Co-speech gestures: Experimental evidence for projection and local accommodation

Summary: Existing analyses of the inferences that arise from co-speech gestures make different predictions about how such inferences should project out of the scope of logical operators. We present experimental evidence for existential and universal projection of such inferences from the scope of quantifiers like ‘None’, lending support to presuppositional treatments.

Background: Co-speech gestures co-occur simultaneously with spoken language expressions, enriching the spoken language utterance by depicting some aspect of the denoted situation. The sentence in (1), produced with the gesture in Fig.1, conveys that John will go up the stairs. According to the Supplemental analysis,[1] co-speech gestures have the same semantic status as appositive relative clauses. According to the Cosuppositional analysis,[2,3] co-speech gestures trigger a conditionalized presupposition; the sentence (2) gives rise to the “cosupposition” that if John were to use the stairs, he would go up the stairs. A key question is how such inferences project out of quantified structures like (3d-f). When combined with a Universal projection theory of presupposition,[4,5] the Cosuppositional analysis predicts universal projection (4c); when combined with an Existential projection theory,[6] the Cosuppositional analysis predicts (4b) to be possible. By contrast, the Supplemental theory may predict a universal inference, but it’s unclear how the (underlined) appositive meaning in (5) could ever project existentially.

Experiments: Exp.1&2 used a Truth Value Judgment Task (TVJT) and Picture Selection Task (PST) to detect the interpretations associated with the gestures \textit{UP/DOWN}, in six different linguistic environments (Table 1): plain affirmative sentences (3a), modal sentences (3b), negative sentences (3c), and quantified sentences (3d-f). In the TVJT, videos of the sentences were paired with contexts that variously made the readings of interest true/false. These contexts involved characters that could either use the stairs up or down (Fig.2); a character at the bottom of the stairs could only go up the stairs, and a character at the top of the stairs could only go down. To create the possibility of conditionalized inferences such as (4b,c), we also made some of the contexts compatible with a hypothetical up/down use of the stairs, by including barriers (e.g., Fig.2a-c). As seen in Table 1, participants in one group saw test items where the direction was merely gestured, while a second group saw a version where the gestures were supported by the verbally asserted phrase “in this direction” (if a particular projection pattern was specific to the gesture, it should not depend on the support of the verbally asserted phrase). The TVJT participants (n=172) saw two training items, followed by 34 test trials (including 2 gesture-less and 8 non-directional gesture controls). In the PST, the pictures were paired such that they differed minimally in whether they verified the reading of interest; e.g., participants saw a video of (3e), and had to choose between Fig.2a and Fig.2b, which differed in whether the universal reading (4c) was made true. The PST participants (n=198) saw two training items and 20 test trials. Finally, in Exp.3 (n=125), we directly elicited inferential judgments, asking participants to watch the videos from Exp.1&2 and rate the strength of the target inferences using a slider.

Results: Exp.1&2: We applied a reading detection analysis[7] using regression models to predict the responses in each linguistic environment by assigning optimal weights to each possible interpretation strategy, e.g., (4a-d). Model comparisons revealed that responses to the quantificational gesture targets were significantly predicted by the presence of Existential projection (for ‘Each’ and ‘None’ in the TVJT, and ‘Exactly-one’ in the PST). Exp.3 (Fig.3): Responses to the quantificational targets were modeled with the interaction of condition (gesture vs. asserted) and projection type (Existential vs. Universal) as a fixed effect; subsequent model comparisons revealed Universal projection from ‘None’ and ‘Exactly one’, while responses to the negative environments indicated the availability of locally accommodating the inferences.

Conclusion: The experimental results provide evidence for existential and universal projection, as
well as local accommodation, of inferences triggered by co-speech gestures. While such findings are difficult to reconcile with the Supplemental analysis,\textsuperscript{[1]} they can be derived on the Cosuppositional analysis\textsuperscript{[2,3]} in combination with existential or universal projection theories.

**Examples & Figures**

(1) John will [use the stairs] \textit{UP}.
(2) John will not [use the stairs] \textit{UP}.

<table>
<thead>
<tr>
<th>GESTURE condition</th>
<th>ASSERTED condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3a) The girl will [use the stairs] \textit{UP}</td>
<td>The girl will use the stairs [in this direction] \textit{UP}</td>
</tr>
<tr>
<td>(3b) The girl \textbf{might} [use the stairs] \textit{UP}</td>
<td>The girl \textbf{might} use the stairs [in this direction] \textit{UP}</td>
</tr>
<tr>
<td>(3c) The girl will \textbf{not} [use the stairs] \textit{UP}</td>
<td>The girl will \textbf{not} use the stairs [in this direction] \textit{UP}</td>
</tr>
<tr>
<td>(3d) Each of the girls will [use the stairs] \textit{UP}</td>
<td>Each of the girls will use the stairs [in this direction] \textit{UP}</td>
</tr>
<tr>
<td>(3e) None of the girls will [use the stairs] \textit{UP}</td>
<td>None of the girls will use the stairs [in this direction] \textit{UP}</td>
</tr>
<tr>
<td>(3f) Exactly one of the girls will [use the stairs] \textit{UP}</td>
<td>Exactly one of the girls will use the stairs [in this direction] \textit{UP}</td>
</tr>
</tbody>
</table>

Table 1: Example test sentences from each linguistic environment. Subject gender ("girl"/"boy") and target gesture (\textit{UP}/\textit{DOWN}) were randomized; Condition (gesture/asserted) was a between subjects factor.

(4) Example of possible interpretation strategies: ‘None’ targets (1e)

(a) \textit{Ignore inference:} None of the girls will use the stairs.
(b) \textit{Existentially project:} None of the girls will use the stairs, but for at least one of the girls, if she were to use the stairs she would go up the stairs.
(c) \textit{Universally project:} None of the girls will use the stairs, but for each of the girls, if she were to use the stairs she would go up the stairs.
(d) \textit{Locally accommodate:} None of the girls will use the stairs in an upwards direction.

(5) None of the girls will use the stairs, which would involve a trajectory like this \textit{UP}.

![Fig. 1: \textit{UP} gesture, which aligned with "use the stairs" (gesture condition) or "in this direction" (asserted condition).](image)

![Fig. 2: Images accompanying the gesture and asserted 'None' targets in (3e). The TTTT target was true on all readings; the TTFT target was false only on the Universally Project reading; the TFFT target was false on both the Existentially Project and Universally Project readings; the FFTT target was true only on the Locally Accommodate reading; the FFFF was false on all readings.](image)

![Fig. 3: Results of Inferential Judgment Task (Exp.3).](image)