some cases be informative, as discussed for instance by Stalnaker (2002), von Fintel (2008), Schlenker (2012).

presuppositions lexically encoded, or are they triggered by a general algorithm?—will make our gestural data theoretically important: we will show that certain pro-speech gestures generate presuppositions even though they may be so uncommon that most informants exposed to them would likely see them for the very first time; this, in turn, will suggest that *some* triggering mechanisms are sometimes needed.

One further point is worth noting. In some cases, there appears to be a requirement that the strongest possible presupposition (relative to a set of alternatives) should be marked (Sauerland 2003, 2008; Percus 2006; Singh 2011; Schlenker 2012). For instance, (9)a is odd because (9)b makes roughly the same claim, but triggers a stronger presupposition.

(9)   a. #Mary believes that Paris is in France.
        b. Mary knows that Paris is in France.

To put it differently, (9)a triggers the inference that it is not presupposed that Paris is in France, which is called an 'anti-presupposition.' While the source of the phenomenon is under debate, it is predicted to arise by a variety of theories whenever an expression competes with another one that makes a comparable at-issue contribution but triggers a stronger presupposition; we will see that gestures bear this out.

2.1.4 Homogeneity inferences

Turning to homogeneity inferences, they were investigated in connection with the inferential behavior of definite plurals, illustrated in (10) (e.g. Löbner 2000; Gajewski 2005; Spector 2013a; Križ 2015, 2016). In a context in which a number of presents were hidden for some children, (10)a behaves roughly like (10)a′ in meaning that Mary will find all of her presents. However, its negation (10)b doesn't mean that Mary won't find all of her presents, as would be expected given the general behavior of negation, but rather that she won't find any. This is the initial puzzle raised by homogeneity inferences.

(10)   a. Mary will find her presents.
            ⇒ Mary will find all of her presents
        a′. Mary will find all of her presents.
            ⇒ Mary will find all of her presents
        b. Mary won't find her presents.
            ⇒ Mary will find none of her presents
        b′. Mary won't find all of her presents.
            ⇏ Mary will find none of her presents

Some accounts take such inferences to be a species of presuppositions (Löbner 2000; Gajewski 2005), while others take them to be *sui generis* (Spector 2013a; Križ 2015, 2016). We will see that they arise with gestures that one may not have seen before, thus highlighting the productivity of the underlying rule.

2.1.5 Supplements and expressives

Finally, supplements and expressives were two categories of inferences raised to prominence in Potts's work (e.g. Potts 2005) in order to show that some expressions

fail to interact scopally with semantic operators. Supplements are usually defined as the meaning of appositive relative clauses, while expressives are words, such as slurs, which convey an evaluation on the speaker's part pertaining to the denoted objects. Later research showed that these two categories display a less unified behavior than one might initially have thought, and thus they will be discussed separately.

One characteristic behavior of supplements is that they usually yield deviance if they are forced to be interpreted immediately in the scope of a negative expression, as in (11)b.

(11)　　a. One of these women helped her son, which saved him.
　　　　　b. #None of these women helped her son, which saved him.

Slurs such as *Frog* (to refer to French people) do not yield such strong deviance, but they behave as if they were interpreted outside the scope of logical operators, as in (12).

(12)　　(#) If I were really prejudiced against the French, I wouldn't hire a Frog. [= pragmatically odd]

One might initially expect that (12) means that *if I were really prejudiced against the French*, *I would hold a negative attitude towards the French and I wouldn't hire one of them*, where the underlined part is the expressive component of *Frog*, interpreted in the scope of the conditional. The data suggest that this is not a possibility: (12) triggers the inference that the speaker in fact harbors such a negative attitude; the slight deviance of the sentence follows because the counterfactual conditional implies that this is not the case, hence a somewhat contradictory meaning.

We will show that precisely the characteristic properties illustrated in (11) and (12) can be replicated with some post-speech and some pro-speech gestures respectively, suggesting that new supplements and expressives can be generated with elements that one might only have had limited exposure to (we write 'limited exposure' rather than 'no exposure' because, in the case of expressives in particular, we do not know whether ones that lack any conventional element are readily understood).

2.2 Gestural typology

Since our goal is to explain how gestures inform and constrain the typology of inferences, we should also say a bit more about the typology of gestures.

2.2.1 Gesture types

It is traditional in the gesture literature to distinguish between four types of gestures: *iconic*, *metaphoric*, *deictic* and *beat* (McNeill 2005: Chap. 2; see also Kendon 2004). We will be concerned with *iconic gestures*, which are characterized by the fact that their form resembles aspects of what they denote, as was the case with the action illustrated in (1). We will also make occasional use of *deictic gestures*, typically involving the extended index finger or sometimes the full hand, which are used to refer to something which is present in the extra-linguistic situation or has been represented in some way in gestural space. *Metaphoric gestures* (which for McNeil "present images

of the abstract") and *beats* (which take "the form of the hand beating time") will play no role here. Some authors, such as Giorgolo (2010:4–5), also have a subcategory of 'emblems,' which are "typically culture-specific gestures, associated with a fixed meaning"—for instance the 'thumbs up' 👍 gesture used in Western culture. In some cases, the distinction between an iconic gesture and an emblem is not self-evident, as an iconic gesture may be more or less conventionalized (this will particularly matter in our discussion of gestural slurs).

2.2.2 Iconic semantics

How should an iconic semantics be developed? Pre-theoretically, an expression has an iconic component if it comes with a requirement that the objects it denotes should resemble some aspects of its form. While the expression *long* is not in itself iconic, it can be modulated in an iconic fashion by changing the length of the vowel (Okrent 2002): *The talk was loooong* attributes to the talk a longer duration than if one had just said *long*, by virtue of a rule that seems to be of the form: *the longer the vowel, the longer the duration of the talk*.[8] But gestures might be wholly iconic, rather than just modulations of conventional forms. Despite important formal work on this topic (Giorgolo 2010), no general approach is available yet. Still, one can take inspiration from the semantics of pictures developed in Greenberg (2013), where it is argued (very roughly) that a picture denotes a situation if the picture can be seen as the geometric projection of that situation on a plane given a pre-established method (e.g. linear perspective projection). Gestures are not pictures, as they are three-dimensional, and dynamic, so it is clear that Greenberg's approach will have to be extended to apply to them. We will leave this important topic aside in the rest of this piece (but see Abusch 2012; Rooth and Abusch 2017, and Cumming et al. 2017 for relevant work). What matters for our immediate purposes is that general principles (such as a projection method) make it possible to understand the denotation of new gestures that might partly or completely lack a conventional element.

2.2.3 Co-speech, post-speech, pro-speech

How do iconic gestures interact with speech? As was illustrated in (1), gestures come in three varieties depending on whether they co-occur with speech (co-speech), follow it (post-speech) or replace it (pro-speech). The main focus in recent semantic research has been on co-speech gestures. Lascarides and Stone (2009) discussed the interaction between co-speech gestures and expressions that introduce discourse referents, in particular dynamic existential quantifiers. Their approach was thus particularly concerned with the anaphoric relations that exist between gestures and the sentences they appear in. Ebert and Ebert (2014) focused instead on the semantic contribution of co-speech gestures, and they pioneered the study of the 'projection of

---

[8]The length does not just intensify the adjective: it is difficult to understand *The talk was shoooort* as meaning that the talk was very short.

co-speech inferences,'[9] i.e. of the way in which inferences triggered by gestures interact with logical operators. Ebert and Ebert (2014) argued that co-speech gestures contribute supplements and thus display the same semantic behavior as appositive relative clauses. Schlenker (2015, to appear a, to appear b) argued against this analysis, in part because it leads one to expect that co-speech gestures should be deviant in negative environments such as (11)b, which doesn't seem to be correct, as illustrated in (13).

(13)   None of these women $\mathbb{LIFT}$_ **helped** her son.
        ⇒ for each of these women, if she had helped her son, lifting would have
        been involved

Instead, Schlenker (2015, to appear a, to appear b) argued that co-speech gestures trigger presuppositions of a particular sort, namely ones that are conditionalized on the content of the modified expression (these special presuppositions were called 'cosuppositions'). On this view, then, *x* $\mathbb{LIFT}$ **helped** *y* triggers the presupposition that *if x helped y, lifting was involved*. This correctly derives the inference observed in (13): as is the case for standard presuppositions, the inference projects universally, as was already illustrated in (8)b; but the inference is conditionalized, hence the underlined conditional. At this point, cosuppositions do not have a counterpart in the standard inferential typology, and thus co-speech gestures won't play a role in the rest of this article.

By contrast, post-speech gestures will play a prominent role. Schlenker (2015, to appear a, to appear b) argued that, unlike co-speech gestures, they do display the distribution of appositive relative clauses, as illustrated in (14). This observation will play a prominent role in our argument that post-speech gestures fill the 'supplement' slot of the inferential typology in (5).

(14)   a. One of these women helped her son – $\mathbb{LIFT}$_ .

        b. #None of these women helped her son – $\mathbb{LIFT}$_ .

Pro-speech gestures have not been the object of detailed formal studies, but it is clear that they can make at-issue contributions, which is unsurprising since they fully replace words (Ladewig 2011; Schlenker to appear b). It was briefly mentioned in Schlenker (to appear b) that they may also trigger presuppositions of their own. In the present piece, we will further build on this observation, but we will show more

---

[9]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.

generally that all the slots of the inferential typology in (5) except that of supplements can be filled with pro-speech gestures.[10]

What constraints are there on the distribution of pro-speech gestures? Research on this topic is in its infancy, but two remarks will be useful. First, several informants mentioned a weak preference for putting pro-speech gestures in clause-final position. As a result, there seems to be a slight preference for (15)b over (15)a.

(15)   a. ?Little Robin will $\mathbb{SLAP}$_   your brother.

         b. Your brother, little Robin will $\mathbb{SLAP}$_   .

Second, there has been increased interest in the connection between signs and gestures (for semantics, see in particular Liddell 2003 and Davidson 2015). It was recently claimed that pro-speech gestures must obey formal constraints that are reminiscent of some rules of sign language grammar (Schlenker and Chemla to appear; Schlenker 2017), including in the area of agreement verbs and of plurals, which will play a role below in our discussion of homogeneity inferences. But since our focus is entirely on semantic interpretation, we will not further discuss gestural grammar in this piece.

2.2.4 Gesture and discourse

Some of the earliest formal analyses of gesture semantics explored their connection to discourse phenomena, and particularly to discourse anaphora and coherence relations. Thus Lascarides and Stone (2009) discuss the interaction between gestures and expressions that introduce discourse referents, in particular dynamic existential quantifiers. Their goal is to study the types of coherence relations that are used to link the content of gestures to the content of the surrounding words they co-occur with. While we will claim that rich inferences can be triggered by (pro- and post-speech) gestures, we will not be able to exclude the possibility that these are due, at least in part, to such coherence relations. Still, the specificity of the inferences triggered will strongly suggest that the detailed iconic contribution of gestures plays a crucial role. Since our goal is to display the typology rather than to fully explain it, we will not further discuss coherence relations in this piece.

As mentioned, some parts of the inferential typology introduced in Sect. 2.1 are thought to have a lexical source, while others follow from productive algorithms. There is in particular an ongoing debate to determine whether some inferential types that are thought to be lexical (such as presuppositions) might, in some cases at least, be re-analyzed as by-products of something else, such as implicatures, information structure, or other mechanisms (for presuppositions, see for instance Simons 2001; Abusch 2010; Schlenker 2010; Chemla 2010; Simons et al. 2010; Abrusán 2011;

---

[10]Schlenker (to appear b) speculates that some aspects of the semantics of co-, pro- and post-speech gestures can be derived from broadly Gricean considerations of manner, depending on whether (i) they can be eliminated without affecting the grammaticality of the sentence, and (ii) they have their own time slot.

Romoli 2015; Tonhauser et al. 2013). While we will consider simple examples that seek to minimize extrinsic discourse factors, it remains possible that these, or more general considerations, play a role in the inferential effects observed below; in fact, we will argue that our presuppositional inferences suggest that general mechanisms are at work to trigger them. In the case of *co*-speech gestures, discourse conditions are believed to play a crucial role: Esipova (2017) argues that under contrastive focus, co-speech gestures make an at-issue rather than a presuppositional contribution, and that this observation extends to standard (non-gestural) presupposition triggers. Since the present study pertains to pro- and post-speech gestures, this particular finding does not apply, but we cannot exclude the possibility that further effects of discourse structure will be found to play a role in our data. Still, we will do our best to focus on *characteristic* properties of inferential types, ones that are not shared with other discourse phenomena, so as to minimize the risk that we might misclassify the source of the observed data.

3 Scalar implicatures: Standard and 'blind'

Gricean and post-Gricean theories of scalar implicatures take them to arise as soon as a clause is compared to a logically stronger (or just non-weaker) alternative that it evokes (Horn 1972; Katzir 2007; Katzir and Fox 2011; Goodman and Stuhlmüller 2013; Bergen et al. 2016). Theories differ about the mechanism by which alternatives are generated. Horn (1972) took alternatives to be determined by lexical scales; Katzir (2007) and Katzir and Fox (2011) took the mechanism to be broader and more syntactic in nature, with further provisions made for the role of additional alternatives provided by the context; while Bergen et al. (2016) take the mechanisms to be in principle unconstrained, except for a cost incurred by the number of words involved. But on all these theories, one may expect that sentences with gestures could evoke further sentences (for instance ones with alternative gestures), which would naturally lead to the derivation of implicatures. We will suggest that this is indeed the case, especially (but not only) when salient alternatives are mentioned in the context.

3.1 Standard scalar implicatures

3.1.1 Contextual vs. non-contextual alternatives

It will prove useful to consider some scalar implicatures that depend on contextual scales, and others that do not. By way of introduction, then, let us consider the paradigm in (16).

(16)   What did you do at the party—did you eat, or drink, or drink a lot?

        a. I drank.
            ⇒ the speaker didn't drink a lot
        b. I didn't drink.
        c. Nobody drank.
        a′. I drank a lot.

     b′. I didn't drink a lot.
         ⇒ the speaker drank
     c′. Nobody drank a lot.
         ⇒ some people drank

(16)a triggers the implicature that the alternatives *I ate* and *I drank a lot* are false. In this case, the context is crucial: (16)a alone would not trigger these inferences. (16)b′ implicates the falsity of the stronger alternative *I didn't drink*, hence the inference that the speaker drank. This is called an 'indirect implicature' because, due to the negative environment, it is now the stronger member of the scale <drink, drink a lot> which triggers an implicature. Similarly, (16)c′ implicates the falsity of *Nobody drank*, hence the inference (again an indirect implicature) that some people drank. In this case, the context is not necessary to trigger the inferences. Katzir (2007) explains why: *drink a lot* is structurally more complex than *drink*, and for this reason the former always evokes the latter (i.e. raises it as an alternative). More precisely, for Katzir (2007; followed by Katzir and Fox 2011), alternatives to a sentence *S* are obtained by considering all lexical replacements of words in *S*, but also substitutions in which sub-constituents of *S* are replaced with other sub-constituents (as well as certain 'salient' constituents). In this way, *drank a lot* in (21)c′ can be replaced with *drank*, and as a result *Nobody drank a lot* evokes the alternative *Nobody drank*, hence the implicature we observe.[11] This is an example of a more general pattern: when a complex sub-constituent is replaced with one of its proper parts (and the result is well-formed), we automatically obtain an alternative to the original sentence; this will become relevant in our discussion of gestural alternatives.

3.1.2 Gestural implicatures

We turn to several implicature-like phenomena in gestures.

❏ *Number-related implicatures*

We start with the distinction between gestural singulars and plurals, illustrated in (17). Such examples were raised as a point of comparison for some sign language constructions in Schlenker and Lamberton (to appear) and Schlenker (2017).

Notation: $\mathbb{CROSS}$ refers to a single iteration of the cross sign, and $\mathbb{CROSS}\text{-}rep_3$ to three unpunctuated repetitions of the cross gesture.[12]

(17)   *Context:* as part of a treasure hunt, the speaker was supposed to look for crosses.
       I entered the room

---

[11] In this case, *x drinks a lot* is both structurally more complex and logically stronger than *x drinks*. But in other cases, a more complex expression is logically weaker. For instance, *x drinks or smokes* is asymmetrically entailed by *x drinks*, but it is more complex than it and thus evokes it as an alternative.

[12] See Sect. 5 for a more thorough discussion of unpunctuated repetitions. Suffice it to say for the moment that these involve iterations of an expression in different parts of gestural space, with short and relatively indistinct breaks between the iterations.

a. and I saw $\mathbb{CROSS}\_$.
⇒ the speaker saw one cross

b. but I didn't see $\mathbb{CROSS}\_$.
⇒ the speaker didn't seen any crosses

c. and I saw $\mathbb{CROSS}\text{-}rep_3\_$.
⇒ the speaker saw several crosses
(examples modified from Schlenker and Lamberton to appear)

In (17)a, we obtain an inference that the speaker saw a single cross. This could be interpreted in two ways: one possibility is that *CROSS* has an 'exactly' meaning, akin to: 'exactly one cross.' An alternative is that it has a weaker meaning, akin to: 'at least one cross.' On the latter view, the 'exactly one' inference is due to an implicature, by competition with another expression that means *several crosses*, or *at least two crosses*. Initial motivation for the implicature-based view is provided by (17)b, which is easily understood to imply that the speaker didn't see *any* crosses.[13] This inference follows if $\mathbb{CROSS}$ means 'at least one cross' but not if it means 'exactly one cross.'

Turning to (17)c, it involves the unpunctuated repetition (notated $\text{-}rep_3$) of three occurrences of the gesture, with movement in gestural space, and it suggests that there were several crosses in the room. While we will come back later to unpunctuated repetitions, their main characteristic for present purposes is that they are realized with no clear break between the repeated gestures, which is crucial to avoid conveying information about a precise number of crosses. The fact that we obtain a reading akin to 'the speaker saw several crosses' suggests that the unpunctuated repetition $\mathbb{CROSS}\text{-}rep_3$ might be precisely the alternative that is needed to enrich the meaning of $\mathbb{CROSS}$ in the positive case in (17)a (but not in the negative case in (17)b, since here the alternative is *less* informative than the uttered sentence). Still, it should be noted that the implicature-based view could be developed by considering a different alternative for $\mathbb{CROSS}$, for instance the punctuated repetition $\mathbb{CROSS}\ \mathbb{CROSS}$, made of two discrete, clearly distinguishable iterations of the same gesture (realized in different parts of gestural space). As long as this construction can have an 'at least two crosses' reading, it can serve as an alternative to trigger the desired implicature. Which alternative ($\mathbb{CROSS}\text{-}rep_3$ vs. $\mathbb{CROSS}\ \mathbb{CROSS}$) is best suited to derive the desired implicature is a question we leave for future research (a homologous question for sign language is, to our knowledge, unsolved as well; see Schlenker and Lamberton to appear for a recent account, but one that does not consider the issue of implicatures).[14]

---

[13] Our point is not that the weak reading denying that the speaker saw exactly one cross does not exist, just that it is not the only possible reading (a similar issue arises with numerals in English, we have 'exactly' readings in addition to their 'at least' readings; see Spector 2013b for a survey).

[14] Two remarks should be added. First, we can check by embedding $\mathbb{CROSS}\ \mathbb{CROSS}$ that it probably has an 'at least two crosses' reading (although this need not be the only possible reading): (i)a can be understood to imply in particular that nobody saw at least two crosses, like (i)b and unlike (i)c.

While we believe that the inferences are relatively clear, they can be brought into sharper focus by prefacing the sentences in (17) with the discourse in (18), which introduces the relevant gestures in their co-speech use, before using them again as pro-speech gestures. This has the effect of explicitly introducing the gestural scales involved in this case.

(18)   –Depending on the room, you should have seen a $\mathbb{CROSS}$_ **cross**

or several $\mathbb{CROSS}\text{-}\mathtt{rep_3}$_ **crosses**.
       –Well, . . .

Let us add that the pro-speech gestures in (17) are unlikely to be just codes for (non-demonstrative) spoken words. First, depending on where the gestures are produced, one may draw the inference that the relevant objects were high or low, on the speaker's right or on the speaker's left—and one may even convey gradient information in this way.[15] Second, in the plural case the precise realization of the repetition will convey fine-grained information as well. As we will see in greater detail in Sect. 5.2, the repeated $\mathbb{CROSS}$ gesture may be realized as a line or as a triangle, with corresponding information about its denotation; and 6 unpunctuated iterations (replacing $\text{-}\mathtt{rep_3}$ with $\text{-}\mathtt{rep_6}$ in (17)c) will trigger the inference that there were many crosses.[16]

❏ *Further implicatures*

We turn to two further gestural implicatures that are not number-related. Consider the paradigm in (19). Our goal is to argue that (19)b′ triggers an indirect implicature:

(i)   a. Nobody saw $\mathbb{CROSS}$ $\mathbb{CROSS}$.
       b. Nobody saw at least two crosses.
       c. Nobody saw exactly two crosses.

Second, the issue of finding the 'right' alternative to yield the 'exactly one' reading of a singular indefinite is not trivial even for the English expression 'a cross'; see for instance Spector (2007) for discussion.

[15]The ability of subjects to infer the gradient geometric position of an object relative to a ground was used in Emmorey and Herzig (2003) to investigate the iconic uses of classifiers in ASL.

[16]Interestingly, when $\mathbb{CROSS}\text{-}\mathtt{rep_3}$ appears under negation, as in (i)a, we might well get the inference that the speaker didn't see *any* crosses (rather than: the speaker didn't see more than one cross); this is also the behavior displayed by existential plurals in English, as in *I didn't see crosses* (see for instance Spector 2007). But the judgments arguably change when $\mathbb{CROSS}\text{-}\mathtt{rep_3}$ is replaced with $\mathbb{CROSS}\text{-}\mathtt{rep_6}$, as in (i)b: we arguably obtain an inference that the speaker didn't see a lot of crosses but still saw some crosses. This would be expected if $\mathbb{CROSS}\text{-}\mathtt{rep_3}$ is evoked as an alternative by $\mathbb{CROSS}\text{-}\mathtt{rep_6}$, which is a strictly more complex gesture. But one would still need to explain why (i)a doesn't evoke the alternative *I didn't see* $\mathbb{CROSS}$, which should trigger the implicature that the speaker did see one cross.

(i)   a. I didn't see $\mathbb{CROSS}\text{-}\mathtt{rep_3}$.
       b. I didn't see $\mathbb{CROSS}\text{-}\mathtt{rep_6}$.

We leave this question open here, noting that related issues arise but have yet to be investigated with respect to sign language unpunctuated and punctuated repetitions (see Schlenker and Lamberton to appear).

while the addressee should not turn the wheel completely, *the addressee should still turn the wheel somewhat*.

(19)   *A driving instructor to a student:*
       In order to get out, you

   a.   should TURN-WHEEL_ .
        ⇒ you should turn the wheel a bit but not much

   b.   should COMPLETELY-TURN-WHEEL_ .
        ⇒ you should completely turn the wheel

   a′. shouldn't TURN-WHEEL_ .
        ⇒ you shouldn't turn the wheel at all, OR you shouldn't turn the wheel just a bit.

   b′. you shouldn't COMPLETELY-TURN-WHEEL_ .
        ⇒ you shouldn't turn the wheel a lot but you should probably turn it a bit

Let us start with the facts in (19)a′. They are complex, possibly with two readings: *you shouldn't turn the wheel at all*, or *you shouldn't turn the wheel just a bit* (*i.e. as I am hereby demonstrating*). If the second reading exists, this need not be very surprising: for an iconic representation to be accurate, it must presumably depict all the relevant facts, and thus a dynamic iconic representation can be taken to include the end of the action it depicts. This entails that gestures could easily have exhaustive readings by virtue of their iconic semantics. If so, the exhaustive reading we obtain in (19)a might not be due to a scalar implicature but just to the iconic semantics of the construction.

Things are different in (19)b′. It triggers an inference that the addressee *should* turn the wheel somewhat. The only plausible way to derive it is by way of an indirect implicature: *you shouldn't COMPLETELY-TURN-WHEEL* evokes the more informative alternative *you shouldn't TURN-WHEEL*, and by negating the latter we obtain the inference that the addressee *should* turn the wheel.

Importantly, the relevant gestural alternative was not introduced by the context in this example, but it is in a sense included in the gesture that was used, since *TURN-WHEEL* is (roughly) the beginning of the gesture *COMPLETELY-TURN-WHEEL*.

This appears to be a more general fact: indirect gestural implicatures can apparently be triggered without contextual alternatives when a gesture contains a less informative one as a sub-part. This is the case in (19)b′, but also in the examples in (20), which give rise to clear indirect implicatures as well: in (20)a, we understand

that Robin isn't very big, but is still big; in (20)b, that Robin isn't very tall, but is still tall. (We believe the facts might be less clear when this condition of inclusion is not met. For instance, if the gesture for $\mathbb{TALL}$ is realized with the dominant hand at the relevant height *without* the accompanying upward movement, we might simply obtain a reading on which it is denied that Robin is exactly that very height.[17])

(20)   a. Robin isn't $\mathbb{VERY\text{-}BIG}\_$.
            ⇒ Robin is big
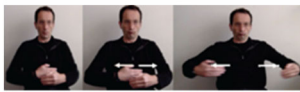
        b. Robin isn't $\mathbb{VERY\text{-}TALL}\_$.
            ⇒ Robin is tall
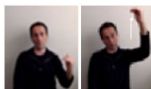
The fact that a gesture might automatically evoke as an alternative a gesture which is one of its component parts is reminiscent of Katzir's observation that syntactically complex expressions evoke simpler ones as alternatives. However Katzir's notion of complexity is purely syntactic, whereas in the present case we need to take into account the complexity of iconic representations; we come back to this point in Sect. 3.3.

Finally, it is worth noting that in some or all of these cases, the gestures contribute gradient iconic information that would be hard to convey in words, at least ones that are not accompanied with a gesture. Thus the gesture for $\mathbb{TURN\text{-}WHEEL}$ may convey information about the position, size and even thickness of the wheel, while the gestures for $\mathbb{VERY\text{-}BIG}$ and $\mathbb{TALL}$ can be modulated to give an indication of the extent of the relevant person's girth or height. This makes it unlikely that these gestures are treated as codes for gesture-free words (which of course might themselves trigger implicatures, if these were relevant here).

3.2 Blind scalar implicatures

As mentioned in Sect. 2.1.2, Magri (e.g. 2009) argued that a sentence may trigger the inference that a logically stronger alternative is false even when contextual knowledge guarantees that, *relative to the context*, the utterance and its alternative are contextually equivalent. This yields deviance, as in (7)a above (repeated as (21)a), because one obtains a contradiction between the asserted meaning and the negation of the logically stronger (but contextually equivalent) alternative. (To reiterate, the reason we do not obtain a standard scalar implicature is that the predicate guarantees that if *some Italians come from a warm country*, *all Italians* do as well, and thus (21)b is not more informative than (21)a relative to contextual knowledge.[18])

---

[17] A further issue is whether, on this 'exactly that very height' reading, the height in question counts as tall or not. As a referee observes, facial expressions might play a role in triggering the latter inference (the referee mentions for instance 'a facial expression with puffy cheeks or widened eyes').

[18] As an anonymous reviewer notes, if *a warm country* were replaced with *warm counties*, (21)a would stop being deviant, and it would trigger the (standard) scalar implicature that *not all Italians come from warm counties*.

(21)   a. #Some Italians come from a warm country.
              b. All Italians come from a warm country.

We believe that some instances of Blind implicatures can be found in the gestural domain as well, but in simple cases one needs to take care to make the relevant alternatives very salient in the context. An initial example is displayed in (22), where co-speech gestures are used to introduce the alternatives.

Notation: For legibility, we only use the picture corresponding to the $\mathbb{CROSS}\_$

gesture. When the gesture is duplicated (in a punctuated fashion), the two occurrences of $\mathbb{CROSS}$ should be realized next to each other rather than in exactly the same position, with a clear break between them.

(22)   I knew that whenever there was a $\mathbb{CROSS}\_$ **[cross]**, it was part

of a $\mathbb{CROSS}$ $\mathbb{CROSS}\_$ **[pair]**.[19] I entered a room and finally saw

     a. ? $\mathbb{CROSS}\_$

     b. $\mathbb{CROSS}$ $\mathbb{CROSS}\_$

Note that the reading discussed earlier in connection with (17)b (where $\mathbb{CROSS}$ was embedded under negation) shows that the unrepeated $\mathbb{CROSS}$ gesture is compatible with an *at least one* reading (a point that also applies to the co-speech gestures at the beginning of (22)), and thus the deviance observed in (22)a is likely due to a Blind implicature rather than to an obligatory *exactly one* reading.

A similar reasoning can be made about the paradigm in (23). The context already establishes that the gesture for $\mathbb{BIG}$ is compatible with the truth conditions for $\mathbb{VERY}\text{-}\mathbb{BIG}$; and this conclusion also follows from the readings obtained in (24) below. In other words, $\mathbb{BIG}$ doesn't mean (or doesn't just mean) something like: 'exactly this big,' but rather 'at least this big.' Still, deviance is obtained in (23)a, and it can naturally be explained as a Blind implicature: given the context, $\mathbb{BIG}$ evokes $\mathbb{VERY}\text{-}\mathbb{BIG}$ as an alternative, and the ensuing implicature gives rise to a contradiction in view of the context.

(23)   In my Weight Watchers' group, everyone who is $\mathbb{BIG}\_$ **[big]** is

---

[19]We use two identical pictures for simplicity, but each occurrence of $\mathbb{CROSS}$ should in fact be realized in a slightly different part of gestural space.

VERY-BIG_ **[*very* big]**.
John is in my group and since he is

    a. ? BIG_ ,

    b. VERY-BIG_ ,
       he is really serious about his diet.

(24)   a. John isn't BIG_ .
       ⇒ John isn't big (let alone very big)

     b. None of my friends is BIG_
       ⇒ none of my friends is big (let alone very big)

3.3 Further issues

While these remarks only scratch the surface of gestural implicatures, they raise two important questions for future research.

First, how are iconic alternatives computed? The question doesn't really arise when the context ensures that the relevant scales are introduced explicitly. But we saw that some implicatures are strongly triggered even in the absence of contextual scales. This was in particular the case when a stronger alternative contained a weaker alternative as a subpart, as in (20).[20] As mentioned, Katzir (2007) proposed that alternatives are computed on the basis of a syntactic algorithm, and we noted above one of its consequences: when a complex sub-constituent is replaced with one of its proper parts, we automatically obtain an alternative to the original sentence. Our data suggest that this theory should be extended to the iconic case: an iconic representation can easily evoke as alternatives representations that it contains as subparts (i.e. as sub-gestures). A syntactic version of this reasoning was applied in (16)b′ to explain why *drink a lot* evokes *drink* even without an explicit context, whereas *drink* needn't evoke *drink a lot* as an alternative. If our suggestion about sub-gestures is on the right track, a generalized version of Katzir's syntactic algorithm should be extended to iconic representations. The extension is not immediate, however, because there is no argument that the iconic representations under study are *syntactically* complex, at least not in the normal sense of 'syntax' (involving derivation trees).

---

[20]In this case, the larger (more complex) sign, for instance VERY-BIG, was more informative than its subpart (i.e. BIG), and for this reason the implicature triggered without contextual alternatives had to be an indirect one: with negation, *John isn't VERY-BIG* triggers the implicature that *John is BIG*.

Second, we noted that some gestures might more easily yield exhaustive readings than their superficial counterparts in words. We hinted that the very nature of an iconic semantics might be responsible for this fact, since a picture that omits an object (visible at the relevant level of granularity) cannot count as an accurate or correct representation of the depicted scene, and similarly for dynamic iconic representations, which should depict the entirety of the relevant event. If so, great care must be taken to argue for the existence of an implicature, as one might mistake exhaustive readings that are due to the iconic semantics for readings with *bona fide* implicatures. This is why we systematically included sentences, such as (17)b and (19)a′, which showed that the relevant gestures could have non-exhaustive readings in negative environments. While we think that these examples show that the readings obtained in non-negative environments are indeed due to implicatures, it is clear that a more complete analysis will have to be developed in tandem with a precise iconic semantics.

3.4 Conclusion on scalar implicatures

The foregoing discussion serves in part as a 'sanity check': because standard theories lead one to expect that implicatures should be productively triggered whenever alternatives are evoked (given the right informativity conditions), pro-speech gestures should be able to trigger implicatures as well, and this is indeed what we found. It is equally expected that this finding should apply to normal and to 'blind' implicatures alike. But the fact that some implicatures appear to be triggered in the absence of contextual alternatives (as was seen in (20)) suggests that a theory of iconic alternatives needs to be developed, with the possibility that Katzir's ideas about alternative generation could be extended to this case. Finally, we noted in connection with the $\mathbb{CROSS}$ gesture in (17) that it is unlikely to just be a code for a (gesture-free) word: depending on how the gesture and its repetitions are realized, they may provide gradient information about the location of the crosses, as well as their number (which is vague with unpunctuated repetitions, yet is suggestive of larger quantities when more iterations are produced). The same remark could have been made about the $\mathbb{TURN}$-$\mathbb{WHEEL}$ gesture in (27): the realization of the gesture may carry implications about the spatial position of the wheel (e.g. low or high), its size, and even about its thickness (depending on the hand configuration). It is thus parsimonious to posit that these gestures iconically denote by themselves, without being codes for other expressions, but that they are fully integrated with the system of implicatures of language.

4 Presuppositions and anti-presuppositions

The existence of gestural scalar implicatures was expected given standard theories. The theoretical situation is far more interesting when it comes to presuppositions: standard frameworks posit that presuppositions are triggered lexically. In other words, a speaker must store in her memory which presuppositions, if any, a given word triggers. This position is in part due to the absence of accepted theories of presupposition generation, despite various arguments that there exist 'triggering algorithms' that make it possible to *deduce* the presupposition of an expression once one

knows its bivalent (i.e. classical, non-presuppositional) semantics, enriched in some cases with a set of scalar alternatives (see Grice 1981; Stalnaker 1974; Abbott 2000; Simons 2001; Abusch 2010; Schlenker 2010; Chemla 2010; Simons et al. 2010; Abrusán 2011; Romoli 2015; Tonhauser et al. 2013). It is thus interesting to note that some pro-speech gestures trigger presuppositions (Schlenker to appear b), and that anti-presuppositions (due to *Maximize Presupposition*) seem to exist as well.

4.1 Presuppositions

4.1.1 Standard presuppositions

As was foreshadowed in Sect. 2.1.3, presuppositions yield characteristic patterns of inference: unlike entailments, they are preserved in questions, under negation, and under *if*, and they give rise to universal positive inferences under *none*-type quantifiers (e.g. Chemla 2009). Two examples are given in (25) and (26), involving the factive verb *know* and the change of state verb *take off*. While inferences might be weaker in the second case, we believe that they can be brought out by contrasting the presuppositional expression *take off* with the non-presuppositional control *be on the ground and then take off* (the latter is non-presuppositional because the first conjunct guarantees that the presupposition of the second conjunct is 'locally satisfied,' with the result that the conjunction *as a whole* doesn't presuppose anything).[21] It can be seen that the presupposition projects out of questions, negated clauses and *if*-clauses in (25)b, c, d and in (26)b(i), c(i), d(i), and that it projects universally out of the scope of *none*-type quantifiers in (25)e and (26)e(i).

(25)   a. John knows that he is incompetent.
           ⇒ John is incompetent
        b. Does John know that he is incompetent?
           ⇒ John is incompetent
        c. John doesn't know that he is incompetent.
           ⇒ John is incompetent
        d. If John knows that he is incompetent, he'll get depressed.
           ⇒ John is incompetent
        e. None of these ten students knows that he is incompetent.
           ⇒ each of these ten students is incompetent

Notation: When a sentence comes in two versions, (i) and (ii), we write (*i*), (*ii*) ⇒ ... if both versions trigger inference ..., and we write (*i*) ⇒ ... if only version (i) does.

---

[21] It is standardly assumed that an expression should not be trivial, in the sense that it should not follow from its 'local context' (Stalnaker 1978; Schlenker 2009). Applied to the first conjunct (= *be on the ground*), this requirement amounts to an anti-presupposition. This means that the conjunction *be on the ground and then take off* is not just a presupposition-free control, but comes with an anti-presupposition on its own. This is a standard problem when one wishes to find controls for presuppositional expressions.

(26) a. At 12:05, the company's plane will (i) take off (ii) be on the ground and then take off.

(i), (ii) ⇒ right before 12:05, the company's plane will be on the ground

b. At 12:05, will the company's plane (i) take off (ii) be on the ground and then take off?

(i) ⇒ right before 12:05, the company's plane will be on the ground

c. At 12:05, the company's plane won't (i) take off (ii) be on the ground and then take off.

(i) ⇒ right before 12:05, the company's plane will be on the ground

d. At 12:05, if the company's plane (i) takes off (ii) is on the ground and then takes off, we'll hear some noise.

(i) ⇒ right before 12:05, the company's plane will be on the ground

e. At 12:05, none of the company's planes will (i) take off (ii) be on the ground and then take off.

(i) ⇒ ? right before 12:05, each of company's planes will be on the ground

4.1.2 Gestural presuppositions

Similar inferential patterns suggest that presuppositions are triggered in some cases in which a gesture indicates the shape of an object, as in (27): $\mathbb{TURN}$-$\mathbb{WHEEL}$ triggers the presupposition that the agent has her hands on a wheel; by contrast, a control of the form *get/be behind the wheel and* $\mathbb{TURN}$-$\mathbb{WHEEL}$ fails to trigger such a presupposition—an expected result because the first conjunct suffices to satisfy the presupposition of the second conjunct, with the result that the conjunction as a whole doesn't presuppose anything.[22]

(27) a. Is Mary going to (i) TURN-WHEEL-small_   (ii)

get/be behind the wheel and TURN-WHEEL-small_   .

(i) ⇒ Mary is currently behind a wheel

b. If Mary (i) TURN-WHEEL-small_   (ii) gets/is behind

the wheel and TURN-WHEEL-small_   , we'll notice.

(i) ⇒ Mary is currently behind a wheel

---

[22]While *get behind the wheel* might be a bit more natural than *be behind the wheel*, *get behind the wheel* triggers the presupposition that the agent is not initially behind the wheel (thanks to E. Chemla and L. Tieu for discussion of this point). As discussed in fn. 21, *be behind the wheel* only triggers an anti-presupposition to the effect that this expression is not trivial in its local context.

c. In this race, none of your friends is going to (i) $\mathbb{TURN}$-$\mathbb{WHEEL}$-small_ (ii) get/be behind the wheel and $\mathbb{TURN}$-$\mathbb{WHEEL}$-small_ .

(i) $\Rightarrow$ in this race, each of your friends is behind a wheel

Similarly, we believe that the gesture for $\mathbb{REMOVE}$-$\mathbb{GLASSES}$ in (28) triggers a presupposition that the agent has glasses on at the relevant time, unlike the control *have glasses on and* $\mathbb{REMOVE}$-$\mathbb{GLASSES}$, which entails but does not presuppose such a fact.

(28) a. At the end of the meeting, will John (i) $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ (ii) have glasses on and $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ ?

(i) $\Rightarrow$ right before the end of the meeting, John will have glasses on

b. If at the end of the meeting John (i) $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ (ii) has glasses on and $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ , we'll notice.

(i) $\Rightarrow$ right before the end of the meeting, John will have glasses on

c. At the end of the meeting, none of your colleagues will (i) $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ (ii) have glasses on and $\mathbb{REMOVE}$-$\mathbb{GLASSES}$_ .

(i) $\Rightarrow$ right before the end of the meeting, each of your colleagues will have glasses on

Similarly but possibly less clearly, the gesture in (29)a(i), b(i), c(i), involving a small (vodka-style) glass, seems to trigger a presupposition about the size of the

agent's glass.[23] In particular, it seems to yield patterns of universal projection of *none*, as in (29)c(i). The presuppositional inference disappears when the gesture is preceded with *have a small glass in front of her and*, as in (29)a(ii), b(ii), c(ii), which is expected since this conjunct justifies the presupposition, so that the entire conjunction lacks this presupposition.

(29)   Context: *What will people do next—eat, drink, or do something else?*

    a. Will Mary (i) $\mathbb{DRINK}$-$\mathbb{SMALL}$_ (ii) have a small glass in front of her and $\mathbb{DRINK}$-$\mathbb{SMALL}$_ ?
    (i) $\Rightarrow$ Mary has a small glass

    b. If Mary (i) $\mathbb{DRINK}$-$\mathbb{SMALL}$_ (ii) has a small glass in front of her and $\mathbb{DRINK}$-$\mathbb{SMALL}$_ , we'll notice.
    (i) $\Rightarrow$ Mary has a small glass

    c. None of our guests (i) will $\mathbb{DRINK}$-$\mathbb{SMALL}$_ (ii) will have a small glass in front of her and will $\mathbb{DRINK}$-$\mathbb{SMALL}$_ .
    (i) $\Rightarrow$ each of the guests has a small glass

A different case is afforded by the gesture $\mathbb{TAKE}$-$\mathbb{RIFLE}$-$\mathbb{SHOOT}$, which presupposes that the agent is not in a shooting position, unlike the gesture $\mathbb{SHOOT}$-$\mathbb{RIFLE}$.[24]

---

[23]It might be important to realize the gesture so as to evoke sipping rather than doing a (quick) vodka shot, as the latter gesture might weaken or erase the presupposition. Lyn Tieu (p.c.) suggests that a clearer effect might be found if the gesture is modified so as to involve sipping something from a small cup. (Thanks to Lyn Tieu for discussion of this point.)

[24]It might be that $\mathbb{SHOOT}$-$\mathbb{RIFLE}$ triggers the opposite presupposition, to the effect that the agent *is* in a shooting position; but the data (and the details of the realization of the gesture) would need to be investigated more closely.

(30)   a. Is Robin going to (i) TAKE-RIFLE-$HOOT_
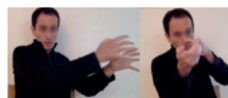
(ii) $HOOT-RIFLE_ ?
(i) ⇒ Robin is not currently in a shooting position

b. If Robin (i) TAKE-RIFLE-$HOOT_
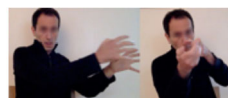
(ii) $HOOT-RIFLE_ , we'll hear something.
(i) ⇒ Robin is not currently in a shooting position

c. None of your friends is going to (i) TAKE-RIFLE-

$HOOT_ (ii) $HOOT-RIFLE_ .
(i) ⇒ each of your friends is currently in a non-shooting position, i.e. none of your friends is currently in a shooting position

It is worth noting that the first part of *TAKE-RIFLE-$HOOT* may be modulated to provide information about the position where rifles are stored, which may be more or less high relative to the speaker. In other words, this gesture may carry gradient spatial information that would be hard to emulate with a (gesture-free) spoken word.

Presuppositions are also triggered by gestures that involve a specific position for an object. This point was discussed in Schlenker and Chemla (to appear) in connection with some verbal gestures that are reminiscent of 'agreement verbs' in sign language (ASL and LSF). Like agreement verbs, these gestures trigger height (or positional) presuppositions when they target a high position. Thus *$LAP-high* in (31)a triggers the inference that the speaker's teammates are very tall (or positioned high)—they might for instance be basketball players. The same inference is triggered in (31)b with universal projection of the 'height' presupposition.

(31)   a. My teammate, will you $LAP-high_ ?
⇒ the speaker's teammate is tall or positioned high

b. If you $LAP-high_ my teammate, we'll notice.
⇒ the speaker's teammate is tall or positioned high

    c. None of your teammates will I ever $\mathbb{SLAP}$-high_
       ⇒ each of the addressee's teammates is tall or positioned high
       (see Schlenker and Chemla to appear, for related examples)

A positional presupposition is also triggered by the gesture $\mathbb{UNSCREW}$-$ceiling$ as in (32).
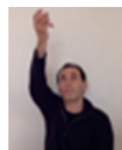
(32)   a. This light bulb, are you going to $\mathbb{UNSCREW}$-$ceiling$_   ?
       ⇒ this light bulb is on the ceiling

   b. If you $\mathbb{UNSCREW}$-$ceiling$_   this lightbulb, don't hurt yourself.
       ⇒ this light bulb is on the ceiling
   c. None of the light bulbs in this room will I ever $\mathbb{UNSCREW}$-
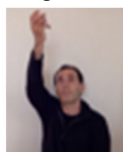
   $ceiling$_   .
       ⇒? each of the light bulbs in this room is on the ceiling

Here too, the precise realization of $\mathbb{UNSCREW}$-$ceiling$ may provide iconic information that would be hard to emulate with a (gesture-free) spoken word, for instance pertaining to what type of bulb is involved (a repeated rotating motion may be indicative of a screw-based bulb, while a short and sharp motion may suggest a bayonet-based system).

Gestures used to describe changes of state trigger presuppositions as well. Thus $\mathbb{TAKE}$-$\mathbb{OFF}$-$\mathbb{ROTATING}$ in (33) displays the same kind of presuppositional behavior as *take off* in (26) (and it differs from the non-presuppositional control *be on the ground and* $\mathbb{TAKE}$-$\mathbb{OFF}$-$\mathbb{ROTATING}$).

(33)   a. At 12:05, will the company's helicopter

    (i) $\mathbb{TAKE}$-$\mathbb{OFF}$-$\mathbb{ROTATING}$_
    (ii) be on the ground and then $\mathbb{TAKE}$-$\mathbb{OFF}$-

ROTATING_ ?

(i) ⇒ right before 12:05, the company's helicopter will be on the ground

b. At 12:05, if the company's helicopter (i) TAKE-OFF-

ROTATING_

(ii) is on the ground and then TAKE-OFF-

ROTATING_ , we'll hear some noise.

(i) ⇒ right before 12:05, the company's helicopter will be on the ground

c. At 12:05, none of the company's helicopters will

(i) TAKE-OFF-ROTATING_

(ii) be on the ground and then TAKE-OFF-

ROTATING_ .

(i) ⇒ right before 12:05, each of the company's helicopters will be on the ground

(see Schlenker to appear b for similar examples)

In addition, the same gesture triggers a presupposition that the subject is helicopter-like in taking off by way of a rotating motion, as shown by the inferences in (34).

(34)   a. Will your company's aircraft/that thing in the distance

TAKE-OFF-ROTATING_ ?

⇒ your company's aircraft/the thing in the distance is helicopter-like

b. If your company's aircraft/that thing in the distance

TAKE-OFF-ROTATING_ , we'll hear some noise.

⇒ your company's aircraft/the thing in the distance is helicopter-like

c. None of your company's aircraft/None of those things in the distance will

TAKE-OFF-ROTATING_ .

⇒ each of your company's aircraft/each of the things in the distance is

helicopter-like
(see Schlenker to appear b for similar examples)

4.2 Anti-presuppositions

4.2.1 Standard anti-presuppositions

As mentioned in Sect. 2.1.3, several researchers have posited a principle, *Maximize Presupposition*, which requires that one choose from a pre-determined set of competitors the Logical Form that *marks the strongest presupposition* compatible with what is assumed in the conversation (Sauerland 2003, 2008; Percus 2006; Singh 2011; Schlenker 2012). Without going into technical details that are discussed elsewhere, let us mention that *Maximize Presupposition* as standardly stated has two key properties. First, it compares Logical Forms whose assertive components are *contextually equivalent*. Second, among the competitors, *Maximize Presupposition* selects the Logical Form that carries the strongest presupposition compatible with the context (more technically, with the 'context set'). When a sentence is uttered which has a presuppositionally stronger competitor, one can thus infer that *this stronger presupposition is not licensed in the context* (this inference is thus an anti-presupposition). This case is illustrated in (35)a,b. When the stronger presupposition is known to be satisfied in the context but is not marked, deviance ensues, as in (9)a, repeated as (35)c.

(35)   Competition between *believe* and *know*

    a. John believes that he is competent.
      ⇒ it is not established that John is competent
    b. Each of my students believes that he is competent.
      ⇒ it is not established that each of my students is competent
    c. #John believes that Paris is in France.

In order to display the effect, one needs to find two competing expressions, one of which triggers a stronger presupposition than the other. This condition is satisfied by the alternatives {*know*, *believe*}. It is also satisfied by the alternatives {*2nd*, *3rd*}, the second and third person features found on some English pronouns. While third person features often cannot be used to refer to the speaker or addressee, this is not invariably the case, as seen in (36)a: the mere possibility that the person seen in the mirror is neither the speaker nor the addressee suffices to license the use of a third person pronoun, as seen in (36)a (where the third person pronoun is boldfaced). And in (36)b the third person reflexive *himself* ranges over various individuals including the addressee.

(36)   a. [Uttered by a speaker with bad eyes in front a mirror].
      He looks like you.... in fact, **he** is you!
    b. Every individual (including you) admires himself.

The key is that in both cases the presuppositions of the first or second person pronouns could not be marked without triggering a presupposition failure. As a result, the third

person pronoun can be used. Crucially, on this analysis a third person pronoun does not by itself trigger a presupposition; rather, it is because of *Maximize Presupposition* that in some cases (but not in others) the non-first, non-second person inference arises.

4.2.2 Gestural anti-presuppositions

We will now argue that instances of *Maximize Presupposition* arise in the gestural domain. As was the case for some implicatures, it will often prove important to make the competing alternatives highly salient in the context. In addition, we will have to take great care to find presuppositionally weak gestures that can compete with presuppositionally stronger ones.

We start with a relatively simple case, discussed in Schlenker and Chemla (to appear). As mentioned, $SLAP in (31) has been compared to sign language agreement verbs. This is because these include in their realization a position in signing space (called a locus) that denotes one of their thematic roles. Schlenker and Chemla (to appear) focus on object agreement verbs in sign language, and gestural verbs with object agreement in spoken language. The distinction between first, second and third person is realized in sign language by loci that correspond to the signer's position, to the addressee's position, or to a variety of third person positions. Schlenker and Chemla argue that a first/second/third person distinction can also be realized in gestures, as is illustrated in (37). A complicating factor is that in this case the second person form, which targets a position in front of the speaker, also seems to do double duty as a neutral form (without person object marking); this is the reason this form is glossed with (-2) in parentheses. On the other hand, attempts to use a third person locus to refer to the addressee yield rather sharp deviance, as illustrated in (37)b (Schlenker and Chemla provide experimental evidence for this type of acceptability contrasts in gestures).

Notation: in the following examples, suffixed -1 indicates that a gesture targets the speaker (as in $SHOOT-1, $SLAP-1), -a that it targets a third person position (neither speaker nor addressee), and (-2) that it targets the addressee (this position can also be used for neutral versions of the gestures, without person specifications). We write (-2^{high}) when the addressee-targeting gesture ends in a high position. $IX-2 is an index pointing towards the addressee (here it is used as a co-speech gesture).

(37)   a. I am going to $SHOOT-1_____ .

       b. You, I am going to $SHOOT(-2)_____ /?? $SHOOT-a_____ .

       c. John, I am going to $SHOOT(-2)_____ / $SHOOT-a_____ .
          (Schlenker and Chemla to appear)

What is the source of the deviance found in (37)b? It might lie in a competition between a presuppositionally weak third person form and presuppositionally strong

first and second person forms. The reason is that a third person form *can* be used to refer to the addressee if a second or first person form could not be used without triggering a presupposition failure, as seen in (38)a, b. But if one attempts to use the third person form to refer to the addressee in the simple sentence in (38)c, deviance ensues: the second person form must be used instead.

(38)   a. This person I saw in the mirror, I wanted to $\mathbb{SLAP}$-$\mathbb{a}$_ – right before realizing that it was $\mathbb{IX}$-$\mathbb{2}$ **[you]**!

    b. I am so angry at my friends... Each of them, I'd like to $\mathbb{SLAP}$-$\mathbb{a}$_ – including $\mathbb{IX}$-$\mathbb{2}$ **[you]**!

    c. You, I am going to #$\mathbb{SLAP}$-$\mathbb{a}$_ / $\mathbb{SLAP}$(-$\mathbb{2}$)_ .

A reviewer notes that things might be more complex, however. As noted in Schlenker (2017), gestural pointing seems to be subject to a constraint whereby one should not establish an arbitrary position for a discourse referent whose denotation is physically present in the context (this mirrors a constraint that was described for sign language pointing signs, e.g. Schlenker 2011). Thus it might be that the constraint at work in (38)c reflects this other constraint (which might or might not be subsumed under *Maximize Presupposition*). It is thus important to find further examples of anti-presuppositions in the gestural domain.

A. Anvari (p.c.) has raised the possibility that a similar effect might hold with height presuppositions. An attempt to test Anvari's suggestion is displayed in (39), where the competing gestures are first introduced as co-speech gestures.

(39)   *Context:* the addressee's very tall brother is present at some distance behind him.

I'd like to **[slap]** you, I'd even like to **[slap]** your giant brother. In fact, **all the people in this room, I'd like to** $\mathbb{SLAP}$(-$\mathbb{2}$)_ . And umh.... your giant brother... him too I will

    a. $\mathbb{SLAP}$(-$\mathbb{2}$)_ .

b. $\mathbb{SLAP}$(-2$^{\text{high}}$)_ .

The boldfaced clause shows that that the neutral form of $\mathbb{SLAP}$ can be used to refer, among others, to tall individuals (since the brother is in the room). The question is whether the neutral form in (39)a might be dispreferred to refer to the tall brother. We are currently agnostic, as we think the data need to be investigated in greater detail.[25]

In (40), we consider a different paradigm, based on the gesture $\mathbb{DRINK}$-$\mathbb{SMALL}$ used in (29). We contrast it with a more neutral gesture $\mathbb{DRINK}$, used as an all-purpose form. It can be checked by way of the boldfaced quantified statement that $\mathbb{DRINK}$ can indeed be applied to a variety of drinking events, including ones that involve vodka glasses. Still, with this highly salient scale in place, it seems to be preferable to use the specific, vodka-related form when it is applicable. As noted above, the difference is presuppositional in nature, and thus the slight deviance obtained in (40) is a good candidate for an effect of *Maximize Presupposition*.

(40)   At a bar:

I might $\mathbb{DRINK}$_ **[enjoy a glass of coke]** or $\mathbb{DRINK}$-

$\mathbb{SMALL}$_ **[drink some vodka]**. . . Hard choice. In fact, **ev-**

erything you have, I'd love to $\mathbb{DRINK}$_ . To start with, this glass of vodka,

a. ?I am going to $\mathbb{DRINK}$_ .

---

[25] See Schlenker et al. (2013) for a discussion of the optionality of height marking with sign language pronouns. (Note that their examples do not involve similar attempts to make very salient the competition between a high and a normal locus.)
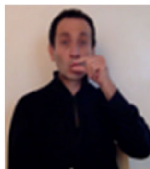
    b. I am going to $\mathbb{DRINK\text{-}SMALL}$_.

While the data involving horizontal gestural loci might be interpreted in different ways, and those involving vertical loci might not be clear yet, the paradigm in (40) suggests that instances of *Maximize Presupposition* can be found with pro-speech gestures. This is expected in view of the observation that a gesture such as $\mathbb{DRINK}$-$\mathbb{SMALL}$ triggers a presupposition that is not triggered by $\mathbb{DRINK}$; due to *Maximize Presupposition*, when the context guarantees that $\mathbb{DRINK}$ competes with $\mathbb{DRINK}$-$\mathbb{SMALL}$, the latter must be used whenever its presupposition is satisfied.

4.3 Conclusion on presuppositions and anti-presuppositions

The existence of pervasive mechanisms of presupposition generation with pro-speech gestures puts new constraints on presupposition theory. While our observations do not preclude the possibility that some presuppositions may be encoded in the lexical entries of spoken words, it suggests that speakers also have access to a 'triggering algorithm' that productively applies to gestures, including ones that they might never have seen before. The challenge for future research will be to specify what this algorithm is, and to determine whether, once it is in place, one still needs to encode some presuppositions in the lexical entries of spoken words: it could be that 'iconic presuppositions' are triggered in a way that does not extend to spoken words, or that a natural algorithm can cover both cases in one fell swoop.[26]

While the existence of gesturally triggered presuppositions imposes new constraints on presupposition theory, the existence of gestural anti-presuppositions is, by contrast, expected: if a presuppositional gesture is evoked by another gesture that has a similar at-issue content but lacks the relevant presupposition, *Maximize Presupposition* should make itself felt, and this is indeed what we found.

Finally, as was the case for implicatures, the gestures we studied provided gradient iconic information that would be hard to match with gesture-free words. We made this point earlier about $\mathcal{TURN}\text{-}\mathcal{WHEEL}\text{-}small$, and again about $\mathcal{TAKE}$-$\mathcal{RIFLE}$-$\mathcal{SHOOT}$ and $\mathcal{UNSCREW}\text{-}ceiling$, but the point could just as easily have been made about $\mathcal{TAKE}$-$\mathcal{OFF}$-$\mathcal{ROTATING}$, whose realization may for instance provide gradient information about the speed of the helicopter take-off. It is all the more remarkable that these strongly iconic elements can generate presuppositions just like normal spoken words.

---

[26]These are just extreme possibilities. It could also be that the algorithm needed for iconic presupposition generation extends to some but not to all presuppositions triggered by spoken words. Let us add that Abrusán's triggering mechanism (Abrusán 2011), which was developed for the case of spoken words, seems to us to be in a good position to derive several of our gestural results, but we must leave a detailed discussion for another occasion (see Schlenker 2018).

5 Homogeneity inferences[27]

5.1 Properties of homogeneity inferences

Recent research has uncovered another class of inferences, termed 'homogeneity inferences' (e.g. Löbner 2000; Gajewski 2005; Spector 2013a; Križ 2015, 2016; Križ and Spector 2017). They primarily arise with definite plurals such as *her presents*, and are characterized by four key properties.

(i) Universal-type readings in unembedded cases: In positive environments (= (41)a, a′), they give rise to the same type of inferences as *all of her presents* (*modulo* the fact that they allow for exceptions in pragmatically constrained fashions, studied by Križ 2015).

(ii) Existential-type readings in negative cases: In negative environments (= (41)b, b′), they give rise to the same type of inferences as *any of her presents* (i.e. of a narrow scope existential quantifier). However, this stops being the case when *her presents* is replaced with *all of her presents* (= (41)c).

(iii) Uncertainty in mixed cases: In addition, cases of infelicity or uncertainty are obtained when some but not all of the presents have the relevant property (in (41)a, a′, b, b′).

(41) a. Mary found her presents.
         ⇒ Mary found (nearly) all of her presents
      a′. Mary always finds her presents.
         ⇒ Mary always finds (nearly) all of her presents
      b. Mary didn't find her presents.
         ⇒ Mary found (nearly) none of her presents
      b′. Mary never finds her presents.
         ⇒ Mary always finds (nearly) none of her presents
      c. Mary didn't find all of her presents.
         ⇏ Mary found (nearly) none of her presents
      d. If Mary finds her presents, we'll start to have dinner.
         ⇒ Mary has presents waiting for her
         ⇏ Mary will either find all or none of her presents

(iv) No projection under *if*: Some have tried to account for these inferences by positing that *x finds his presents* triggers a presupposition that *x finds all or none of his presents* (Löbner 2000; Gajewski 2005). But a final property suggests that this is unlikely to be correct: such an inference fails to project out of the antecedent of conditionals, unlike standard presuppositions. As a result, there is a sharp contrast in (41)d between the existence presupposition of *her presents*, which does project, and the homogeneity inference, which does not.

Without going into theoretical issues that are complex, let us note that most or all accounts (including recent ones such as Spector 2013a; Križ 2015, 2016; Križ and Spector 2017) locate the source of homogeneity inferences in the semantics of predicates. Simplifying somewhat, in the Spector/Križ theories, the semantics of a

---

[27]Thanks to Manuel Križ and Benjamin Spector for helpful remarks on this part.

predicate *P* ensures that *P* is neither true nor false (i.e. that it returns a third truth value, #) when applied to a plurality which is non-homogeneous with respect to *P*, in the sense that some members of the plurality satisfy *P* and others don't. As a result, *Mary found her presents* has the value # if Mary found some but not all of her presents; it has the value *true* if Mary found all of her presents; and it has the value *false* if Mary found none of her presents.

Importantly, the third truth value behaves roughly like the indeterminacy (or uncertainty) sometimes produced by vague statements, rather than like a presupposition. Thus for the sentence *Mary found her presents* to be clearly true, Mary must have found all of her presents (hence Property (i): universal-type readings in unembedded cases); for it to be clearly false, Mary must have found none of her presents (which derives Property (ii): existential-type readings under negation). When Mary found some but not all of her presents, the value of the sentence is vague (hence Property (iii): deviance in mixed cases). But because vagueness is not a presupposition, we do not see a projection behavior under *if* (hence Property (iv): no projection under *if*). To the extent that predicates—or operators associated with them—are at the source of the phenomenon, it will be particularly interesting to find cases of gestural predicates that yield homogeneity inferences. But in case one thinks that the nature of the nominal plural plays a role as well, we will show that it too can be made gestural while preserving the effects.

5.2 Finding homogeneity inferences with pro-speech gestures

In order to find homogeneity inferences with pro-speech gestures, we will combine two mechanisms we already discussed. First, we will introduce plurals by way of repetitions of a gesture, as in (17)c (we will investigate diverse types of repetitions, as is done in Schlenker and Lamberton to appear). Second, we will use gestural verbs with object agreement to realize definite anaphora. We will later reproduce the effect with simple pointing gestures, but for theoretical purposes this is less informative on the assumption that homogeneity inferences are triggered by predicates, as proposed in the literature.

Since the details of plural gestures will matter, we should say a bit more about their realization. In sign languages, in homesigners, and (we believe) in gestures, *punctuated repetitions* are made of the discrete iteration of the same sign. By contrast, *unpunctuated repetitions* involve iterations with shorter and less distinct breaks between them, which makes these iterations less distinct and sometimes harder to count (for homesigners, see Coppola et al. 2013 and Abner et al. 2015; for sign languages, see Pfau and Steinbach 2006 and Schlenker and Lamberton to appear; for gestures, see Feldstein 2015 and Schlenker and Lamberton to appear). As Schlenker and Lamberton argue, in unpunctuated and punctuated repetitions alike, the iterations are typically produced in different parts of signing space, and their arrangement provides iconic information about the shape of the denoted group. They further argue that in default situations, each iteration of a *punctuated* repetition stands for a separate object (a condition that can be overridden), whereas *unpunctuated* repetitions stand for pluralities with vague numerical threshold conditions. While they primarily focus on ASL, they propose that these generalizations also apply to pro-speech gestures in non-signers.

Let us consider the paradigm in (42). An unpunctuated repetition of $\mathbb{CROSS}$ (written as +) appears in position *a* as the object of *see*; this has the function of introducing an indefinite plural. The gesture $\mathbb{TAKE\_2\text{-}handed\text{-}a}$ then targets this same position, realizing a meaning akin to *take them*.

Notation: We write + for the $\mathbb{CROSS}$ gesture, as in (17); below we will also use *o* for an O-shaped gesture representing medallions. + + + refers to three punctuated iterations, $+\text{-}rep_3$ and $+\text{-}rep_6$ to three and six unpunctuated iterations respectively. — indicates that the repetitions are arranged on a horizontal line, $\wedge$ that they are arranged as a vertical triangle. In (42), the subscript a in $[+\text{-}rep_3\text{—}]_a$ indicates that the gesture is made in position a, which we take to be realized roughly in front of the speaker, on the dominant side. When two gestures appear in different loci, a represents a position on the speaker's dominant side and b represents a position on the speaker's non-dominant side. As before, $\mathbb{IX}\text{-}a$ refers to an index pointing towards gestural locus a, while $\mathbb{IX}\text{-}hand\text{-}a$ is a variant in which an open hand, palm up, points towards a.

(42)   *Context:* in a treasure hunt, the speaker is supposed to find a particular cross.
          You will enter a room. You will see $\boxed{[+\text{-}rep_3\text{—}]_a}$
          $\Rightarrow$ the adressee will see some crosses (horizontally arranged)
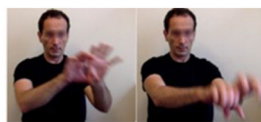
a. **and you will $\mathbb{TAKE\_2\text{-}handed\text{-}a\_}$** .
    $\Rightarrow$ the addressee will take them (all)
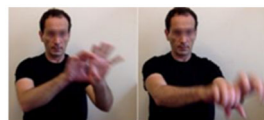
b. **but you will not $\mathbb{TAKE\_2\text{-}handed\text{-}a\_}$** .
    $\Rightarrow$ the addressee will take none
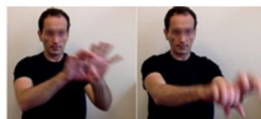
c. **and if you $\mathbb{TAKE\_2\text{-}handed\text{-}a\_}$** , **you will win the prize.**
    $\not\Rightarrow$ you will take all or none[28]

The plural gesture (boxed) triggers the inference that the addressee will see some crosses (horizontally arranged). We can then check that the four properties discussed above in connection with definite plurals hold in this case as well.
(i) Universal-type reading in unembedded cases: (43)a intimates that the addressee should take (nearly) all crosses.

---

[28]Here and in (44)c, we only mean that the sentence does not trigger the inference that the addressee will in fact take all or none. We do not make a claim as to what is required for the addressee to win the prize; but in this connection the gestural judgments seem to us to be similar to those obtained if $\mathbb{TAKE\_2\text{-}handed\text{-}a}$ is replaced with the spoken words *take them*.

(ii) Existential-type readings in negative cases: (42)b intimates that she should take none.

(iii) Uncertainty in mixed cases: It isn't very clear whether the order was or wasn't fulfilled if the addressee took some but not all crosses.

(iv) No projection under 'if': Finally, there need not be an assumption in (42)c that the addressee will take either all or none of the crosses. If anything, the context leads one to expect the addressee should take just one cross.

It is worth emphasizing that the iconic nature of the gesture, which involves two hands and might thus help obtain a 'take all' reading, does not suffice to derive the inferential patterns we observed. For if *you will* $\mathbb{TAKE\_2\text{-}handed\text{-}a}$ just meant: *you will take them all*, its negation in (42)b should just mean: *you will not take them all*. But this fails to derive the stronger inference obtained, to the effect that the addressee will take none. In other words, while iconicity might play a role in the readings obtained, it must be supplemented with a mechanism to derive the specific pattern of inference associated with homogeneity.

As we already observed in connection with $\mathbb{CROSS}$ in (17), it is unlikely that the plural gesture (notated here as $+\text{-}rep_3$ and $+\text{-}rep_6$) is a code for a (gesture-free) spoken expression, as it can be modulated to have fine-grained iconic and quantitative implications that would be difficult to translate precisely. Thus the boxed part of (42) (= (43)a) can be replaced with (43)b to indicate that the addressee will see *quite a few* crosses (arranged horizontally). The same quantitative inferences are obtained in (43)c, d (where $\wedge$ indicates that the iterations are produced with a triangular shape), but with the understanding that the crosses are arranged as a triangle. Finally, in (43)e, f, which involve three punctuated iterations (notated as +++), we obtain an inference that three crosses will be seen, arranged on a horizontal line or as a triangle, as the case may be. If the gesture for $\mathbb{TAKE\_2\text{-}handed\text{-}a}$ is broad enough to target the entire area in which the plural gesture is realized, the same inferences are obtained as in (42).

(43) a. $+\text{-}rep_3\_$——
      b. $+\text{-}rep_6\_$——
      c. $+\text{-}rep_3\_\wedge$
      d. $+\text{-}rep_6\_\wedge$
      e. +++_——
      f. +++_$\wedge$

The same remarks apply to the gestural verb $\mathbb{TAKE\_2\text{-}handed}$: by raising or lowering the target of the gesture, it may be modulated to provide iconic information about where the crosses will be found (higher or lower). So it too is unlikely to be a code for a (gesture-free) spoken word.

We note that the same result can be obtained without making use of a gestural verb (as mentioned, on the assumption that homogeneity effects are due to predicates, this observation is unsurprising in view of the behavior of normal [non-gestural] verbs). In (44), a contrast is established between three medallions (represented on the speaker's non-dominant side) and some crosses (represented on the dominant side). A pointing gesture (by way of a pointing index or of an open hand) towards the dominant side is

then understood to refer to the crosses, and this gives rise to the same homogeneity inferences as in (42).

(44) *Context:* in a treasure hunt, the speaker is supposed to find medallions or crosses.
You will enter a room. You will see [o-rep_3_—]$_b$, and also $\boxed{[+\text{-rep}_3\text{_}\text{—}]_a}$,
⇒ the addressee will see some medallions (horizontally arranged), and some crosses (horizontally arranged)

    a. **and you will take IX-a / IX-hand-a.**
      ⇒ the addressee will take (all) the crosses
    b. **but you will NOT take IX-a / IX-hand-a.**
      ⇒ the addressee will take none of the crosses
    c. **and if you take IX-a / IX-hand-a, you will win the prize.**
      ⇏ the addressee will take either all or none of the crosses

Here too, the boxed part can be replaced with any of the realizations in (43) to yield slightly different quantitative or iconic inferences.

5.3 Conclusion on homogeneity inferences

We conclude that homogeneity inferences can be reproduced with pro-speech gestures, including when both the plural and the verb are realized as pure gestures. Their iconic properties make it unlikely that these are codes for gesture-free words. On a theoretical level, these examples suggest that what triggers homogeneity effects (a property of predicates, according to the literature) is automatically extended to gestures that one may not have seen before: homogeneity effects thus seem to be productive (this need not be surprising if they are due to operators that associate with predicates, or if the relevant property of predicates holds throughout the lexicon).[29]

6 Supplements and expressives

Another broad class of inferences is triggered by appositive relative clauses ('supplements') and some derogatory terms such as 'honkey' ('expressives') (Potts 2005). While they don't quite display a unified behavior, these inferences differ from entailments, implicatures and presuppositions in yielding little interaction with logical operators, as if they were interpreted without regard to them (in simple cases at least). We discuss them in turn, focusing on some of their most characteristic properties. (Our discussion of gestural supplements is somewhat brief because the topic has been discussed at some length in the literature, e.g. in Schlenker 2015, to appear a, to appear b.)

---

[29]As Manuel Križ (p.c.) notes, one may in the future study further realizations of the gestural predicate involving a repetition of the verb to indicate a plurality of actions. This option is open in sign language (Kuhn 2015) as well as in gestures (Schlenker 2017), and it would thus be interesting to see how it interacts with homogeneity effects.

6.1 Supplements

6.1.1 Standard supplements

Unlike presuppositions, supplements must make a non-trivial contribution (Potts 2005). And unlike all the expressions discussed so far, their acceptability is restricted: they may be degraded in the scope of a negative expression, as in (45)c. This behavior could be attributed to the meaning of *which*, as it might play a role akin to anaphoric *this* in the second conjunct of (45)c′. But under embedding, for instance under *if*, the behavior of a conjunct is very different from that of a supplement: the former but not the latter is interpreted within the scope of the *if*-clause, as shown in (46).

(45)   a. Mary helped her son, which saved him.
         b. One of these women helped her son, which saved him.
         c. #None of these women helped her son, which saved him.
         c′. #None of these women helped her son, and this saved him.

(46)   a. If Mary helps her son, which will save him, our problem will be solved.
           ⇒ if Mary helps her son, this will save him
         b. If Mary helps her son and this saves him, our problem will be solved.
           ⇏ if Mary helps her son, this will save him

6.1.2 Gestural supplements

Schlenker (2015, to appear a, to appear b) argues that in these respects post-speech gestures display the behavior of appositive relative clauses.[30] To give but one example, $\mathbb{SLAP}$ used as a post-speech gesture has the same distribution as the appositives in (45)–(46), as shown in (47)–(48). Schlenker (to appear b) argues that in English as well as in ASL, the generalizations can be extended to post-speech and post-sign facial expressions.[31]

---

[30] Appositive relative clauses display a behavior which is very close to that of clausal parentheticals, as shown in (i)–(ii), and for this reason more sophisticated data would be needed to decide whether post-speech gestures behave like parentheticals or like appositives (as is granted by Schlenker to appear a, to appear b).

(i)   a. Mary helped her son (this saved him).
          b. One of these women helped her son (this saved him).
          c. #None of these women helped her son (this saved him).

(ii)   If Mary helps her son (this will save him), our problem will be solved.
       ⇒ if Mary helps her son, this will save him

For present purposes, the difference doesn't matter, since both classes exhibit varieties of supplemental meanings. (In some restricted environments, appositives can take narrow scope with respect to some logical operators, whereas this is difficult for clausal parentheticals. See Schlenker 2010, 2013a, 2013b for discussion.)

[31] As mentioned in Sect. 2.2.3, Schlenker (to appear a, to appear b) argues that co-speech gestures and co-speech/sign facial expressions display a very different behavior: they are not prohibited in the immediate scope of negative expressions, and they do not trigger supplements, but rather presuppositions whose content is conditionalized on the meaning of the modified expression.

(47) a. Mary will punish her enemy – $\mathbb{SLAP}\_$.

  b. One of these women punished her enemy – $\mathbb{SLAP}\_$.

  c. #None of these women punished her enemy – $\mathbb{SLAP}\_$.
  (adapted from Schlenker to appear a, to appear b)

(48) a. If Mary punishes her enemy – $\mathbb{SLAP}\_$, we'll hear about it.
  ⇒ if Mary punishes her enemy, slapping will be involved.
  b. If Mary punishes her enemy and this involves some slapping, we'll hear about it.
  ⇏ if Mary punishes her enemy, slapping will be involved. (adapted from Schlenker to appear a, to appear b)

6.1.3 Conclusion on supplements

Gestural supplements differ from the other gestures studied here in that they are post- rather than co-speech gestures, and their semantic behavior seems to be due to this difference. Potts (2005) took the behavior of supplements to be triggered by an abstract lexical element that he equated with the 'comma intonation'—possibly just a pause before an appositive relative clause. The same abstract lexical element could in principle be responsible for the semantic behavior of post-speech gestures. It is thus hard in this case to argue against a (very abstract) lexical account of the phenomenon.

6.2 Expressives

6.2.1 Standard expressives

As briefly mentioned in Sect. 2.1.5, expressives (e.g. the ethnic slur *honkey*) are grammatical in all environments, but fail to interact with logical operators (Potts 2005; there are debates about the nature and explanation of their behavior under verbs such as *say* and *think*, a context we disregard here).

(49) a. Robin should hire a honkey.   a′. Robin is a honkey.
  ⇒ the speaker has a negative attitude towards white people
  b. Will you hire a honkey?   b′. Is Robin a honkey?
  ⇒ the speaker has a negative attitude towards white people
  c. None of these guys will hire any honkey.   c′. None of these guys is a honkey.
  ⇒ the speaker has a negative attitude towards white people

Several researchers have argued, against Potts (2005), that expressives just trigger varieties of presuppositions (e.g. Macià 2002; Sauerland 2007; Schlenker 2007). But

if so, these presuppositions must display a non-standard behavior (Thommen 2017; see also Schlenker 2016). The reason is that these purported expressive presuppositions cannot be justified in the same way as standard presuppositions. This can be seen in (51)b with the slur *Frog*, whose basic expressive behavior is illustrated in (50).[32]

(50)   a. I won't hire a Frog.
            ⇒ the speaker is prejudiced against the French
        b. Will you hire a Frog?
            ⇒ the speaker is prejudiced against the French

(51)   There's plenty of implicit bias, but...
        if I were really prejudiced against the French, I wouldn't hire

        a. a Frenchman.
            ⇏ the speaker is prejudiced against the French
        b. (#) a Frog.
            ⇒ the speaker is prejudiced against the French
        c. one of these Frenchmen I'd unconsciously hate.
            ⇏ the speaker unconsciously hates the French

A presupposition triggered in the consequent of a conditional can normally be justified by information provided in the antecedent. While this is the case of the control sentence in (51)c (which does not entail that the speaker unconsciously hates the French, just that she would *if* she were really prejudiced against them), things are different in (51)b: the inference that the speaker is prejudiced against the French is inherited by the entire sentence. The result is pragmatically odd (which we notate as (#)): the use of subjunctive mood in the *if*-clause carries the implication that the speaker is not really prejudiced against the French, but the use of *Frog* in the consequent suggest that she is.

In these cases, one might argue that expressive presuppositions are indexical in nature, in the sense that they must be evaluated with respect to the *context* parameter of the sentence. Technically, a conditional manipulates the *world* parameter of a clause, rather than its context parameter, and for this reason the expressive presupposition of *Frog* may fail to be evaluated with respect to the non-actual worlds introduced by the *if*-clause (this is, informally, the proposal of Schlenker 2007). Importantly, this analysis won't extend to disjunctions (Schlenker 2016; Thommen 2017). A presupposition triggered in the second part of a disjunction can normally be satisfied thanks to the negation of the first disjunct, as is illustrated in (52). Unlike *if*, *or* does not affect the value of the world parameter, hence intensionality is not responsible for this phenomenon. In dynamic semantics (e.g. Beaver 2001), the explanation lies in the dynamic behavior of *or*: a presupposition triggered in the second disjunct ought to be satisfied with respect to the set of contexts compatible with what the speech act participants take for granted, *updated* with the negation of the first disjunct.

---

[32]Thanks to Lyn Tieu for discussion of these examples.

(52)   Either this house doesn't have a bathroom, or the bathroom is in a funny
         place. (modified from an example attributed to Partee)
         $\nRightarrow$ this house has a bathroom

But the facts are quite different with *bona fide* expressives. As is shown in (53)b, the
expressive presupposition triggered by *Frog* in the second disjunct cannot be satis-
fied thanks to the negation of the first disjunct, and as a result the inference is that the
speaker is prejudiced against the French (if the negation of the first disjunct could sat-
isfy the expressive requirement, we would only obtain a presupposition to the effect
that if the speaker is really prejudiced against the French, she is prejudiced against
the French—which is a tautology). Things are arguably different in (53)c, which need
not imply that the speaker does unconsciously hate the French; rather, the sentence
can be interpreted to just presuppose that *if* the speaker is really prejudiced against
the French, she unconsciously hates them.[33]

(53)   There's plenty of implicit bias, but...
         either I am not really prejudiced against the French, or

         a. I won't hire a Frenchman.
            $\Rightarrow$ the speaker is prejudiced against the French
         b. (#) I won't hire a Frog.
            $\Rightarrow$ the speaker is prejudiced against the French
         c. I won't hire one of these Frenchmen I unconsciously hate.
            $\nRightarrow$ the speaker unconsciously hates the French

6.2.2 Gestural expressives

Our goal is not to explain why expressives display this behavior (it could be that they
should be analyzed along the lines of Potts 2005, or that they are a non-standard vari-
ety of presupposition triggers). Rather, we will note that several pro-speech gestures
display the same offensive behavior, as is shown in (54)–(55).[34]

(54)   I won't hire a

         a. ELONGATED-EYES.
            $\Rightarrow$ the speaker is prejudiced against Asian people
         b. EFFEMINATE-HAND.
            $\Rightarrow$ the speaker is prejudiced against gay people
         c. HANDICAPPED-HAND.
            $\Rightarrow$ the speaker is prejudiced against people with disabilities

---

[33]Things are complicated by the fact that some sentences of the form (p *or* qq'), where qq' carries a
presupposition q, give rise to readings in which the entire sentence presupposes $\underline{q}$ (see for instance Beaver
2001; Beaver and Geurts 2011; and Schlenker 2016 for discussion of the general issue, often labelled
the 'Proviso Problem'). Our point is that this is not the only possible reading for (53)c, whereas (53)b
obligatorily carries the implication that the speaker is in fact prejudiced against the French.

[34]Needless to say, our examples are mentioned, not used. We refrain from including pictures to reduce any
offensiveness. We apologize for any offense these examples may cause despite these precautions.

(55)   Will you hire a

    a. ELONGATED-EYES?
    ⇒ the speaker is prejudiced against Asian people
    b. EFFEMINATE-HAND?
    ⇒ the speaker is prejudiced against gay people
    c. HANDICAPPED-HAND.
    ⇒ the speaker is prejudiced against people with disabilities

Importantly for our purposes, these expressions display the same interaction with conditionals as *bona fide* expressives, as shown in (56). Specifically, these examples seem nearly contradictory because the counterfactual implies that the speaker does not hold the relevant prejudice, but the speaker's use of a slur in the consequent leads to the opposite conclusion.

(56)   There's plenty of implicit bias, but. . .

    a. (#) if I were really prejudiced against Asian people, I wouldn't hire a ELONGATED-EYES.
    ⇒ the speaker is prejudiced against Asian people
    b. (#) if I were really prejudiced against gay people, I wouldn't hire a EFFEMINATE-HAND.
    ⇒ the speaker is prejudiced against gay people
    c. (#) if I were really prejudiced against handicapped people, I wouldn't hire a HANDICAPPED-HAND.
    ⇒ the speaker is prejudiced against people with physical disabilities

The same facts carry over to the crucial tests involving disjunction, as shown in (57). This suggests that the expressions under study share the fine-grained behavior of expressives.

(57)   There's plenty of implicit bias, but. . .

    a. (#) either I am not really prejudiced against Asian people, or I won't hire a ELONGATED-EYES.
    ⇒ the speaker is prejudiced against Asian people
    b. (#) either I am not really prejudiced against gay people, or I won't hire a EFFEMINATE-HAND.
    ⇒ the speaker is prejudiced against gay people
    c. (#) either I am not really prejudiced against handicapped people, or I won't hire a HANDICAPPED-HAND.
    ⇒ the speaker is prejudiced against people with disabilities

Richard (2008) noted that the pragmatic effects of expressives and of presuppositions are rather different. (58)a explicitly introduces a presupposition that the speaker has a negative attitude towards Caucasians—and yet (58)b appears to be far more offensive. Irrespective of the reason, we believe that the same observation carries over to expressive gestures.

(58)   a. Everybody knows that I hate Caucasians. Are you one?
    b. Are you a honkey?

6.2.3 Conclusion on expressives

It thus seems that pro-speech gestures can function as expressives,[35] which completes our argument that the full inferential typology we started out with (in (5)) can be replicated with pro- and post-speech gestures.

Still, one must ask once again whether expressive gestures could be codes for (gesture-free) English words—for if this were the case the import of our conclusion would be affected (it would just show that there are gestural codes for expressive words, rather than irreducibly gestural expressives). Unlike most of the other gestures we considered in this piece, the cases of expressive gestures we studied might be conventionalized, at least in part. Still, we believe that some of them have iconic-like implications that might not be so easy to translate very concisely. In particular, $\mathbb{HANDICAPPED}$-$\mathbb{HAND}$ is indicative of a particular kind of disability (one that affects the body), rather than something more general, and one might try to modulate the gesture to determine if more precise iconic implications can be obtained. This is something we leave for future research.

Similarly, it would be interesting to determine whether gestures that one has never seen before can be categorized as expressives. This would extend to the expressive case the argument from productivity that was made in earlier examples. Without such productivity, one might take expressive gestures to be acquired in the same way as spoken expressives, with no implication that there must be a mechanism of 'expressive content generation' that can somehow extract an expressive component from a term one may see for the first time. By contrast, if such a mechanism exists (and can thus be applied to gestures that are not conventional), one would have to ask what the underlying algorithm is, i.e. what is the rule by which one can extract from a new gesture an expressive component. We leave this question for future research.

7 Conclusions

7.1 Results

What have we achieved? We have shown that all the slots of the inferential typology in (5) can be filled with pro- or post-speech gestures. In each case, we found gestures that triggered the relevant type of inference according to some characteristic tests, and with one exception, we also argued that the relevant gestures had two additional properties: (a) they could be modulated iconically so as to provide gradient spatial information about the denoted situations; (b) they could probably be understood to

---

[35] As an anonymous referee suggests, this is certainly the case of co-speech gestures as well: the sentence in (i), where the gesture co-occurs with *John*, suggests that the speaker is prejudiced against Asian / gay / handicapped people (and that John belongs to the relevant group). We don't further discuss co-speech gestures here because their interaction with the modified words raises complexities of its own (see for instance Schlenker to appear a).

(i)   I won't hire $\mathbb{ELONGATED}$-$\mathbb{EYES}$/ $\mathbb{EFFEMINATE}$-$\mathbb{HAND}$/ $\mathbb{HANDICAPPED}$-$\mathbb{HAND}$ **John**.

yield the relevant inferences even without prior exposure. The exception pertained to expressives and supplements: the gestural expressives we studied did seem to have a conventional character (still, it might be possible to modulate some in an iconic fashion); and the gestural supplements we discussed clearly owed their supplemental character to their post-speech nature, which leaves open the possibility that an abstract lexical element (such as the 'comma intonation') is responsible for their semantic behavior.

Of course, property (b) requires some caution, since it is not trivial to determine which gestures one has or hasn't encountered before. Still, properties (a) and (b), when applicable, made important theoretical points. The existence of gradient iconic effects makes it very unlikely that the relevant gestures are just codes for gesture-free words. It seems more parsimonious to directly analyze their semantics as being gestural in nature. The existence of the relevant inferences in gestures that one may not have encountered before highlights the productive character of the underlying semantic rules.

7.2 Theoretical implications

7.2.1 Implications for different inferential types

What are the theoretical implications of our results? For scalar implicatures, our findings are unsurprising, as implicatures are expected to arise as soon as there are differences of informativity among alternative expressions. For presuppositions, our findings are more interesting. We take them to argue for a productive 'triggering algorithm' that divides the global informational contribution of a gestural expression between a presuppositional and an at-issue component. But this leaves open several questions. First, is part or all of the algorithm specifically dependent on the details of an iconic semantics, rather than on more general properties of information transmission? For instance, it could be that stable parts of a dynamic iconic representation are understood to correspond to presupposed information; or it could be that, irrespective of the details of the iconic representation, two gestures with the same global content will divide it in similar ways between an at-issue and a presuppositional contribution. Second (and relatedly), will this algorithm extend to cases that have been given a lexical treatment in spoken language? These questions are open, and they will have to be investigated in tandem with the construction of an explicit iconic semantics, possibly along the lines of Greenberg (2013). But we believe one should at least explore a heuristics according to which *the same triggering algorithm applies to pro-speech gestures and to 'normal' words*. If so, gestures provide a powerful new tool to uncover the detailed properties of this algorithm, for two reasons: they can often be understood without prior exposure, which makes it possible to see the triggering algorithm 'in action'; and in future research, they could be minimally modified to determine at which precise point a presupposition is generated.

For homogeneity inferences, our results suggest that appropriate theories should eschew lexical stipulations, or that these should be extended to some gestures; this need not be surprising in view of recent theories, which locate the source of homogeneity in a general property of predicates. For supplements, things are complex:

Potts (2005) placed the source of their non-standard semantics in a 'comma intonation,' and one could argue that it applies to post-speech gestures as well. For expressives, while the data seem clear, their theoretical import has yet to be determined, in part because their conventionalized status makes it hard to argue that their meaning is inferred without prior exposure (but further examples might show that the relevant processes are productive).

7.2.2 General implications

While our findings have different implications in each case, they also suggest general lessons.

(i) First, gestures can profitably be investigated with the methods of formal semantics: the fine-grained typology we outlined would not have been possible without the sophisticated tests developed in contemporary formal work.

(ii) Second, with the possible exception of expressives, pro-speech gestures make it possible to create 'on the fly' some new 'words' that have a clear meaning, thanks to their iconic semantics. This could be a powerful tool to determine how new meanings interact with the rest of the linguistic system. Creating new spoken words would be much more laborious because one would have to find ways to teach subjects their intended semantics; iconicity obviates this difficulty.

(iii) Third, this method suggests that there are productive principles at work in nearly all domains we surveyed: pro-speech gestures seem to immediately find their appropriate place in a rich inferential typology. In some cases, such as presuppositions, researchers have been tempted to encode much of the behavior of expressions in their lexical entries. Our findings suggest that there are broader principles that makes it possible to *deduce* what these properties are, at least in some cases.

(iv) Fourth, this conclusion might suggest a question about the acquisition of semantics: could the development of the rich inferential typology surveyed above be almost entirely non-lexical? In our discussion, the key ingredients were the informational content of a gesture, sometimes its timing (to distinguish pro- from post-speech gestures), and the expressions it competed with (to derive scalar implicatures and anti-presuppositions). Since most gestures could arguably be categorized on the basis of 'zero-shot learning,' rich lexical meanings were unlikely to play a role in that case. Does this reflect the way semantic acquisition works outside of gesture semantics? This would be a very interesting direction to investigate in the future.

(v) Fifth, a lot hinges on a more detailed understanding of how an iconic semantics works. It could be that some inferences discussed above (for instance, some presuppositions) are specifically due to the workings of an iconic semantics, possibly combined with constraints on anaphoric dependency and coherence in dynamic iconic scenes (see for instance Abusch 2012; Cumming et al. 2017); this, in turn, might suggest that they will not extend beyond the iconic domain. To come to clarity on this matter, we will need to understand how the iconic semantics of gestures works.

7.3 Perspectives

On an empirical level, pro- and post-speech gestures are a rich source of new data that could profitably be investigated by semantics; they should also help broaden recent debates about the semantics of co-speech gestures. As we have seen, pro- and post-speech gestures may have theoretical implications for important questions in semantics. Finally, they should matter for a proper comparison between sign language and spoken language: sign languages notoriously have an iconic component that is hard to match with spoken words alone. While it is increasingly accepted that sign with iconicity should be compared to speech with gestures rather than to speech alone (Goldin-Meadow and Brentari 2017), there is no reason to restrict attention to co-speech gestures: pro- and post-speech gestures may have a crucial role to play in the comparison (Schlenker to appear b, 2017).

References

Abbott, Barbara. 2000. Presuppositions as nonassertions. *Journal of Pragmatics* 32: 1419–1437.

Abner, Natasha, Kensy Cooperrider, and Susan Goldwin-Meadow. 2015. Gesture for linguists: A handy primer. *Language and Linguistics Compass* 9(11): 437–449.

Abrusán, Márta. 2011. Predicting the presuppositions of soft triggers. *Linguistics & Philosophy* 34(6): 491–535.

Abusch, Dorit. 2010. Presupposition triggering from alternatives. *Journal of Semantics* 27(1): 37–80.

Abusch, Dorit. 2012. Applying discourse semantics and pragmatics to co-reference in picture sequences. In *Sinn und Bedeutung 17*, eds. Emmanuel Chemla, Vincent Homer, and Grégoire Winterstein, 9–25.

Beaver, David I.. 2001. *Presupposition and assertion in dynamic semantics*. Stanford: CSLI.

Beaver, David I., and Bart Geurts. 2011. Presupposition. In *Stanford encyclopedia of philosophy*. Available at http://plato.stanford.edu/entries/presupposition/. Accessed 19 April 2018.

Bergen, Leon, Roger Levy, and Noah Goodman. 2016. Pragmatic reasoning through semantic inference. *Semantics and Pragmatics* 9(19): 1–55.

Chemla, Emmanuel. 2009. Presuppositions of quantified sentences: Experimental data. *Natural Language Semantics* 17(4): 299–340.

Chemla, Emmanuel. 2010. Similarity: Towards a unified account of scalar implicatures, free choice permission and presupposition projection. Ms., LSCP, Paris.

Chierchia, Gennaro, Danny Fox, and Benjamin Spector. 2012. The grammatical view of scalar implicatures and the relationship between semantics and pragmatics. In *Semantics: An international handbook of natural language meaning*, eds. Paul Portner, Claudia Maienborn, and Klaus von Heusinger. Berlin: de Gruyter.

Clark, Herbert H. 1996. *Using language*. Cambridge: Cambridge University Press.

Coppola, Marie, Elizabet Spaepen, and Susan Goldin-Meadow. 2013. Communicating about quantity without a language model: Number devices in homesign grammar. *Cognitive Psychology* 67: 1–25.

Cumming, Samuel, Gabriel Greenberg, and Rory Kelly. 2017. Conventions of viewpoint coherence in film. *Philosophers' Imprint* 17(1): 1–29.

Davidson, Kathryn. 2015. Quotation, demonstration, and iconicity. *Linguistics & Philosophy* 38(6): 477–520.

Ebert, Cornelia, and Christian Ebert. 2014. Gestures, demonstratives, and the attributive/referential distinction. Handout of a talk given at Semantics and Philosophy in Europe (SPE) 7, Berlin.

Emmorey, Karen, and Melissa Herzig. 2003. Categorical versus gradient properties of classifier constructions in ASL. In *Perspectives on classifier constructions in signed languages*, ed. Karen Emmorey, 222–246. Mahwah: Lawrence Erlbaum Associates.

Esipova, Maria. 2017. Focus on what's not at issue: Gestures, presuppositions, supplements under Contrastive Focus. Talk given at Sinn und Bedeutung 2017, Berlin-Potsdam.

Feldstein, Emily. 2015. The development of grammatical number and space: Reconsidering evidence from child language and homesign through adult gesture. Ms., Harvard University.

von Fintel, Kai. 2008. What is presupposition accommodation, again? *Philosophical Perspectives* 22(1): 137–170.

Fricke, Ellen. 2008. Grundlagen einer multimodalen Grammatik des Deutschen: Syntaktische Strukturen und Funktionen. Habilitation treatise, European University Viadrina, Frankfurt (Oder).

Gajewski, Jon. 2005. Neg-raising: Polarity and presupposition. PhD diss., MIT.

Geurts, Bart. 2011. *Quantity implicatures*. Cambridge: Cambridge University Press.

Giorgolo, Gianluca. 2010. Space and time in our hands. PhD diss., Uil-OTS, Universiteit Utrecht.

Goldin-Meadow, Susan, and Diane Brentari. 2017. Gesture, sign and language: The coming of age of sign language and gesture studies. *Behavioral and Brain Sciences* 40(e46).

Goodman, Noah D., and Andreas Stuhlmüller. 2013. Knowledge and implicature: Modeling language understanding as social cognition. *Topics in Cognitive Science* 5(1): 173–184.

Greenberg, Gabriel. 2013. Beyond resemblance. *Philosophical Review* 122(2): 215–287.

Grice, H. P. 1981. Presupposition and conversational implicature. In *Radical pragmatics*, ed. P. Cole, 183–198. New York: Academic Press.

Heim, Irene. 1983. On the projection problem for presuppositions. In *West Coast Conference on Formal Linguistics (WCCFL) 2*, eds. Michael Barlow, Daniel Flickinger, and Michael Westcoat, 114–126. Stanford University: CSLI.

Horn, Laurence R. 1972. On the semantic properties of the logical operators in English. PhD diss., University of California at Los Angeles.

Katzir, Roni. 2007. Structurally-defined alternatives. *Linguistics & Philosophy* 30(6): 669–690.

Katzir, Roni, and Danny Fox. 2011. On the characterization of alternative. *Natural Language Semantics* 19(1): 87–107.

Kendon, Adam. 2004. *Gesture: Visible action as utterance*. Cambridge: Cambridge University Press.

Križ, Manuel. 2015. Aspects of homogeneity in the semantics of natural language. PhD diss., University of Vienna.

Križ, Manuel. 2016. Homogeneity, non-maximality, and all. *Journal of Semantics* 33(3): 493–539.

Križ, Manuel, and Benjamin Spector. 2017. Interpreting plural predication: Homogeneity and non-maximality. Ms., Institut Jean-Nicod.

Kuhn, Jeremy. 2015. Cross-categorial singular and plural reference in sign language. PhD diss., New York University.

Ladewig, Silva. 2011. Syntactic and semantic integration of gestures into speech: Structural, cognitive, and conceptual aspects. Frankfurt (Oder). PhD diss., European University Viadrina, Frankfurt (Oder).

Lascarides, Alex, and Matthew Stone. 2009. A formal semantic analysis of gesture. *Journal of Semantics* 26(3): 393–449.

Liddell, Scott K. 2003. *Grammar, gesture, and meaning in American Sign Language*. Cambridge: Cambridge University Press.

Löbner, Sebastian. 2000. Polarity in natural language: Predication, quantification and negation in particular and characterizing sentences. *Linguistics & Philosophy* 23: 213–308.

Macià, Josep. 2002. Presuposicion y significado expresivo. *Theoria: Revista de Teoria, Historia y Fundamentos de la Ciencia* 17(3): 499–513.

Magri, Giorgio. 2009. A theory of individual-level predicates based on blind mandatory scalar implicatures. *Natural Language Semantics* 17(3): 245–297.

Magri, Giorgio. 2017. Blindness, short-sightedness, and Hirschberg's contextually ordered alternatives: A reply to Schlenker (2012). In *Linguistic and psycholinguistic approaches on implicatures and presuppositions*, eds. Salvatore Pistoia-Reda and Filippo Domaneschi, 9–54. London: Palgrave Macmillan.

McNeill, David. 2005. *Gesture and thought*. Chicago: University of Chicago Press.

Okrent, Arika. 2002. A modality-free notion of gesture and how it can help us with the morpheme vs. gesture question in sigh language linguistics (or at least give us some criteria to work with). In *Modality and structure in signed and spoken languages*, eds. Richard P. Meier, Kearsy A. Cormier, and David G. Quinto-Pozos, 175–198. Cambridge: Cambridge University Press.

Percus, Orin. 2006. Anti-presuppositions In *Theoretical and empirical studies of reference and anaphora: Toward the establishment of generative grammar as an empirical science*, ed. Ayumi Ueyama, 52–73. Report of the Grant-in-Aid for Scientific Research (B), Project No. 15320052, Japan Society for the Promotion of Science.

Pfau, Roland, and Markus Steinbach. 2006. Pluralization in sign and in speech: A cross-modal typological study. *Linguistic Typology* 10: 49–135.

Potts, Christopher. 2005. *The logic of conventional implicatures*. Oxford: Oxford University Press.

Richard, Mark. 2008. *When truth gives out*. Oxford: Oxford University Press.

Romoli, Jacopo. 2015. The presuppositions of soft triggers are obligatory scalar implicatures. *Journal of Semantics* 32: 173–219.

Rooth, Mats, and Dorit Abusch. 2017. Picture descriptions and centered content. *Sinn und Bedeutung* 21.

Sauerland, Uli. 2003. Implicated presuppositions. Handout for a talk given at the University of Milan Bicocca.

Sauerland, Uli. 2007. Beyond unpluggability. *Theoretical Linguistics* 33: 231–236.

Sauerland, Uli. 2008. Implicated presuppositions. In *Sentence and context: Language, context, and cognition*, ed. Anita Steube. Berlin: de Gruyter.

Schlenker, Philippe. 2007. Expressive presuppositions. *Theoretical Linguistics* 33(2): 237–246.

Schlenker, Philippe. 2009. Local contexts. *Semantics & Pragmatics* 2(3): 1–78. https://doi.org/10.3765/sp.2.3.

Schlenker, Philippe. 2010. Supplements within a unidimensional semantics I: Scope. In *Logic, language and meaning: 17th Amsterdam colloquium*, eds. Maria Aloni, Harald Bastiaanse, Tikitu de Jager, and Katrin Schulz, 74–83. Berlin: Springer.

Schlenker, Philippe. 2011. Iconic agreement. *Theoretical Linguistics* 37(3–4): 223–234.

Schlenker, Philippe. 2012. Maximize presupposition and Gricean reasoning. *Natural Language Semantics* 20(4): 391–429.

Schlenker, Philippe. 2013a. Supplements within a unidimensional semantics II: Epistemic status and projection. In *North East Linguistic Society* (*NELS*) 40, eds. Seda Kan, Claire Moore-Cantwell, and Robert Staubs, 167–182. Vol. 2. Amherst: GLSA.

Schlenker, Philippe. 2013b. Supplements without bidimensionalism. Ms., Institut Jean-Nicod and New York University.

Schlenker, Philippe. 2015. Gestural presuppositions. *Snippets* (Issue 30). https://doi.org/10.7358/snip2015-030-schl.

Schlenker, Philippe. 2016. The semantics/pragmatics interface. In *The Cambridge handbook of formal semantics*, eds. Maria Aloni, and Paul Dekker, 664–727. https://doi.org/10.1017/CBO9781139236157.023.

Schlenker, Philippe. 2017. Gestural grammar. Ms., Institut Jean-Nicod and New York University.

Schlenker, Philippe. 2018. Triggering iconic presuppositions. Ms., Institut Jean-Nicod and New York University.

Schlenker, Philippe. to appear a. Gesture projection and cosuppositions. *Linguistics & Philosophy*.

Schlenker, Philippe. to appear b. Iconic pragmatics. *Natural Language & Linguistic Theory*.

Schlenker, Philippe, and Emmanuel Chemla. to appear. Gestural agreement. *Natural Language & Linguistic Theory*.

Schlenker, Philippe, Jonathan Lamberton, and Mirko Santoro. 2013. Iconic variables. *Linguistics & Philosophy* 36(2): 91–149.

Schlenker, Philippe, and Jonathan Lamberton. to appear. Iconic plurality. *Linguistics & Philosophy*.

Simons, Mandy. 2001. On the conversational basis of some presuppositions. In *Semantics and Linguistic Theory (SALT) 11*, eds. Rachel Hastings, Brendan Jackson, and Zsofia Zvolenszky, 431–448.

Simons, Mandy, Judith Tonhauser, David Beaver, and Craige Roberts. 2010. What projects and why. In *Semantics and Linguistic Theory (SALT) 20*, eds. Nan Li and David Lutz, 309–327.

Singh, Raj. 2011. Maximize presupposition! And local contexts. *Natural Language Semantics* 19(2): 149–168.

Slama-Cazacu, Tatiana. 1976. Nonverbal components in message sequence: The "mixed syntax". In *Language and man: Anthropological issues*, eds. William C. McCormack and Stephen A. Wurm, 217–227. Mouton: The Hague.

Spector, Benjamin. 2006. *Aspects de la pragmatique des opérateurs logiques*. PhD diss., University of Paris VII.

Spector, Benjamin. 2007. Aspects of the pragmatics of plural morphology: On higher-order implicatures. In *Presuppositions and implicatures in compositional semantics*, eds. Uli Sauerland and Roumiana P. Stateva, 243–281. New York: Palgrave-Macmillan.

Spector, Benjamin. 2013a. Homogeneity and plurals: From the strongest meaning hypothesis to superval-uations. Presented at *Sinn und Bedeutung* 18, University of the Basque Country.

Spector, Benjamin. 2013b. Bare numerals and scalar implicatures. *Language and Linguistics Compass* 7(5): 273–294. https://doi.org/10.1111/lnc3.12018.

Spector, Benjamin. 2014. Scalar implicatures, blindness and common knowledge-comments on Magri (2011). In *Pragmatics, semantics and the case of scalar implicatures*, ed. Salvatore Pistoia Reda 146–169. London: Palgrave.

Stalnaker, Robert. 1974. Pragmatic presuppositions. In *Semantics and philosophy*, eds. Milton Munitz and Peter Unger 197–213. New York: New York University Press.

Stalnaker, Robert. 1978. Assertion. In *Syntax and semantics 9*, 315–332. New York: Academic Press.

Stalnaker, Robert. 2002. Common ground. *Linguistics & Philosophy* 25(5–6): 701–721.

Thommen, Tristan. 2017. Are expressives presuppositional? The case of slurs. Ms., Institut Jean-Nicod, CNRS.

Tieu, Lyn, Philippe Schlenker, and Emmanuel Chemla. 2018. Linguistic inferences without words. Manuscript.

Tonhauser, Judith, David Beaver, Craige Roberts, and Mandy Simons. 2013. Toward a taxonomy of pro-jective content. *Language* 89(1): 66–109.