Evidence for subunit structure when gesturers communicate in/transitive actions

Gesture is assumed to be holistic, or a global representation of an event [1, 2] (the 'holophrastic view'). However, recent research suggests that pantomime (aka *silent gesture*) is 'language-like' and may contain subunits amenable to linguistic analysis [3] (the 'compositional view'). One area of intense investigation is the emergence of transitivity distinctions in pantomime: gesturers, like signers, manipulate handshape to differentiate transitive and intransitive events [4, 5], which suggests that at least some aspect of pantomime is combinatorial.

However, work to date is not readily generalizable as it concerns (a) relatively few event types, (b) just two handshape features, and (c) whether the proportion of these features is higher in one class of predicate or the other. We argue that this simultaneously underestimates the total information available in the signal while overestimating the importance of a selected few. Here, we consider a broader range of events and handshape features. Further, we use an analysis that makes item-by-item decisions based on these features, more faithfully emulating a sender's task in communicating transitivity information. The current work thus presents a stronger rebuttal to the holophrastic view of pantomime.

Method: We elicited single-gesture utterances from 6 participants from an American university. Pantomimes were produced in response to vignettes of 72 unique events that involved the manipulation (transitive) or movement (intransitive) of a variety of objects. Each utterance was thus 'verb-like.' We annotated these 432 (6 * 72) productions for 6 handshape parameters individually linked to transitivity marking in sign languages (Table 1). We trained linear support vector classifiers to predict whether a given pantomime is in/transitive, using a 6-fold leave-one-out paradigm: The data were split into 6 partitions, trained on 5 of the partitions and tested on the 6th, producing an accuracy score. This is done in a round-robin fashion such that each partition was the test set once. We computed mean accuracy and compared it against chance using the probability mass function of the binomial distribution. To assess the degree semantic class affects handshape production, we additionally performed the analysis on three subsets of the data: *Alternating verbs* (n = 174), *Verbs of manipulation and movement* (n = 234), and *Verbs of tool-use and manner* (n = 108). (The first two sets are disjoint, while the last set is a proper subset of manipulation/ movement verbs.) Classes were determined via the lexical entailments of each pantomime's gloss. Finally, we averaged the model weights for each predictor across all 6 Folds in each analysis to assess handshape parameter importance.

Results: Classifiers trained on all verbs in the dataset achieved a mean accuracy of 59% ($p < 0.001$). Performance on alternating predicates was poor (54%, n.s.), but performance on verbs of manipulation/ movement and tool-use/ manner was good (67%, p = 0.003; and 82%, $p < 0.0001$, respectively). See Figure 1. Among manipulation/ movement and tool-use/ manner verbs, four predictors were consistently identified as relevant to transitivity marking (Table 1). All predictors are associated with *transitive* items (no predictor crossed 0 across Folds), showing that transitives are overtly and exhaustively marked.

Implications: The analyses show that transitivity information is present in the form of pantomimed actions, even though single-gesture utterances appear to be holistic at first blush (*contra* the 'holophrastic view.'). Further, pantomimes do not seem to form a monolithic class, but vary predictably in their form-meaning correspondences, building on results in [4, 5]. The analysis also suggests that certain, narrowly defined semantic categories may enjoy a reliable coding preference that is not exclusively available to broader classes. Finally, the analysis of the predictors indicate that transitive pantomimes are phonetically more complex than intransitives and suggests that their syntax is similarly more complex (e.g., involve more projections).
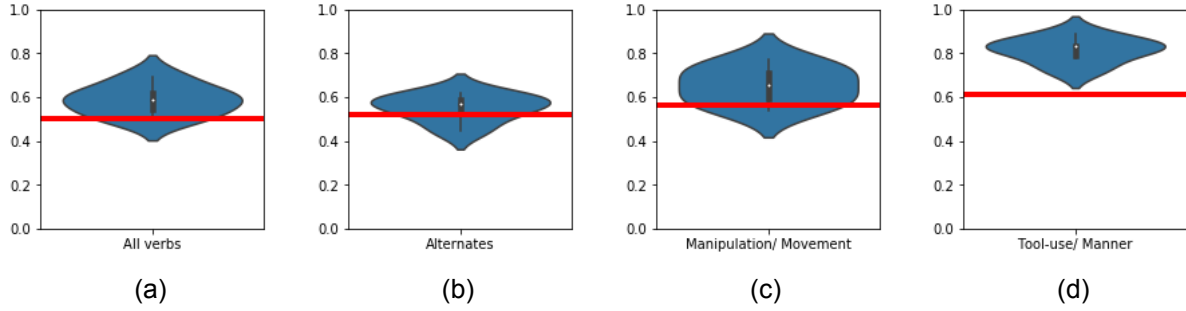
| (a) | (b) | (c) | (d) |

Figure 1: Violin plots showing distribution of classifier accuracies (0.0 = 0% accurate, 1.0 = 100% accurate). Red line represents blind baseline (chance).

Analysis/ Features	2-handed?	Finger Complexity	Flexion	Flexion (NSF)
All verbs	1.1995	0.1928	0.3761	–
Alternates	1.6667	–	–	-0.3442
Manip/Mvmt	0.6691	0.3559	0.7668	0.2083
Tool/Manner	0.4604	0.4444	1.0999	0.0723

Table 1: Average model coefficients for the four best predictors. Positive values correspond with 'transitive' labels. '2-handed?' = whether the production involved one or two hands (categorical); 'Finger complexity' = a measure of ease of articulation (1 to 4); 'Flexion' = degree of curvature of the selected (profiled) finger (1 to 7); 'Flexion (NSF)' = degree of curvature of the non-selected (backgrounded) fingers (-1 to 1). Note that in the analysis of all verbs and of alternate verbs, not all predictors were consistently selected as being most informative.

References

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