Silent gestures have morphological structure

“Evidence for argument structure in the form of pantomime”
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INTRO

1. The emerging field of ‘Super Semantics’ asks whether semantic theory may extend to non-standard objects of study, such as gesture (Schlenker et al., 2020)
2. Depending on their relation to speech, gestures may convey:
   a. pre- or co-suppositional (Ebert & Ebert, 2014)
   b. at-issue and
   c. supplemental information
3. When gesture takes on the full communicative load (aka silent gesture or pantomime), further language-like properties emerge (Goldin-Meadow & Brentari, 2017)
4. Silent gesture, thus, may contain the raw material on which sign languages are built (Malaia & Wilbur, 2008)
5. Alternatively, gestures are holistic, mimetic depictions of the events they represent; cannot be decomposed into parts (e.g., McNeil, 2005; Arbib, 2010)
1. Agents, themes represented via iconic handshapes in sign languages (Benedicto & Brentari, 2004)
   'Iconicity': motivated link btw. how sign/word/gesture looks/sounds and what it means
2. Gesturers also manipulate handshape in non/agentive events (Brentari et al., 2012, 2015, 2017), but this may not generalize.
3. Previous work:
   a. Only **two** aspects of handshape (=handshape parameters)
   b. Only **two** predicates (i.e., *put-at* and *be-at*)
   c. Only analyzed **mean proportion** of parameters in each class (transitive or intransitive) of predicate
      ➢ **THUS:**
      total information available in the signal **underestimated**
      the importance of a select few features **overestimated**
4. Current project:
   a. 6 handshape parameters
   b. 72 different predicates
   c. Gestures are classed as
INITIAL OBSERVATIONS

‘The book fell on its side’

‘Someone put the book on its side’
INITIAL OBSERVATIONS

‘The car passed by the tower’

‘The person cut the bread (w/ a knife)’

[Diagram: visual representation of agent, ground, and instrument/theme concepts]
DESIGN: OVERVIEW

1. Film silent gestures

2. Extract handshape(s)

3. Annotate handshape(s)

4. Deploy algorithm

5. Output 1: In/trans guesses

6. Output 2: Model weights

Features

<table>
<thead>
<tr>
<th>Features</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fing. comp.</td>
<td>0.934</td>
</tr>
<tr>
<td>Joint comp.</td>
<td>0.002</td>
</tr>
<tr>
<td>Flexion</td>
<td>1.103</td>
</tr>
<tr>
<td>NSF Flexion</td>
<td>0.023</td>
</tr>
<tr>
<td>Δaperture</td>
<td>0.543</td>
</tr>
<tr>
<td>Two-handed</td>
<td>1.078</td>
</tr>
</tbody>
</table>

"The person walked backwards"
DESIGN: STIMULI

ALTERNATE

• MANIPULATION
• TOOLS
• MANNER

INTRANSITIVE

15

17

11

TRANSITIVE

36

14

22

7

MOVEMENT

x72
DESIGN: ELICITATION

1. **Participants:**
   a. 3M, 3F
   b. all right-handed
   c. 5 Americans, 1 Brit
   d. 27-35 years old
      \[ M_{\text{age}} = 31.66 \]
   e. No signing/acting experience

2. **Task:**
   View each stimulus and silently gesture them

3. **Output:**
   \[ 6 \times 72 = 432 \text{ silent gestures} \]
DESIGN: HANDSHAPE PARAMETERS

- **flexion:**
  degree of curvature of the selected fingers

- **flexion of unselected fingers:**
  degree of curvature of the unselected fingers

- **finger complexity:**
  number and membership of finger groups

- **joint complexity:**
  number and membership of joint groups

- **aperture change:**
  hand changes open-to-close or close-to-open

- **two-handed:**
  whether a gesture use one or two hands
DESIGN: LSVM

1. Data split into 6 partitions randomly; equal proportion of in/transitive items

2. For each fold, train linear support vector machine (LSVM) on 5/6 partitions, test on 6th

3. LSVM predicts transitivity class of each unseen pantomime, item-by-item

4. Process generates a prediction accuracy score; repeat 6 times, s.t. every partition serves as test set once; report average accuracy

5. Python 3.0/Scikit-learn

Predicts whether gesture is transitive or intransitive
RESULTS

Model performance

- **All verbs**: 59% with p < 0.001
- **Alternates**: 54% n.s.
- **Manipulation/Movement**: 67% with p < 0.001
- **Tool-use/Manner**: 82% with p < 0.001

Model weights

<table>
<thead>
<tr>
<th>Category</th>
<th>(\Delta\text{Aperture} )</th>
<th>Two-handed</th>
<th>Fing. compl.</th>
<th>Flexion</th>
<th>NSF flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>All verbs</td>
<td>0.4448</td>
<td>1.0961</td>
<td>0.1872</td>
<td>0.4188</td>
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<tr>
<td>Alternates</td>
<td>0.7356</td>
<td>1.3052</td>
<td>0.3203</td>
<td>0.8030</td>
<td>-0.3632</td>
</tr>
<tr>
<td>Manip/Mvmt</td>
<td>0.4959</td>
<td>0.7356</td>
<td>0.477</td>
<td>1.1129</td>
<td>0.1803</td>
</tr>
<tr>
<td>Tool/Manner</td>
<td>0.4959</td>
<td>0.7356</td>
<td>0.477</td>
<td>1.1129</td>
<td>0.1217</td>
</tr>
</tbody>
</table>

Transitive: Green
Intransitive: Blue
CONCLUSIONS

1. Transitivity information is available in pantomimed signal
   a. Identity of event or participant not relevant to findings, but...
   b. Information available more faithfully in events with increasing numbers of event participants
   c. Information not available in causative-inchoative events, likely related to representing volumes with hands
   d. May point to iconicity of argument structure, not transitivity

2. Four handshape features accurately predict transitivity class

3. For all significant analyses, transitive pantomimes were more marked than intransitives
   a. Intransitives of all classes were not distinctly marked by handshape
   b. Suggests that internal structure of transitive pantomimes is more complex (e.g., involve more projections)
   c. Consistent with theoretical and typological accounts of linguistic encoding of causation:
      Visual complexity (e.g., increased finger complexity, flexion) may correlate with structural complexity (e.g.,
      more syntactic projections)
SELECT REFERENCES


