

Cognition and Semiotics

MA Cognitive Semiotics, Fall 2020

Lecture 7
Monday Oct 19th

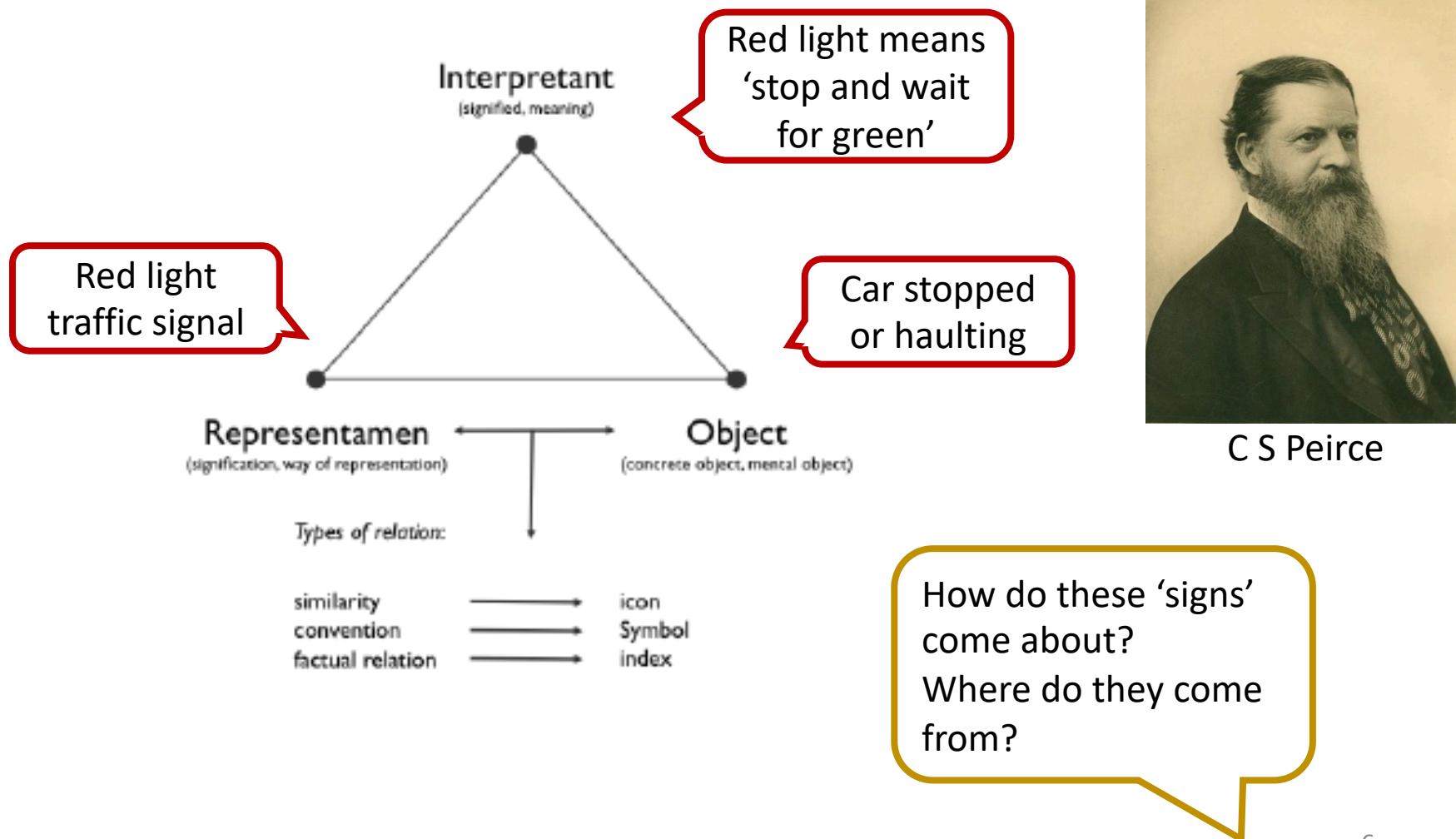
Overview

- Today's lecture: Semiotics in the lab I
 - Mid-term evaluation
 - Studying emergence of language?
 - Experimental semiotics essentials
 - Iconicity and systematicity
 - Environmental factors on emerging communication systems
 - Summary

Concepts and notions ahead:

- Triadic sign
- Object, representation and meaning
- Icon, index and symbol
- Motivated signs
- Emergence
- Evolutionary driving factors
- Observer bias
- Experimental semiotics
- Bootstrapping/grounding
- Compression of evolution
- Ecological validity
- Form and referent
- Referential semiotic games
- Coordination semiotic games
- Referential linguistic games
- Systematicity
- System level iconicity
- Structural iconicity
- Transitive events
- Manipulation events
- Construction events
- Environmental constraints

Peirce and the Triadic sign



Peirce and the Triadic sign

Peirce: types of relations:

- 3 basic semiotic functions

- Icon

Refers to object by means of similarity

e.g. drawing of the object, a map, etc.

- Index

Refers to object by real relation (e.g. causal)

e.g. smoke, a foot print, pointing, etc.

- Symbol

Refers to object by means of convention / habit

e.g. a word, "red" for danger, etc.

- Examples?



C S Peirce

What's going on here?



Emergence of real languages

- New ‘languages’ continuously emerge due to the establishment of new practices, migration, etc.
- Some are local varieties of existing verbal language – others are ‘new’ languages
- In class 2: The example of home-sign → **Nigaraguan Sign Language (NSL)** development (all time favorite)
- Cohort-to-cohort development from communication system to ‘full’ grammar and language
- Many examples, incl “contact languages”



Emergence of real languages

- Can we study language evolution?
- Many have thought that they could!
- In 1866, the Linguistic Society of Paris banned any discussions on the origins of language due to the shortage of empirical evidence
- Since 1990's the topic has gain renewed interest (probably as an effect of the cognitive turn in language sciences)

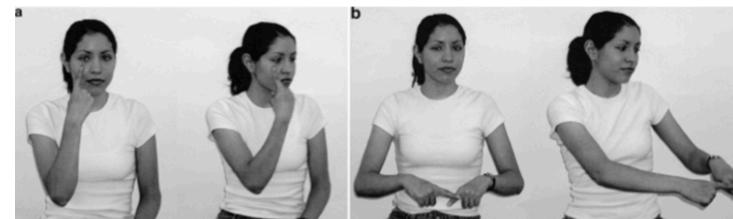


Studying the emergence of language

- Why not just look at the world?
- Challenging to pinpoint **causal directions** and individual **driving factors** in language evolution

- Biology
- Individual cognition and learning
- Social interaction
- Observer bias

"See" (a) and "Pay" (b), produced in a neutral direction and spatially modulated to the signer's left.



The Emergence of Two Functions for Spatial Devices in Nicaraguan Sign Language

- For example: the Nicaraguan sign language has been interpreted as evidence for innate Universal Grammar (cf. wikipedia on innateness hypothesis) and as evidence for the socio-cultural origin of language (e.g. Michael Tomasello)!

Studying the emergence of language

- What is Experimental semiotics (ES)?
- About *meaning-making in communication*
 - "[...] a relatively new line of research on human communication which investigates **the generalities of human semiosis** rather than the specifics of spoken dialogue" – Galantucci
- It asks: *How can we get knowledge about emergence and evolution of human communication systems?*

What is ES?

- Coined by *Bruno Galantucci* and *Simon Garrod*

Their definition of semiotics:
Non-(or pre-)verbal,
communicative signs/sign
systems

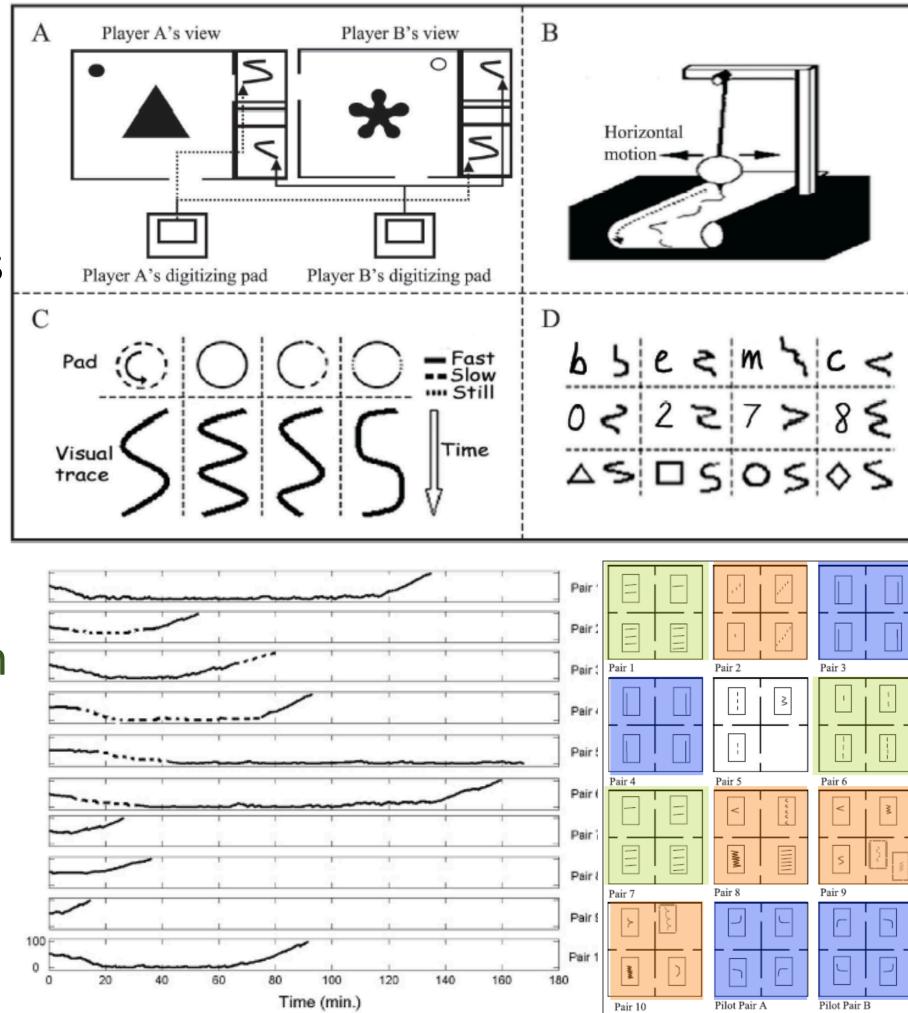
Experimental semiotics then:
Not just the study of semiotic questions using
experiments, but the study of the emergence of
new (non-verbal), communicative sign systems

- So, how **can** we then get knowledge about emergence and evolution of human communication systems?

Put humans in a lab and let
them communicate without the
use of established conventions!

What is ES? Initial example

- **Super-short:** Galantucci (2005)
- Pairs are to coordinate positions of artificial agents in a computer game.
- Each room has a symbol. Participants can only communicate graphically, using a special device that only records horizontal movement.
- (Most) participants developed a communication system quickly
- Different systems emerged (based on numeration, symbol or game map)
- The signs were perceptually distinct, easy to produce, and tolerant to variations



Break-down of ES Essentials

- Aim:

To investigate the emergence and evolution of human sign systems, i.e. bootstrapping/grounding of symbol systems

How do symbolic systems (such as language) emerge from motivated signs?

What are the constraints on the emergence, and what consequences do they have for the symbolic system?

- “it focuses on interactions that occur **in the absence of pre-established communicative conventions**. In other words, experimental semioticians study **forms of communication which emerge de novo**.”

ES Essentials

- Aim:

To investigate the emergence and evolution of human sign systems, i.e. bootstrapping/grounding of symbol systems

- There are real humans interacting in natural environments!
-＼(ツ)／-
- But lacks experimental control
- And rarely development of novel communication systems
- Certain manipulations would be unethical...

ES Essentials

- ES Methods:

1. Controlled laboratory studies

- We can design environments and systematically manipulate variables and parameters one-by-one to test specific hypotheses about mechanisms and causal relations

2. Real humans

- Access to the full history of the evolution of a sign system (rather than a synchronic cut)

3. Communicative task (often small games)

- We can take measurements that are difficult to get “in the wild”

4. No use of pre-established signs

ES Essentials

- This allows for:
Manipulations of novel factors

"experimental semioticians can manipulate factors the effects of which might not be appreciated via the [Natural Approach] because, in the real world, such factors have little, if any, variation."

ES Essentials

- This allows for:
'Compression' of evolution

By creating small, artificial environments, ES researchers can observe the birth and evolution of a new sign system – from beginning to end – within a few hours

"One of these opportunities is that of having access to the complete history of the development of a communication system."

ES Essentials

Lack of ecological validity

Participants may use their linguistic abilities and experiences when designing a new sign system

- Disadvantages?

The problem of time scales (experiments take place on very short time scales while language evolution belongs to very long time scales)

Often hard to transfer observations from impoverished experimental environments directly to the case of language

ES Essentials

Three main experimental designs

- Referential semiotic games
- Coordination semiotic games
- Referential linguistic games

ES Essentials

Three main experimental designs

- Referential semiotic games
- Coordination semiotic games
- Referential linguistic games
 - Pairs of participants play games with a referential tasks, but are prevented from using spoken and written language
 - Often one participant is given a target item to communicate to the partner that have to identify the target on a list
 - e.g. pictionary games

ES Essentials

Three main experimental designs

- Referential semiotic games
 - Coordination semiotic games
 - Referential linguistic games
- "studies performed with referential semiotic games all share the feature that, whereas **the set of forms that people use for communication is open, the set of referents to communicate in the game is typically closed** and pre-determined by the experimenter"

ES Essentials

Three main experimental designs

- Referential semiotic games
 - Coordination semiotic games
 - Referential linguistic games
- Participants get both an open set of communicative forms to navigate and coordinate in a virtual world - and also an open set of referents to be negotiated
 - Players of a coordination semiotic game move an agent in a virtual space with the overt goal of coordinating the moves with the partner
 - e.g. Galantucci's room game

ES Essentials

Three main experimental designs

- Referential semiotic games
 - Coordination semiotic games
 - Referential linguistic games
- "successful communication can be supported by different sets of referents and, in consequence, coordination semiotic games require players to converge on a common choice of referents as well [as] on a common set of forms to indicate the referents"
 - "coordination semiotic games typically require players to communicate through fairly unusual means"
 - = Manipulation of environment

ES Essentials

Three main experimental designs

- Referential semiotic games
- Coordination semiotic games
- Referential linguistic games
- For studying "how sophisticated forms of language-like structures might emerge and evolve"
- with a closed set of communication forms as well as a closed set of referents
- e.g. artificial or alien language studies

ES Essentials

Three main experimental designs

- Referential semiotic games
 - "Thanks to the closed sets of communication forms, it is possible to create simple measures of language-like structures.
 - e.g. compositionality and "dialect" (protosyntax)
- Coordination semiotic games
- Referential linguistic games

ES Essentials

Three main experimental designs

- Referential semiotic games
- Coordination semiotic games
- Referential linguistic games

Set of communication forms: **Open**

Set of referents: **Closed**

Suited for studying emergence and evolution of simple systems

ES Essentials

Three main experimental designs

- Referential semiotic games
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Set of communication forms: **Open**

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ES Essentials

Three main experimental designs

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Set of communication forms: **Open**

Set of referents: **Closed**

Suited for studying emergence and evolution of simple systems

Set of communication forms: **Open**

Set of referents: **Open**

Suited for studying emergence and evolution of simple systems

Set of communication forms : **Closed**

Set of referents: **Closed**

Suited for studying more complex language-like structures

ES Core Themes

1. Linguistic properties as the consequence of communication
 - Do key properties of natural language require explanations specific to natural language, or can they be explained in terms of general principles of human communication or cultural transmission? (e.g. combinatoriality)
2. Social factors in communication
 - What role do social factors play in the emergence and evolution of human communication systems? (e.g. convergence, interactive alignment, divergence)
3. The bootstrapping of communication

ES Core Themes

3. The bootstrapping of communication

- How do humans **bootstrap** a communication system?
 - What characterizes the successful emergence of a communication system, and what goes wrong when it fails?
-
- E.g. *Fay* : Motivated signs are needed for grounding
 - Young languages are more “motivated”, i.e. rely on other types of representation than the symbolic one (e.g. indexical and iconic forms of representation)
 - “motivated signs helped ground shared meanings, and interaction drives sign refinement until much of the sign’s initial complexity is lost, making them simpler, more symbolic, and more efficient to produce”
 - ES-studies show that pairs that use motivated signs are successful, but pairs that don’t are not

Bootstrapping example

Aim: To compare human participants' ability to bootstrap a communication system using different mediums.

Mediums: Vocal only (non-ling.) / Gesture only / Vocal+gesture

Methods: Dyads communicate and guess items from a list known by both participants. Dyads are in one of the three conditions.

- Measuring effectiveness (% correct) and efficiency (time)

Stimuli:

Emotion	Action	Object
Tired	Fleeing	Rock
Pain	Sleeping	Fruit
Angry	Fighting	Predator
Hungry	Throwing	Water
Disgust	Chasing	Tree
Danger	Washing	Hole
<i>Happy</i>	<i>Eating</i>	<i>Mud</i>
<i>Ill</i>	<i>Hitting</i>	<i>Rain</i>

Examples: <http://comlab.me/ComLab/Bootstrap.html>

Bootstrapping human communication

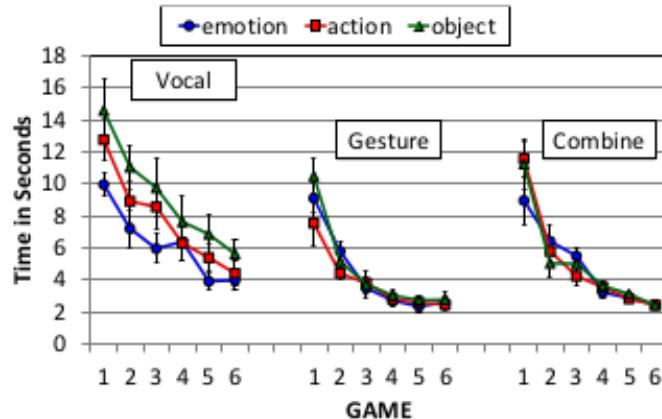


Fig. 4. Mean time (in seconds) to communicate across item categories (emotion, action, and object) and Games (1–6) by participants in the vocal, gesture, and combined communication conditions. Error bars indicate the standard errors of the means.

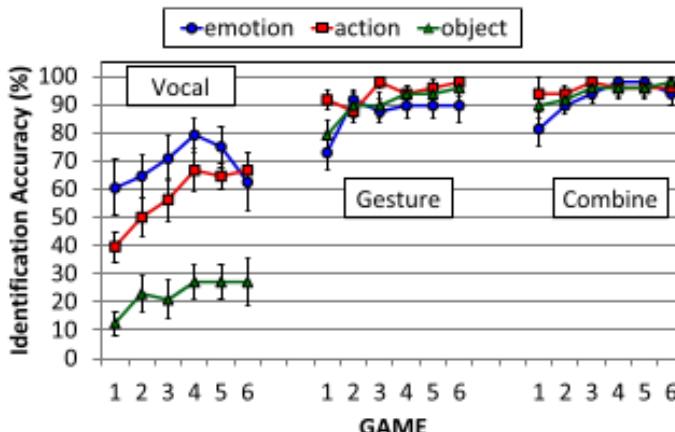


Fig. 3. Mean identification accuracy across item categories (emotion, action, and object) and Games (1–6), expressed as percentage scores, by participants in the vocal, gesture, and combined communication conditions. Error bars indicate the standard errors of the means.

Efficiency: Time taken to communicate is reduced in all conditions, but Vocal is less efficient compared to the other two conditions

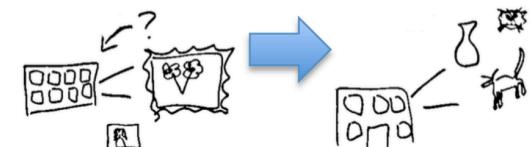
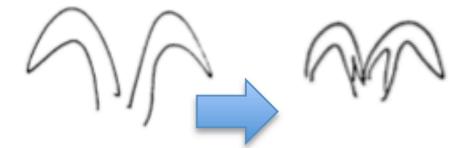
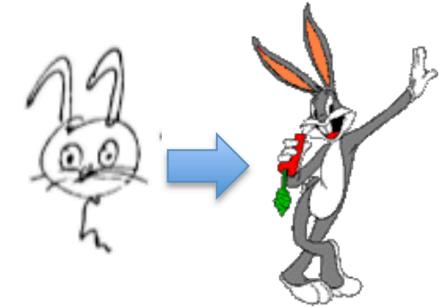
Effectiveness: Identification accuracy improved in all conditions, but less in Vocal compared to the other two conditions

In summary

- Communication by **gesture was more accurate and more efficient** than communication by non-linguistic vocalization
 - "We believe that participants performed better in the gesture condition (compared to the non-linguistic vocalization condition) because *gesture better lends itself to the production of motivated signs*"
- Rationale: The possibilities for making iconic/indexical (**motivated**) signs vocally are limited

Systematicity and iconicity

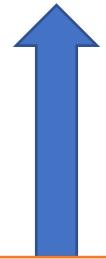
- *Iconicity on three levels?*
- 1. **Icons** critically rely on resemblance to referents: sign => referent
- 2. **Symbols** only needs to be recognized (and individuated from other symbols)
– i.e. be iconic to previous instances of use in successful communication: sign => same sign
- 3. **Systematicity** within the sign system: related meanings take similar forms: sign => sign with related meaning



Systematicity and system-level iconicity

- *Thus, Fay et al argues:*
- Through use, signs loose their strong ties (iconicity) to their referents and become increasingly arbitrary
 - Such simpler, symbolic signs help production and comprehension (e.g. linguistic alignment)
- However, they start to organize themselves in non-coincidental, systematic ways within the semantic system
 - Increase in system-level iconicity
- What are the advantages of systematicity?
 - Systematicity in language?

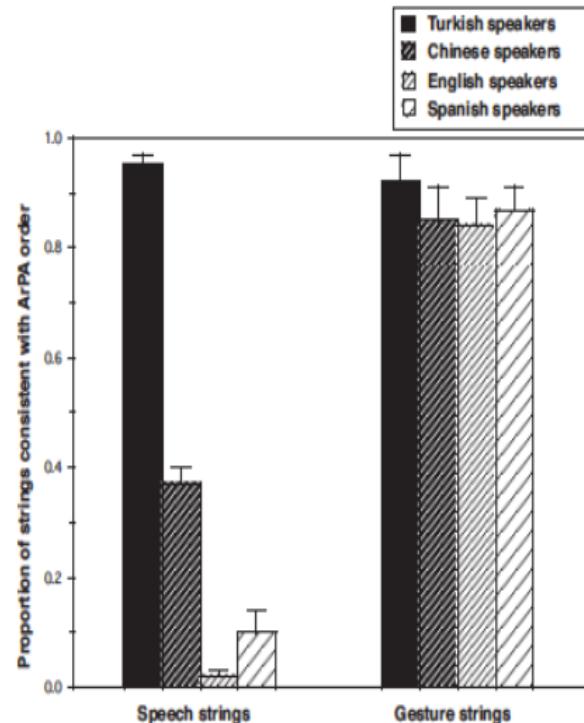
Decrease in iconicity at the (single) sign level



Increase in iconicity at sign system level

Systematicity in nonverbal “language”

- Goldin-Meadow *et al* suggested that communication systematically favours a certain ‘universal word order’ for cognitive ease
- Participants of different languages used manual gestures to represent simple transitive events displayed on a computer screen
- Results: all groups had a strong preference for producing communicative gesture strings analogous to the SOV order; **subject -> object -> verb** (actor -> patient -> action)



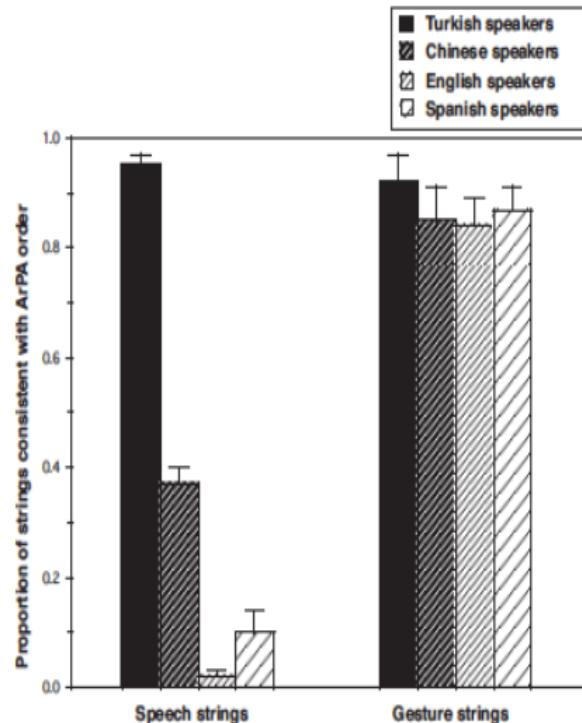
The natural order of events: How speakers of different languages represent events nonverbally

Susan Goldin-Meadow^{*†}, Wing Chee So[‡], Aslı Özyürek^{§¶||}, and Carolyn Mylander^{*}

^{*}Department of Psychology, University of Chicago, 5730 South Woodlawn Avenue, Chicago, IL 60637; [†]Department of Psychology, National University of Singapore, Republic of Singapore 119077; [‡]Department of Linguistics, Radboud University Nijmegen, 6525 HT Nijmegen, The Netherlands; [§]Max Planck Institute for Psycholinguistics, 6500 AH Nijmegen, The Netherlands; and ^{¶||}Department of Psychology, Koc University, 34450 Istanbul, Turkey

Systematicity in nonverbal “language”

- “(...) ArPA may reflect a *natural sequencing for representing events. Entities are cognitively more basic and less relational than actions, which might lead participants to highlight entities involved in an action before focusing on the action itself, thus situating Ar and P before A.*”(page 9166)



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This relates to Structural iconicity

- The structure of sign systems (such as language) might be motivated by structure of the referents, through the principle of structural iconicity
- Structural iconicity: “...is the arrangement of the linguistic signs that *mirrors the relation of their referents*, creating a kind of diagram. For example, the order of clauses or sentences in a narrative may *mirror the actual sequence of events they describe*” (Sandler & Lillo-Martin. 2006:496)

$CL_1 = E_1$ $CL_2 = E_2$

S1. John came home and took a shower

$CL_1 = E_2$ $CL_2 = E_1$

S2. John took a shower when he came home

Difference in event structure

- Transitive events can have different structural properties, which is captured by: The dependency-relationship between objects and actions
- Object *manipulation* events – e.g. "throwing a paper plane" – Objects logically precede actions
- Object *construction* events – e.g. "building a sand castle" – Objects logically follow actions



Christensen et al. (2016) paper

- What were they trying to achieve?
- How did they attempt to achieve it?



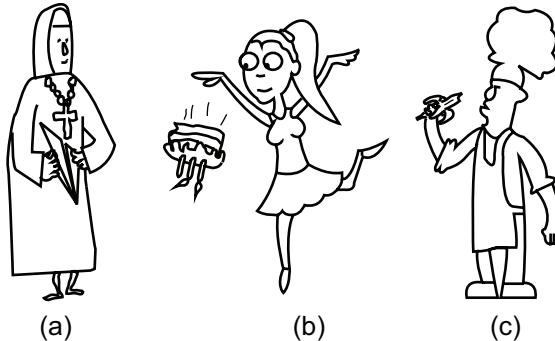
Cognition
Volume 146, January 2016, Pages 67-80



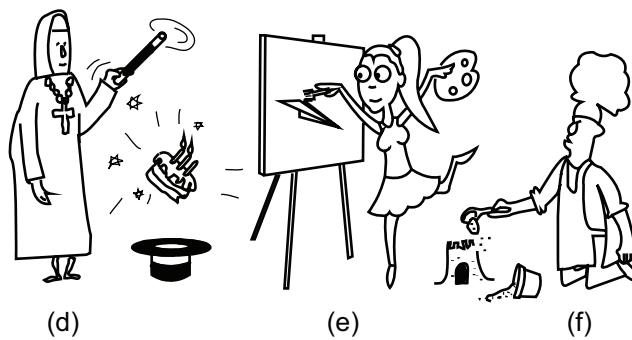
Environmental constraints shaping constituent order in emerging communication systems:
Structural iconicity, interactive alignment and conventionalization

Experimental procedure

Examples from stimulus set 1: manipulation events



Examples from stimulus set 2: construction events



You	2	8	5	2	1	3	6	7	8
Partner									

You	3	2	1	2	8	6	5	4	7
Partner									

You	1	2	6	2	4	8	3	5	7
Partner									

You	3	6	2	2	8	1	5	4	8
Partner									

Start by ensuring that you agree about the pics
Then, no talking and no helping each other



Christensen et al. (2016) paper

- **Question:** *Is constituent (i.e. word) order affected by the type of event to be communicated?*
- **Hypotheses** Following a principle of structural iconicity:
- **The order** in which participants produce gesture strings to communicate transitive events **will follow the logical structure of reference events**
 - Participants will predominantly produce gesture strings with SOV order for object manipulation events
 - Conversely, object construction events will elicit more gesture strings with SVO order

Christensen et al. (2016) paper

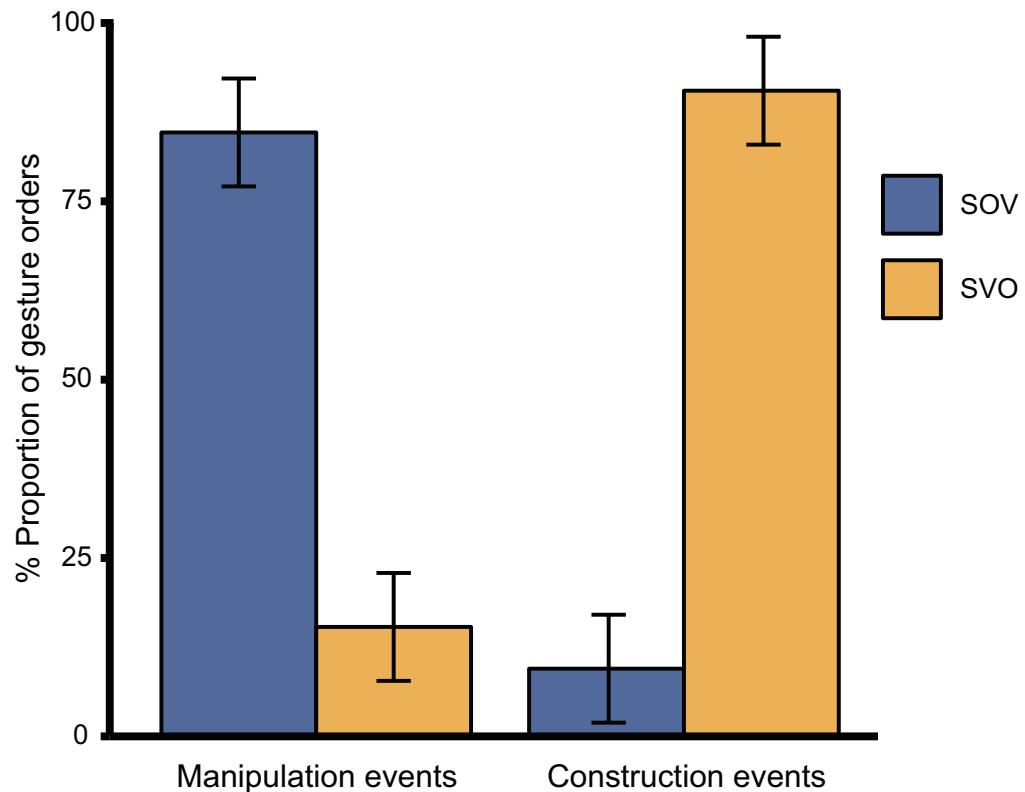
Setup:



- Methods:
 - 25 dyads were engaged in a **referential game**. All were native speakers of Danish
 - Participants took turns in matching and referring to images using only gestures
 - Two conditions (order balanced)
 - Object manipulation events
 - Object construction events

Christensen et al. (2016) paper

Findings Exp 1:



Summary of Exp 1

- Participants consistently produced SOV gestures for manipulation events and SVO for construction events following the predictions
- This indicates that participants gesture orders are motivated by the sequential structure of the stimulus scenes (rather than a cognitive bias)
- However, most *spoken* languages only use *one* constituent order for the two types of transitive events
- Different motivational sources/pressures?

Experiment II: Alignment

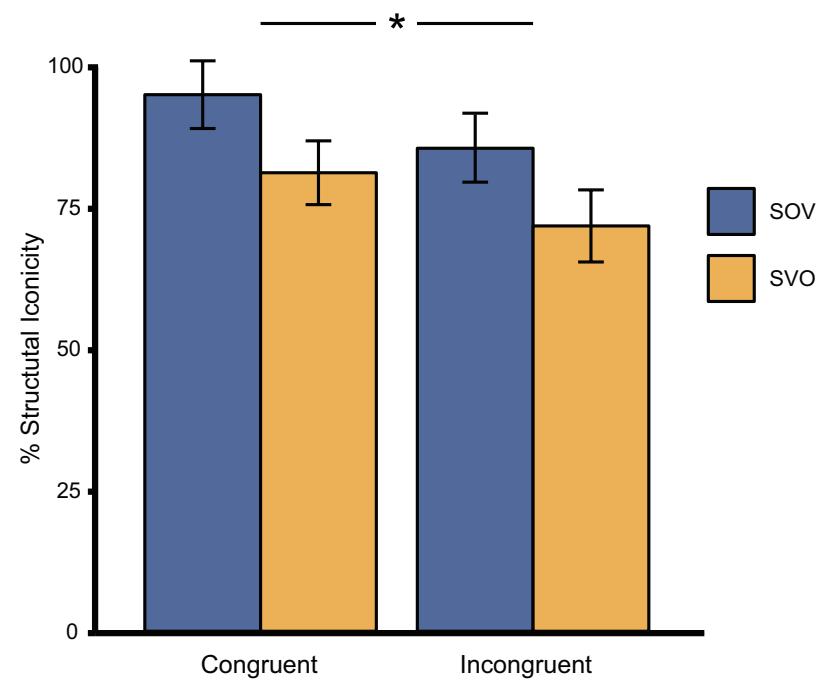
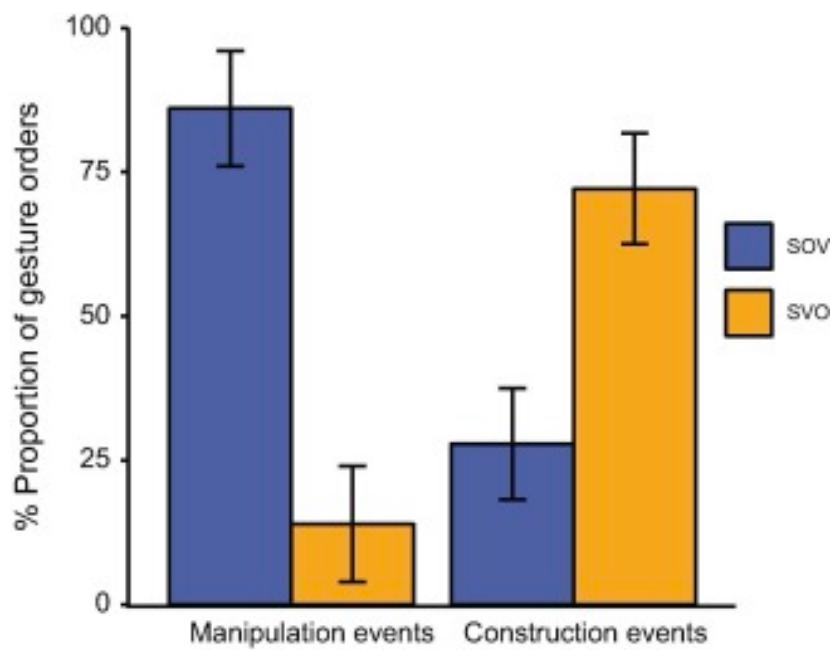
- **Question 2:** *Is constituent order affected by the dialogical nature of the task?*
- **Hypotheses** When people communicate, there may be pressures towards agreement on how to communicate about objects and events

Interactive alignment: “... in dialogue, the linguistic representations employed by the interlocutors become aligned at many levels, as a result of a largely automatic process. This process greatly simplifies production and comprehension in dialogue. (...)"

- They investigate the extent to which participants used the same gesture order as their partner in the preceding trial when the event structure was either congruent or incongruent with the preceding gesture order

Christensen et al. (2016) paper

Findings Exp 2:



Summary Exp 2

- Participants were influenced by their partners previous gestures
- I.e. significantly less inclined to produce the constituent order afforded by the referent scenarios if their partner had used another order just before
- Interactive alignment can work to make communicative practices simpler and more similar **at the expense of iconicity**

Experiment III: Conventionalization

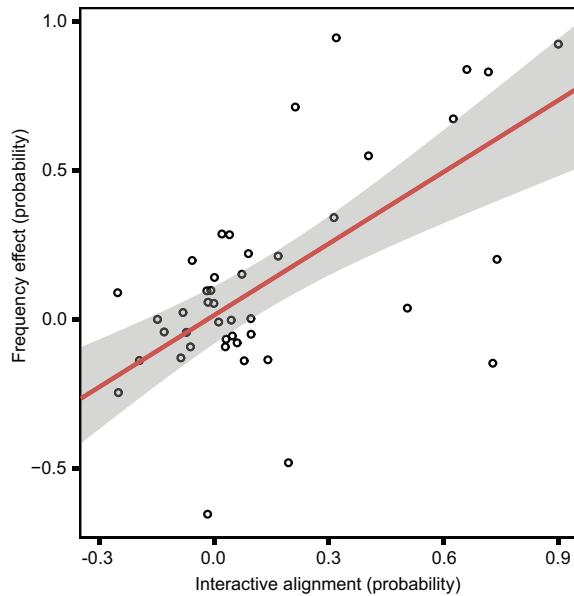
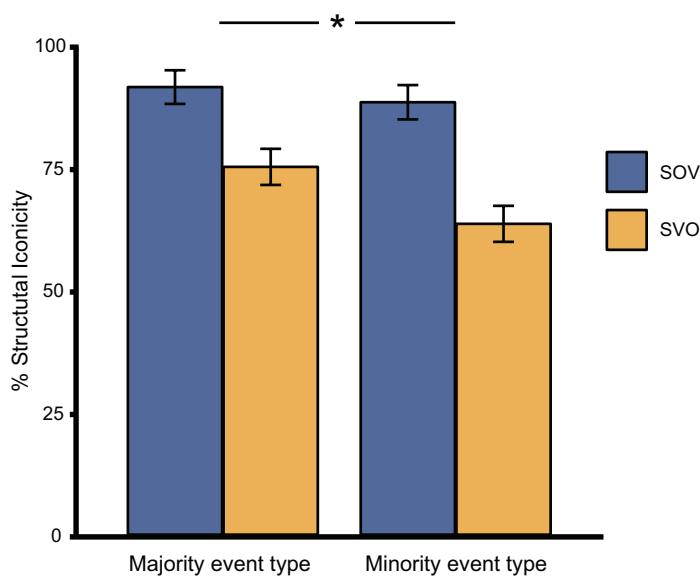
- What if participants encounter some types of stimuli more often than others?
- They investigate the **conventionalization** of gesture order as a function of event frequency (majority/minority patterns)
 - And test if **interactive alignment** drives this conventionalization effect
- Hypothesis: **pairs that align more** in terms of gesture order, are **also more inclined to generalize the constituent order** afforded by the **majority** event type to the **minority** event type.

Will a **skewed frequency** of the two event types **create pressure** for the stabilization of a single gesture order over time?

Group 1: 80% manipulation;
20% construction
Group 2: 80% construction;
20 manipulation

Christensen et al. (2016) paper

Findings Exp 3:



Altering the relative frequencies of event types had a significant effect

Significant correlation between frequency and alignment:

The more participants align, the stronger the conventionalization of a single gesture order for both event types

Christensen et al. - in summary

- Innate or internal biases have been stressed as the main sources of linguistic structure
- The gesture study suggest that a number of external, or environmental, factors might also impact structure in communication systems

External factor 1:
Event structure
Gesture strings tend to iconically reflect the inherent structure of the two event types

?

External factor 3: Event frequency altering the relative frequencies of event types – **this might, on a larger time-scale, lead to full convention-alization of a single order**

External factor 2:
Interactive alignment
Gesture order is further shaped by alignment, which improves understanding

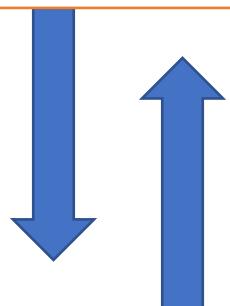
Wrapping up Experimental Semiotics I

- A. Experimental Semiotics investigates the emergence and evolution of human communication
- B. It does so using experimental methods, allowing for experimental manipulation and compression of evolution
- C. Three main types of games:
 - 1) Referential semiotic games
 - 2) Coordination semiotc games
 - 3) Referential linguistic games

Wrapping up Experimental Semiotics I

- Three core themes:
 1. Linguistic properties as a consequence of communication
 2. Social factors in communication
 3. Bootstrapping of communication
- Fay et al.
 - A. Communication systems using gesture are more effective and efficient compared to non-linguistic vocalization
 - B. Motivated signs offer grounding of the communication system, which affords bootstrapping
 - C. However, *through use* they start to organize themselves in non-coincidental, systematic ways within the semantic system

Decrease in iconicity
at the sign level



Increase in iconicity
at sign system level

Wrapping up Experimental Semiotics I

- Christensen et al.
 - Dialogical tasks provide a useful way of testing various predictions in relation to emerging communication systems
- Gesture order is influenced by:
 1. Properties of the referent stimuli
 2. The communicative situation and interactants
 3. The relative distribution, or frequency, of referent types
- Cognition-internal biases *do not* provide a full account of communication systems evolving in the lab
- Environmental factors constrain structure in emerging communication systems

Mid-term evaluations

- What could be done better:
- What is working well:

Recap – concepts and notions

- Triadic sign
- Object, representation and meaning
- Icon, index and symbol
- Motivated signs
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See you next week