

# **Gesturing to be understood: hearing speakers produce silent gesture that benefit comprehension**

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# Silent gesture

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Silent gesture is the gesture-based communication system created by hearing speakers when communicating exclusively in manual modality.

Bias hearing speakers bring with them when creating a new communication system



# Silent gesture

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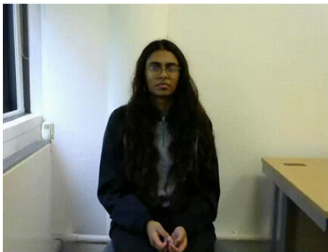
Silent gesture is fundamentally built upon iconicity.

Iconicity: Perceptual resemblances between aspects of symbols and aspects of meaning.



# Multiple choices in silent gesture production

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## Action-based gesture

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gesturer's body represents itself and performs a related action.

## Perception-based gesture

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gesturer performs a gesture related to the physical characteristic of the referent.



## Other gesture

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I jmyh& jxyzwj& r gqj r & jxyzwj&

# Systematicity in silent gesture production

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Systematic gesture for “telephone” (upper) and “to break” (lower) (Ortega & Özyürek, 2020)

## Systematic gesture form

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To express a given concept, hearing speakers reliably employ a specific gesture with a subtype of iconicity

## Action bias

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Hearing speakers are more likely to produce action-based gestures than perception-based gestures

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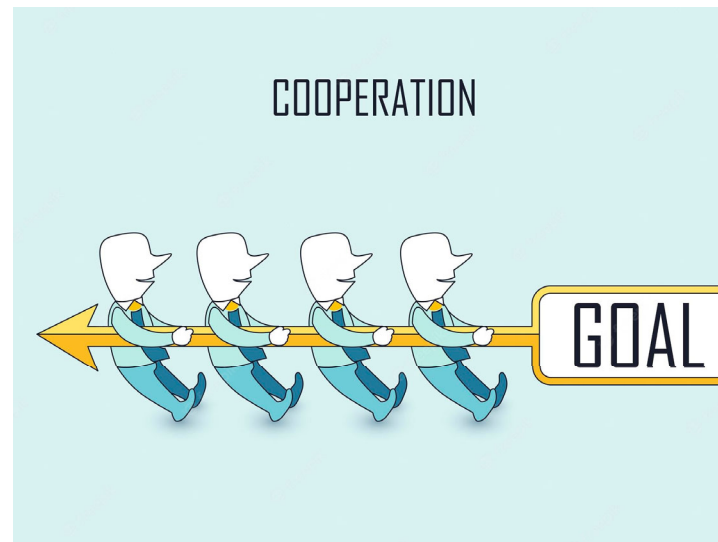
**What are the general principles that govern a gesturer's choice when multiple subtypes of iconicity are available to express the same concept?**

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## The current study

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**Silent gesture is fundamentally usage-based and is designed to achieve efficient communication.**



# Experiment 1

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Individual is motivated to provide sufficient information.  
They produce gestures with high communicative values – gestures that are likely to be correctly interpreted.

**Systematic gesture form**

Most frequently  
produced gesture

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Less frequently  
produced gesture

**Action bias**

Action-based  
gesture

>

Perception-based  
gesture



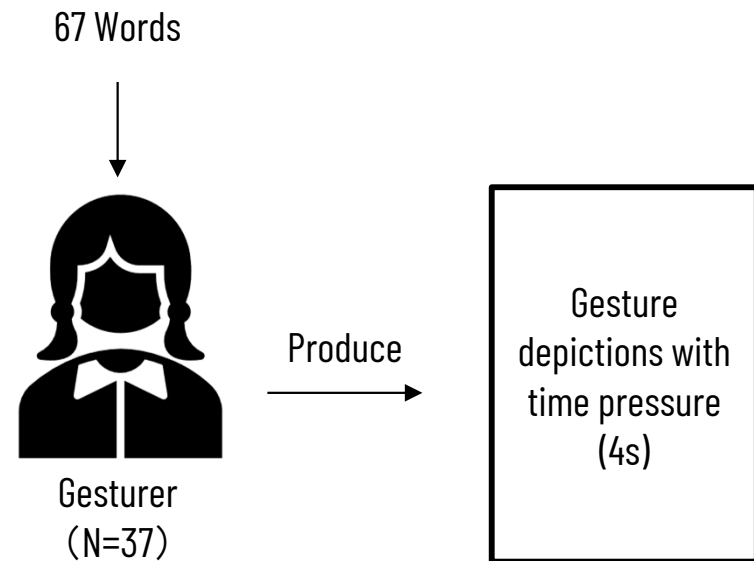
# Experiment 1 - Production Phase

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Hearing speakers (N=37) produce gestures for a target word in 4 seconds (67 target words in total).

The 67 concepts were taken from previous studies on silent gesture. All of them are **objects**.

Hearing speakers were observed to produce one gesture or sequences of gestures to depict the target word.



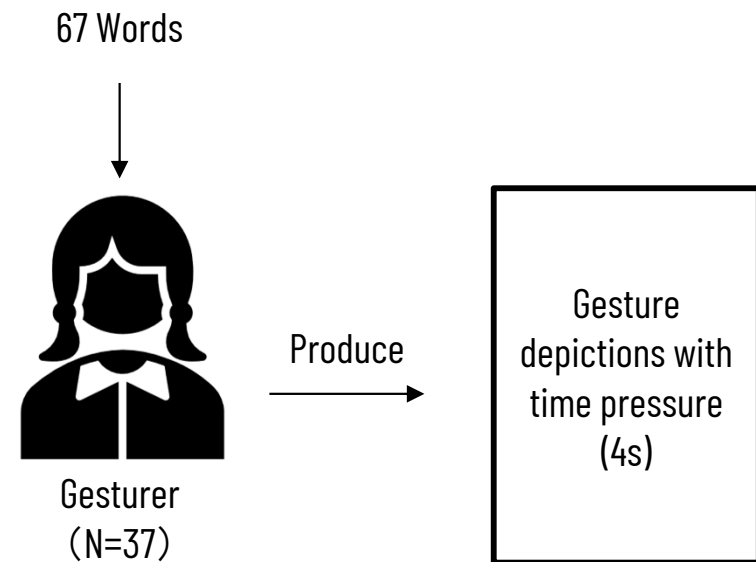
# Experiment 1 - Production Phase

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All gestures were coded in terms of:

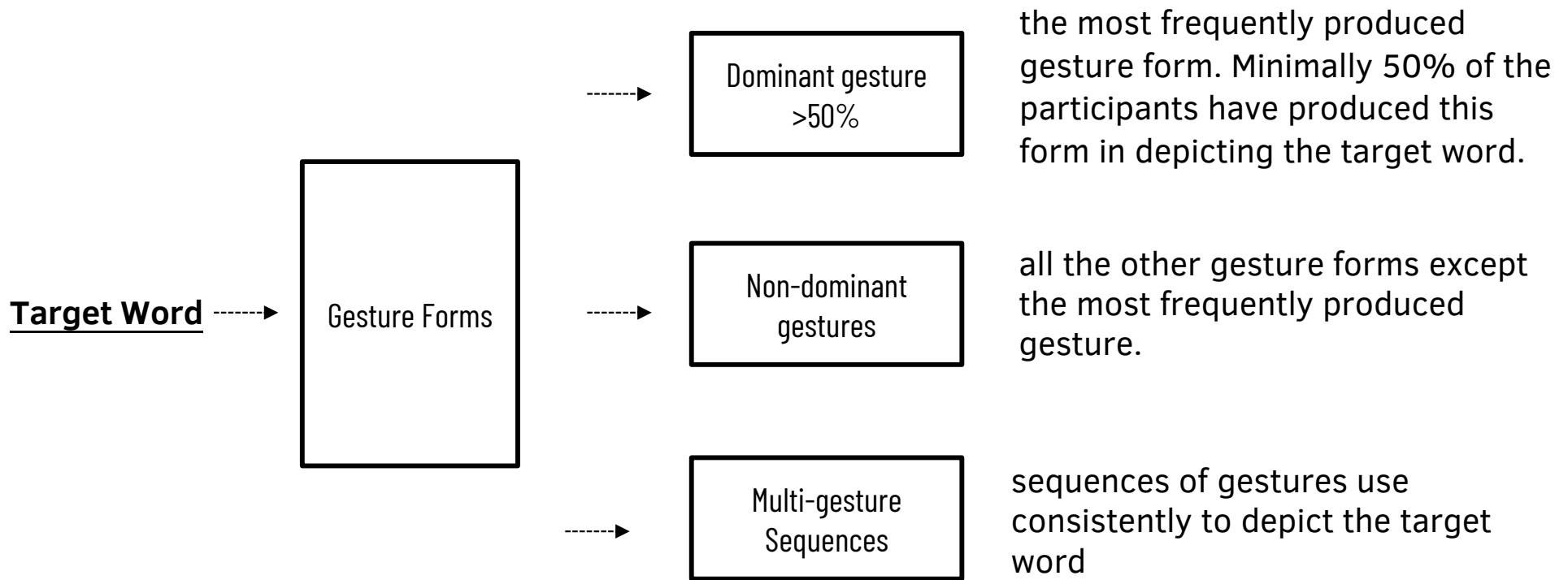
- **Forms** (i.e., hand shape, orientations, movement, placement)
- **Conceptual component** (i.e., aspect of the target words' meaning that gesture iconically represented)
- **Mode of representation** (i.e., action-based or perception-based).

Gesture depictions were coded as the same gesture form if they shared the **same conceptual component** and **three of the four parameters** in the forms.



# Experiment 1 - Production Phase

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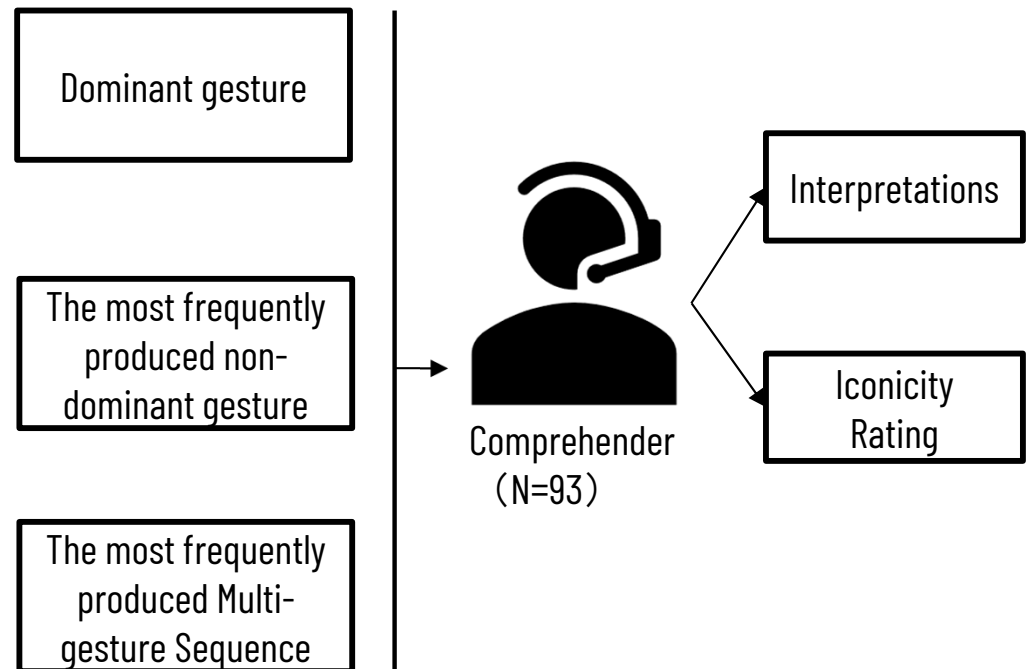


# Experiment 1 - Comprehension Phase

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93 Naïve hearing speakers took part in the comprehension phase

They provided **interpretations** and **iconicity rating** for the dominant gesture, non-dominant gesture, and dominant multi-gesture sequence for 34 target words that elicited dominant gesture in the production phase.



# Experiment 1 - Comprehension Phase


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What object does the gesture(s) represent? Please answer in one word that refers to an object.

Please type in your answer in the text box.

Interpretation



Watch the video above. How well does the gesture represent the word Door?

Very poorly 1	2	3	4	5	6	Very well 7
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Iconicity  
Rating

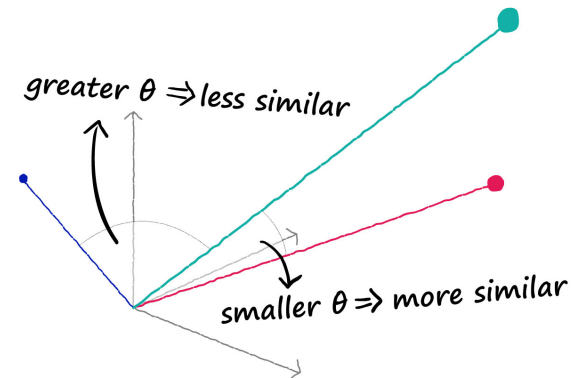
# Measuring the communicative value of a gesture form

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The communicative value of a gesture form was established based on the Shannon Entropy and the Semantic Relatedness.

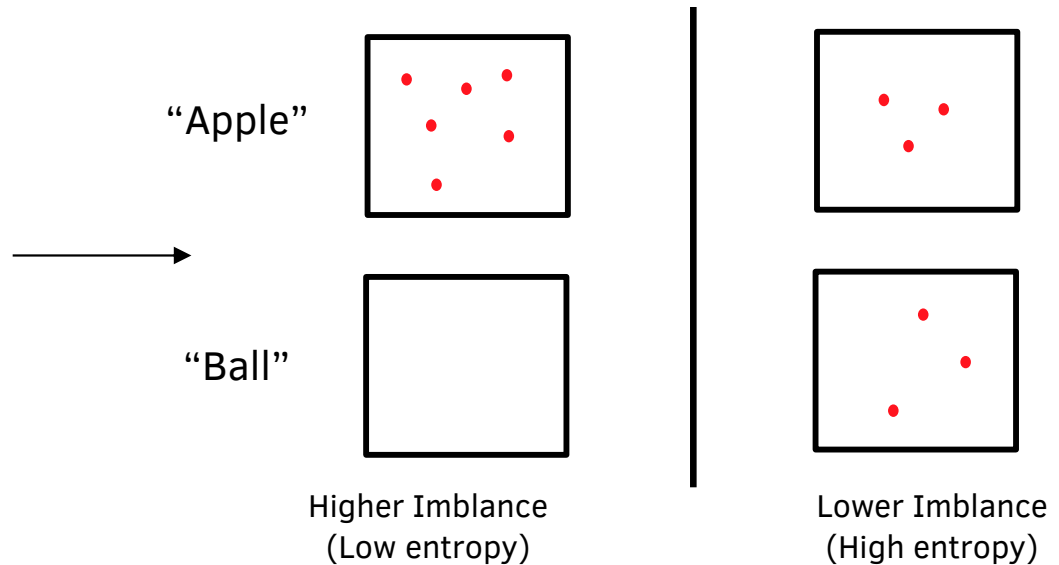
## SHANNON ENTROPY


$$H(X) = - \sum_{i=1}^n p_i \log_2 p_i$$




# Measuring the communicative value of a gesture form

Entropy measures the average level of uncertainty of the possible interpretations of a gesture form.



The lower entropy of a gesture form means comprehenders are more likely to interpret the gesture form consistently.

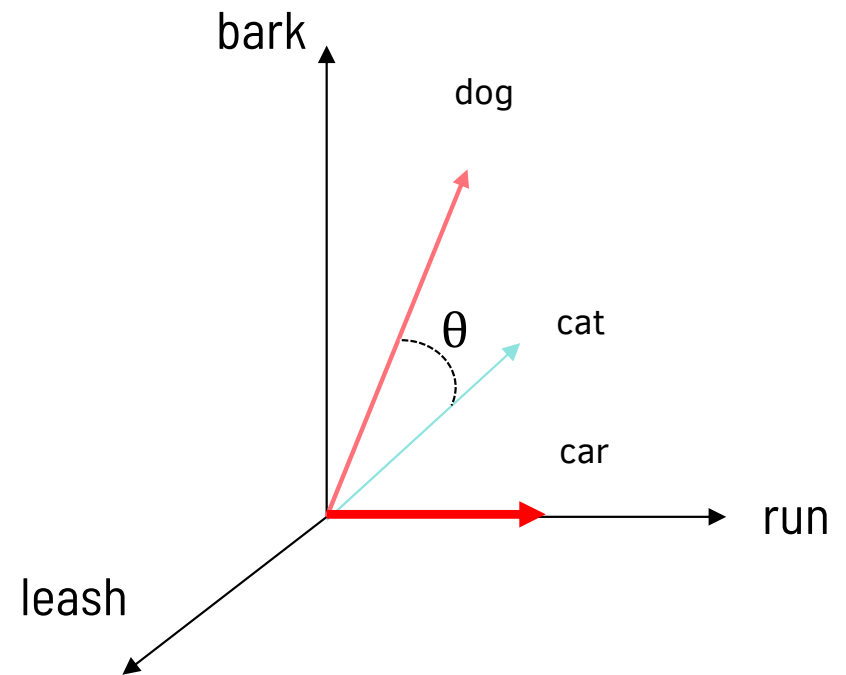
# Measuring the communicative value of a gesture form

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Semantic relatedness represents the average semantic distance between the interpretations and the target word for the gesture form

We obtained the semantic distance via the distributional semantic framework:

The semantic meaning of a word is represented as a multi-dimensional vector, in which each dimension represent the word co-occurred with the target word in the corpus





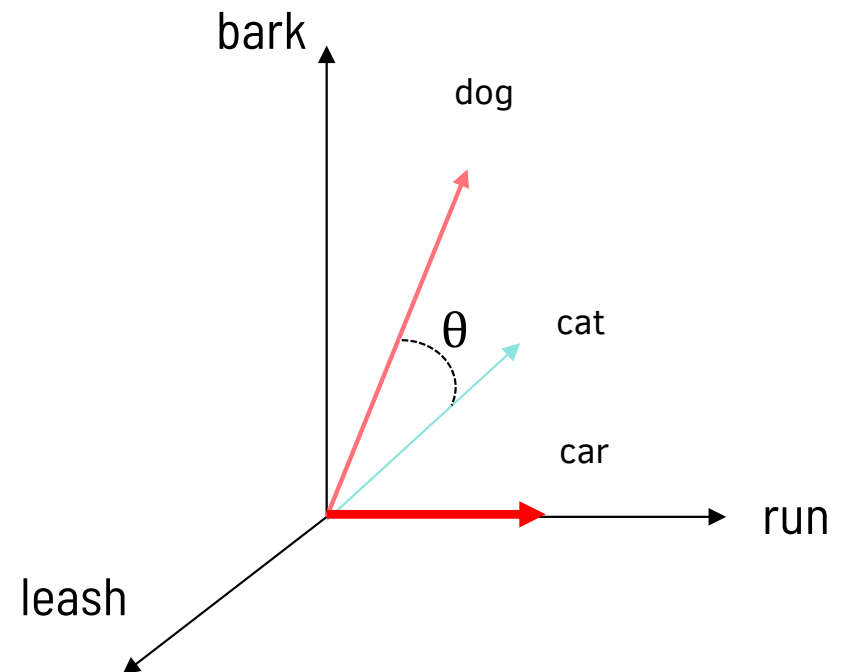
## Measuring the communicative value of a gesture form

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The semantic distance is calculated as the cosine of the angle between two vectors (words).

The semantic relatedness **gets closer to 1** when the interpretations and target words are **closer semantically**.

We used GloVe vectors for word representation, which was obtained from 840 billion words through web crawling (Pennington et al., 2014).



# Experiment 1

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**To what extent do gesturers make choices that facilitate comprehenders in silent gesture production**

**Systematic gesture form**

Dominant gesture

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Most frequently produced non-dominant gesture

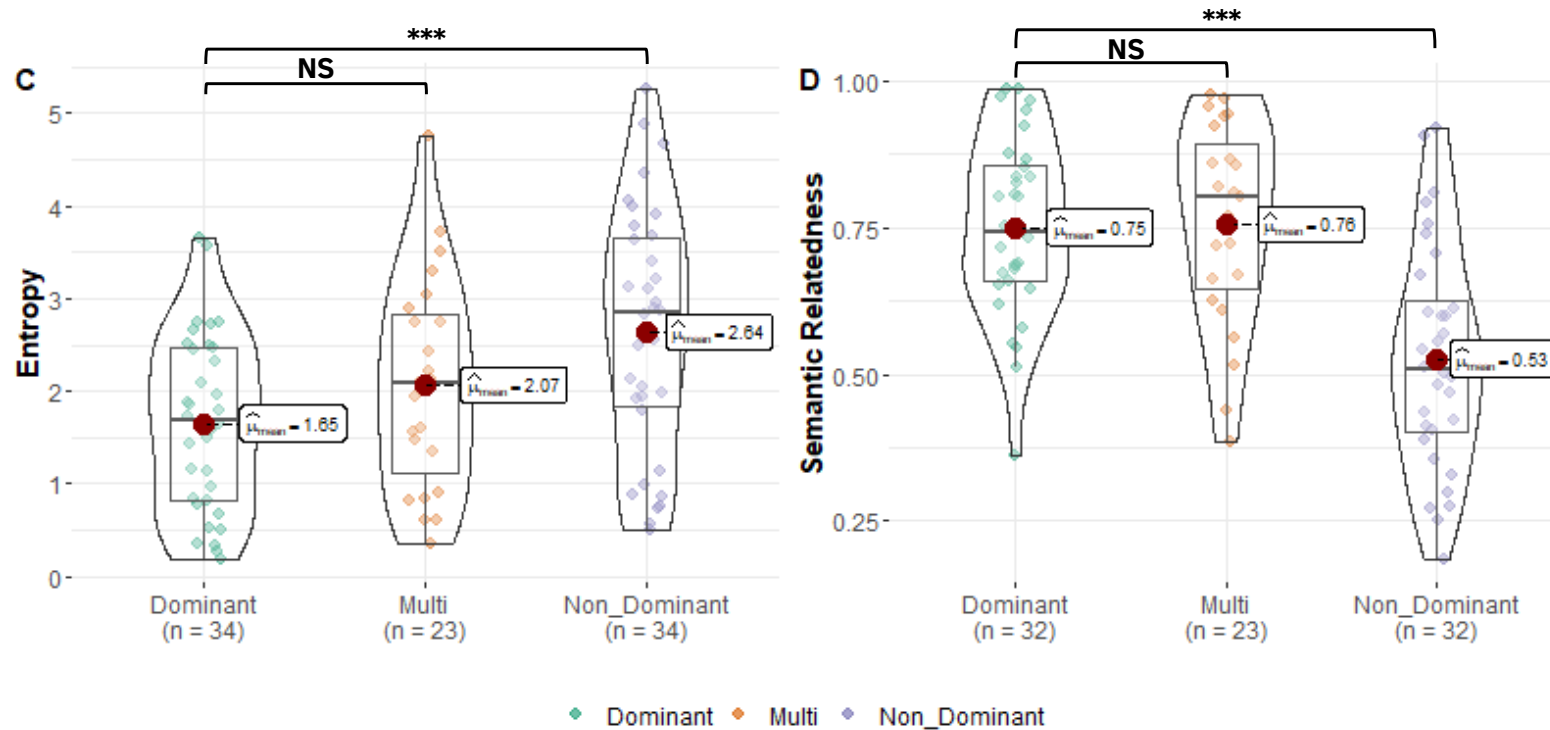
**Action bias**

Action-based gesture

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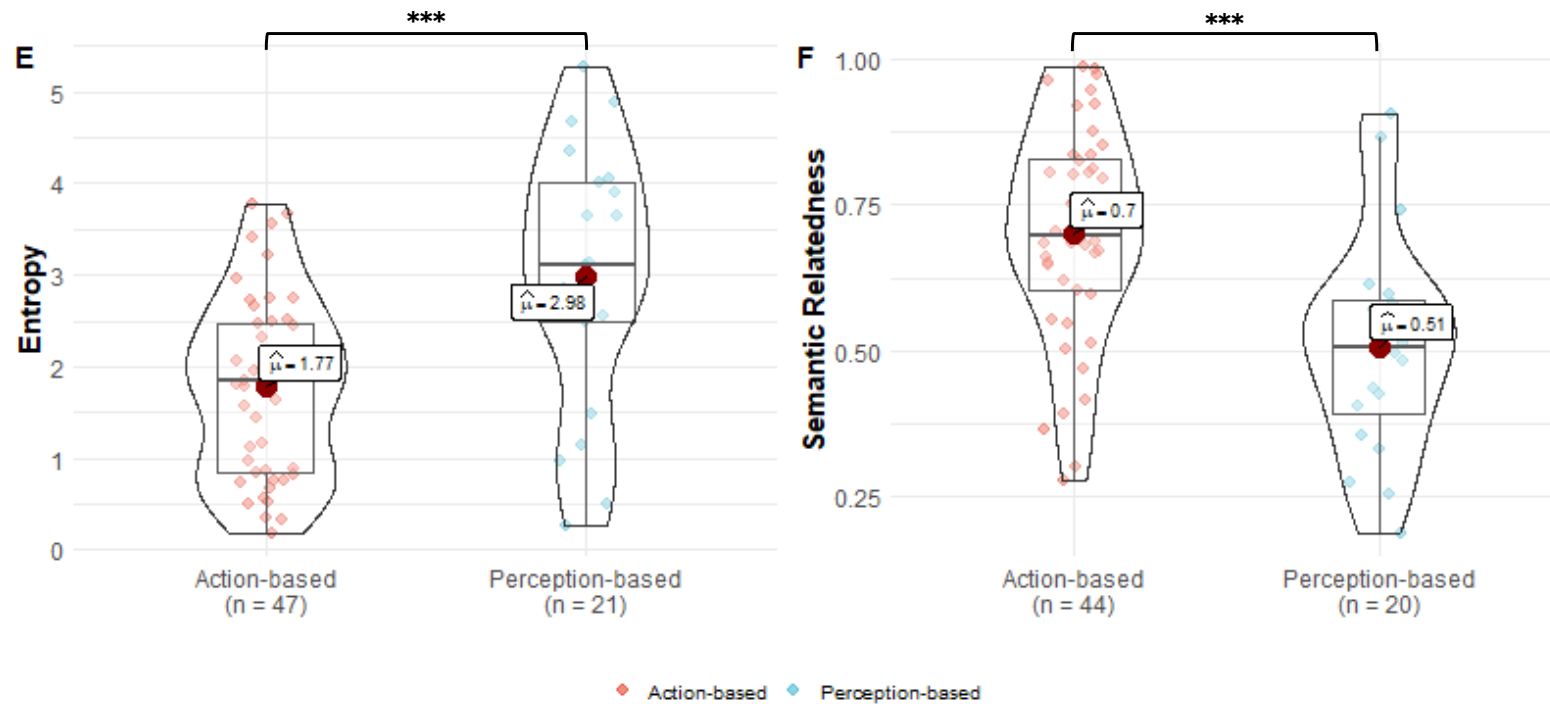
Perception-based gesture

## Result & Discussion – systematic gesture form



The most frequently produced gestures are easy-to-understand gestures

## Result & Discussion – action bias



**Action-based gestures are generally better understood compared to perception-based gestures**

## Experiment 2

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- People are intelligent communicators – they tend to produce gestures that are efficient for the comprehenders
- Around 41% of the gesture depictions include a non-dominant gesture



## **Experiment 2**

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**Why hearing speakers produce non-dominant gestures if they are trying to provide sufficient information?**

### **Non-dominant gesture is sufficient**

Hearing speakers who produced non-dominant gesture over-estimate the communicative value of the non-dominant gesture

## Experiment 2

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Hearing speakers (N=79) produce gestures for a target word in 4 seconds.

Dominant gesture

They then provided **communicative value rating** for the dominant gesture, non-dominant gestures for the 34 target words.

We include the non-dominant gestures which is produced by at least 10% of the participant. There are 93 gesture depictions selected.

Non-dominant gestures


67 Words



Gesturer  
Comprehender  
(N=79)

Gesture depictions with time pressure (4s)

# Experiment 2 - Comprehension Phase




0:00 / 0:01

Watch the video above. How well do you think the addressee could guess the meaning of this gesture?

Very poorly 1	2	3	4	5	6	Very well 7
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Comprehensibility Rating  
(7-point Likert scale)



0:00 / 0:05

Watch the video above. How well does the gesture represent the word Door?

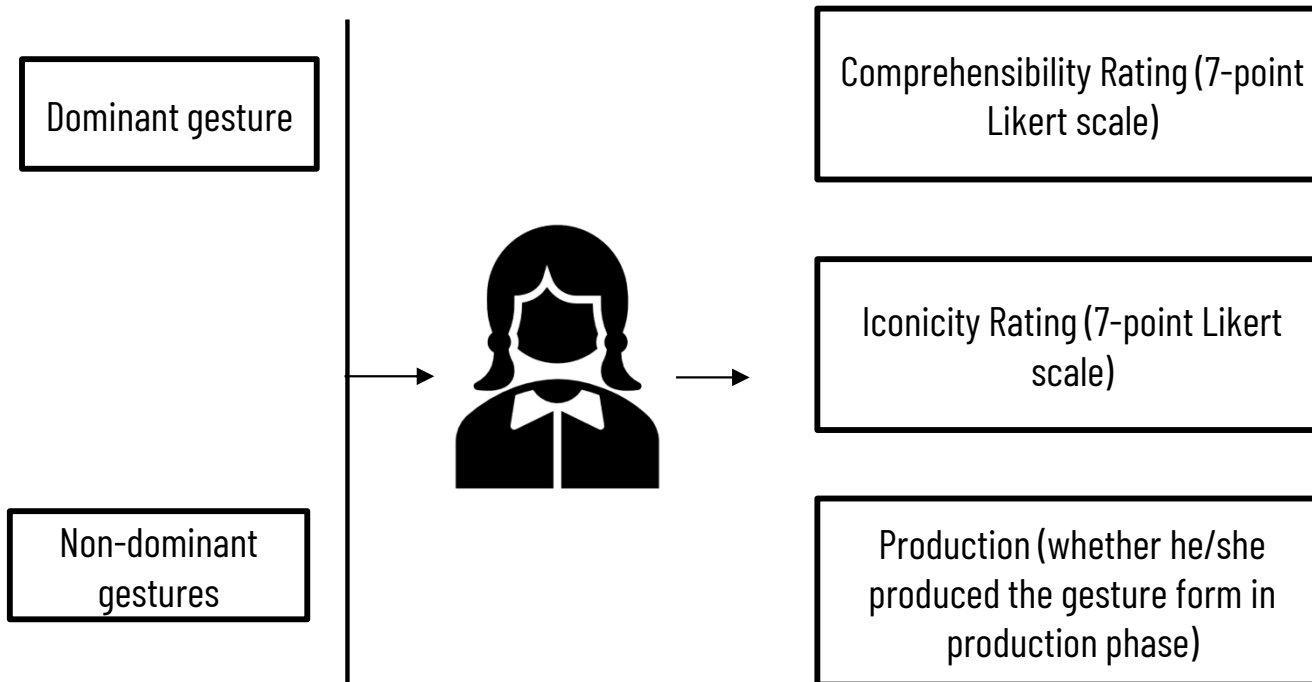
Very poorly 1	2	3	4	5	6	Very well 7
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Iconicity Rating  
(7-point Likert scale)



## Experiment 2 - Comprehension Phase

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## Experiment 2

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**Do hearing speakers who produced the specific non-dominant gesture overestimate the communicative value of that non-dominant gesture?**

Comprehensibility Rating

Iconicity Rating

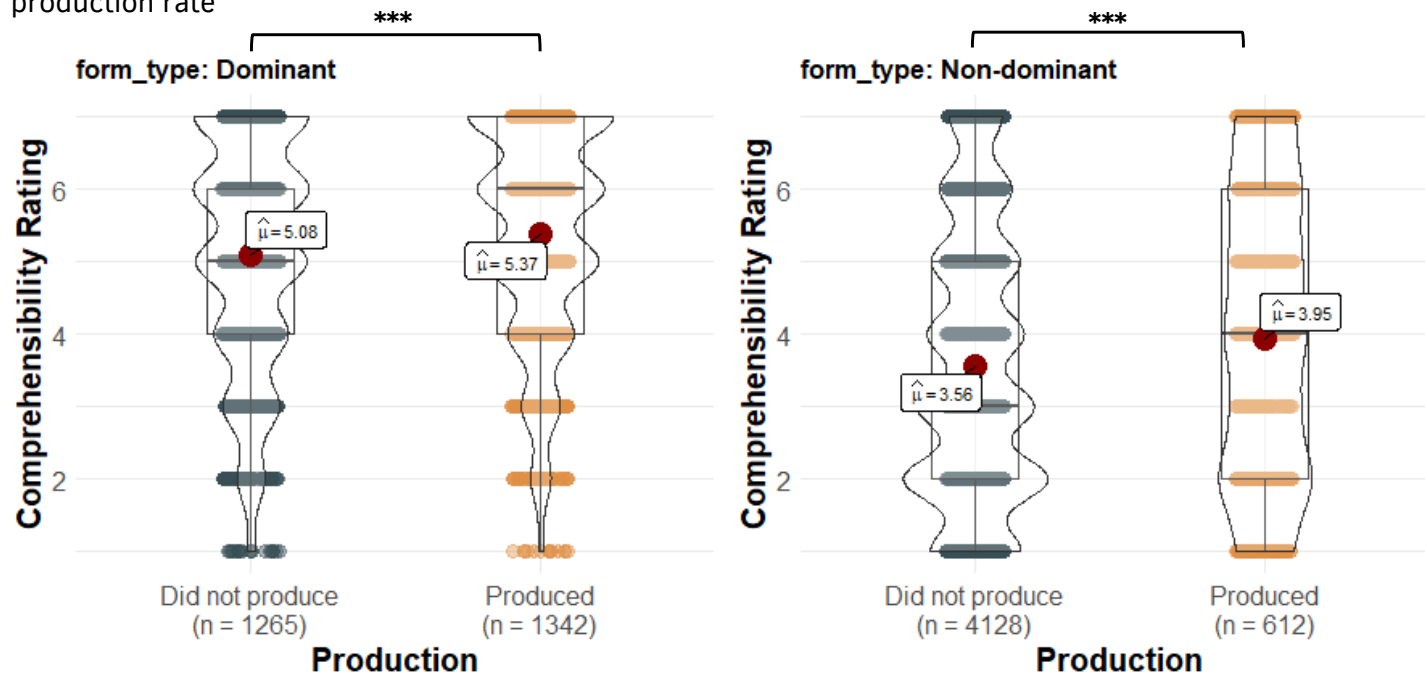
Production

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Not production

## Experiment 2 - Result & Discussion

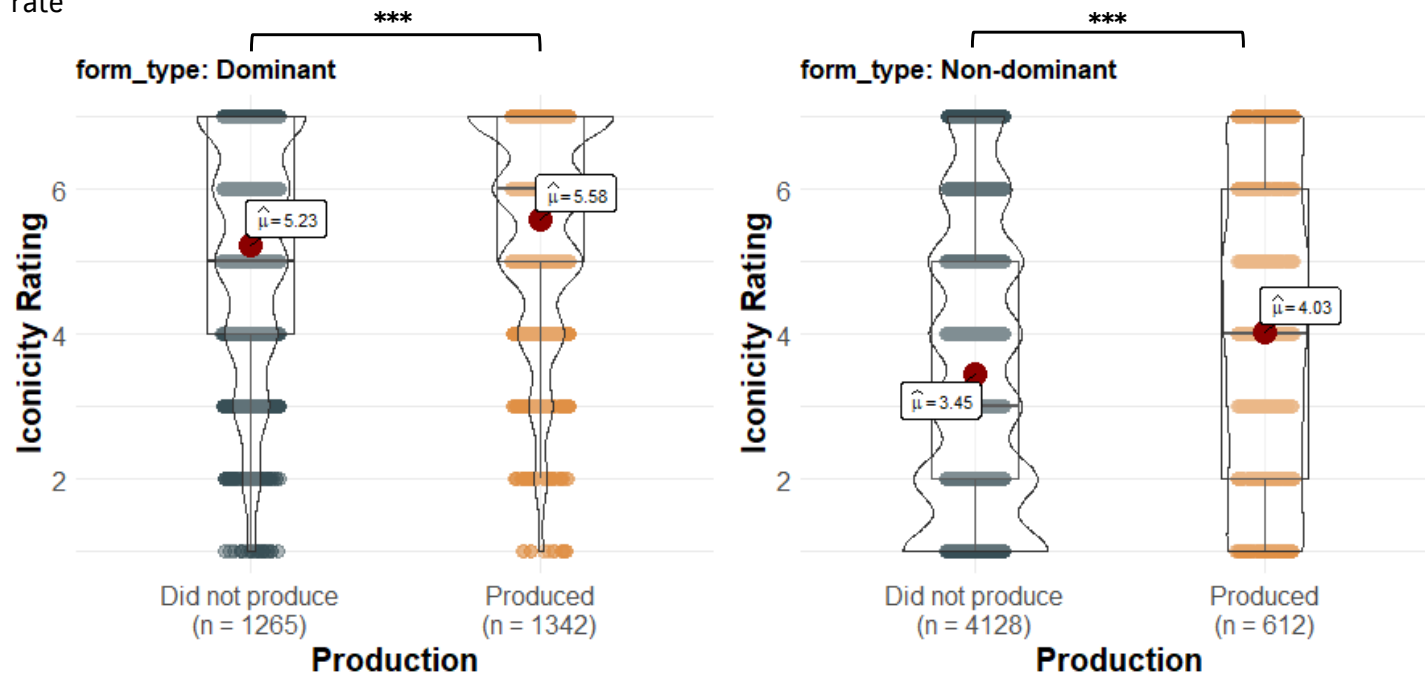
Distribution of comprehensibility rating in terms of gesture production between gesture with different production rate



**Hearing speakers who produced the gesture form provide higher comprehensibility ratings compared to those who didn't produce the gesture form**

## Experiment 2 - Result & Discussion

Distribution of iconicity rating in terms of gesture production between gesture with different production rate



**Hearing speakers who produced the gesture form provide higher iconicity ratings compared to those who didn't produce the gesture form**

## Experiment 2

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Comprehensibility Rating

Iconicity Rating

Production

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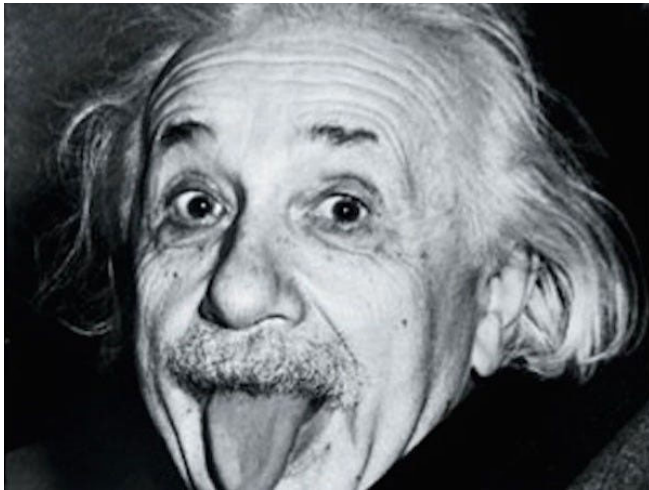
Not production

Participants are motivated to provide sufficient information when they produce a non-dominant gesture – they overestimate the communicative value of the non-dominant gesture

## Summary

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- **Comprehender-oriented explanation:** the observed systematicity results from hearing speakers' motivation to provide sufficient information.
- Hearing speakers were more likely to produce gesture that is easy to be understood



## Take home message

People are intelligent communicators when they are communicating in a novel modality - they structure their communication in a way that is efficient for the comprehenders.

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# Thanks!

## Q & A

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More questions?  
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