

Bimanual Coordination and Topic/Comment Structure

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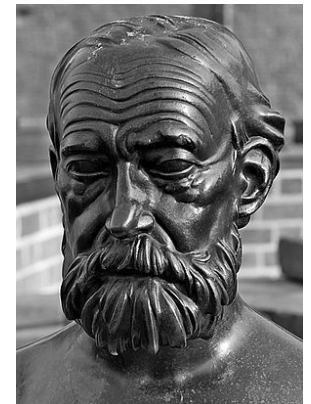
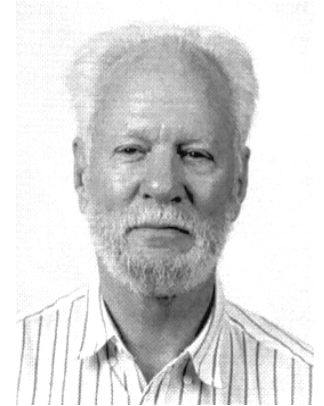
What is special about human language?

Properties in which human languages differ from animal communication systems:

- ▶ CF Hockett 1960, thirteen “design features” of human languages, e.g.
 - ▷ Displacement:
We can talk about entities and events not given in the speech situation.
 - ▷ Double articulation:
 - The smallest meaningful elements (words, morphemes) consist of a combination of linguistic entities (phonemes) that do not carry meaning.
 - This allows for a great number of smallest meaningful elements, far more than reported for any non-human communication system.
- ▶ **Compositionality** (Frege 1884 ff.):
 - ▷ Meaningful elements themselves can be combined
 - ▷ The meaning of such combinations can be derived from the meaning of the parts and the way they are put together.
 - ▷ This allows for many, many more meaningful expressions, in particular for an infinity with
- ▶ Recursion (Chomsky, e.g. Chomsky, Hauser & Fitch 2002):
 - ▷ Syntactic rules generate complex expressions that serve as input to the same syntactic rules again.

About recursion:

- ▶ Human languages may lack it (Everett, on Pirahã)
- ▶ But even without recursion, the number of meaningful expressions is very large,
- ▶ but learnable – due to compositionality.



What is compositionality?

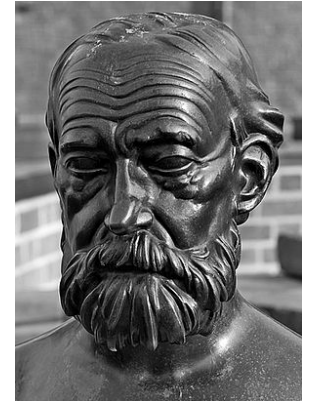
Compositional interpretation:

- ▶ The meaning of a syntactically complex expression is determined by the meaning of its immediate parts and the way how they are syntactically combined.
 - ▷ Historical source: Frege (“Frege’s principle”), Carnap, Katz, Montague, Davidson, Cresswell, Partee ...
 - ▷ Known exception: Idioms, e.g. *a red herring*
 - ▷ Recent overview:
E. Machery, M. Werning, W. Hinzen: *Oxford Handbook of Compositionality*.
- ▶ Examples of compositional interpretation:
 - ▷ $[[[two\ times\ [three\ plus\ four]]]]$
= $[[two]]\ [[times]]\ [[three\ plus\ four]]$
= $[[two]]\ [[times]]\ [[three]]\ [[plus]]\ [[four]]$
= $2\ \times\ (3\ +\ 4)$
 - ▷ $[[[the\ cat]\ [is\ [on\ [the\ mat]]]]]$
= $[[the\ cat]]\ \circ\ [[is\ [on\ [the\ mat]]]]$
= $[[the]]\ \circ\ [[cat]]\ \circ\ [[is]]\ \circ\ [[on\ the\ mat]]$
= $[[the]]\ \circ\ [[cat]]\ \circ\ [[is]]\ \circ\ [[on]]\ \circ\ [[the\ mat]]$
= $[[the]]\ \circ\ [[cat]]\ \circ\ [[is]]\ \circ\ [[on]]\ \circ\ [[the]]\ \circ\ [[mat]]$
= $[UNIQUE\ \circ\ CAT]\ \circ\ [PREDICATE\ [TOP\ [UNIQUE\ [MAT]]]]$

Why compositionality?

Why is compositionality a central principle of interpretation?

- ▶ Decrease of acquisition effort;
in typical languages and under most assumptions, we have
 - ▷ About 10^3 to 10^5 minimal units (morphemes and lexemes).
 - ▷ About 10^2 combination rules (word formation and phrase formation – syntax)
- ▶ Increase of expressive power:
 - ▷ With recursive rules and non-bounded expression length, an infinity of concepts.
 - ▷ With non-recursive rules: still a very high number.
- ▶ Solves a bottleneck in cultural evolution (cf. Smith & Kirby 2012):
 - ▷ need to express an increasingly large number of concepts
 - ▷ need to increase learnability
 - ▷ need to increase ease of memorization
 - ▷ need to form new concepts, to adapt to new situations
 - ▷ need to increase decoding speed (Pagin 2012)



Frege on compositionality:

It is astonishing what language can do. With a few syllables it can express an incalculable number of thoughts, so that even a thought grasped by a terrestrial being (“Erdenbürger”) for the very first time can be put into an outfit (“Einkleidung”) which will be recognized by someone to whom the thought is entirely new. This would be impossible, were we not able to distinguish parts in the thoughts corresponding to the parts of a sentence, so that the structure of the sentence serves as the image of the structure of the thoughts.

(1923, Logische Untersuchungen, 3. Teil, Gedankengefüge):

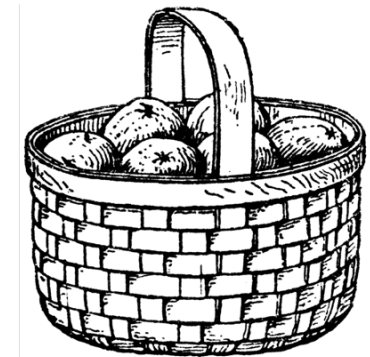
Compositionality: Precursors?

Question:

- ▶ Are there functional homologues of compositionality that may be understood as precursors to linguistic compositionality?
- ▶ Possible answers:
 - ▷ Action sequences, e.g. hunting, collecting, preserving, food preparation, fire making
 - ▷ Conceptualization and creation of tools.

Tool making (and perhaps other complex activities) lead to a “compositional mind”

- ▶ Cf. Stout e.a. 2008 on functional correlates between tool making and language



How did compositionality arise?

A question difficult to assess:

- ▶ There are hardly any species with intermediate forms of compositional interpretation
 - ▷ One possible case: A “suffix” in Campbell Monkey’s alarm calls, referring to non-prototypical membership to a class, something like *-ish* in *blue / blue-ish* (Ouattara e.a. 2009)
 - ▷ Compositionality in the wagging dance of bees, probably an entirely different matter
- ▶ So, let’s speculate and re-engineer a solution from the human perspective!



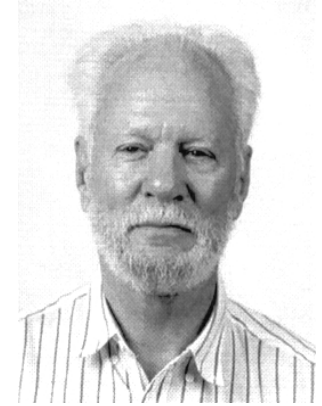
A plausible proposal:

- ▶ **Referring** to an entity and then **predicating** something about it.
- ▶ Works well, even across cultures:



Me Tarzan, you Jane

Topic-Comment Structure



Topic-comment structure in human communication

- ▶ Hockett (1958):
“The most general characterization of predicative constructions is suggested by the terms **topic** and **comment** [...]:
The speaker announces a topic and then says something about it.
- ▶ Long established history (cf. Krifka & Musan 2012)
 - ▷ underlying subject/predicate distinction in Aristoteles
 - ▷ **mubtada** and **xabar**, ‘beginning’ and ‘message’ in Arabic tradition,
 - ▷ **le point du depart** and **l’enonciation** with Henri Weil (1844),
 - ▷ **psychologisches Subjekt** and **psychologisches Prädikat**, Georg.v.d.Gabelentz (1869)
 - ▷ Hermann Paul (1880): “The psychological subject is that what the speaker wants to draw the attention of the hearer to, the psychological predicate is what the speaker wants the hearer to think about it.”
 - ▷ **theme** and **rheme**:
Mathesius (1929), Firbas (1964), Daneš (1970), Sgall & Hajičová (1987)

How are topics realized?

In so-called “subject prominent” languages like English:

- ▶ The typical topic is the subject.

Jacqueline Kennedy married Aristoteles Onassis.

Topic: Jacqueline Kennedy

Aristoteles Onassis married Jacquelin Kennedy.

Topic: Aristoteles Onassis

- ▶ But this is not necessary:

65 million years ago, a meteorite hit Earth.

Topic: time, (Earth)

*As for the dinosaurs, a meteorite hit Earth
and drove them to extinction.*

Topic: dinosaurs

In so-called “topic prominent languages” like Japanese:

- ▶ Dedicated topic marker *wa*:

sakana wa tai ga ii
fish TOP red.snapper NOM excellent

Topic: fish

‘as for fish, red snappers are excellent’

General tendencies:

- ▶ Sentence-initial position
- ▶ Deaccented, reduced prosody
- ▶ typically definite, that is, identifiable by speaker and addressee

What is topic/comment about?

Suggested modeling in Reinhart (1982): File Cards

- ▶ *Jacqueline Kennedy married Aristoteles Onassis.*
Topic: Jacqueline Kennedy
Comment: that she married Aristoteles Onassis.
- ▶ *Aristoteles Onassis married Jacqueline Kennedy.*
Topic: Aristoteles Onassis.
Comment: that he married Jacqueline Kennedy.

Influence on ease of recall:

- ▶ Cf. Repp & Drenhaus 2011
on influence of topic choice and recall in German.

Jacqueline Kennedy

...

...
has married Aristoteles Onassis

Aristoteles Onassis

...

...
has married Jacqueline Kennedy

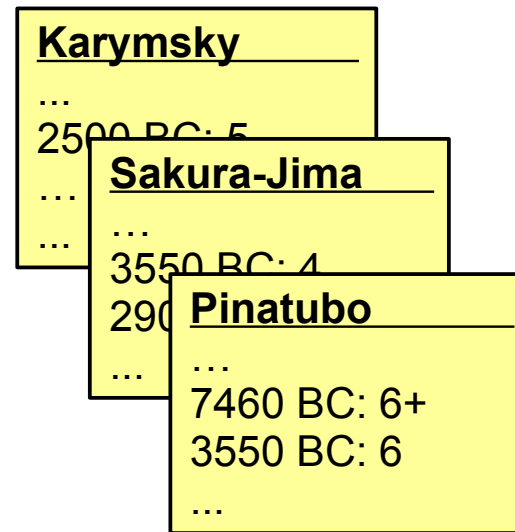
Topic-Comment Structure and information storage

Nature of topic-comment structure

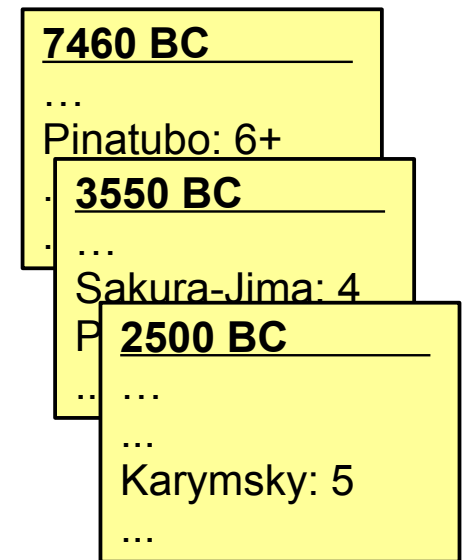
- ▶ Reinhart suggests that topic-comment structure appeals to a way how information is organized in the human mind
- ▶ Bear in mind that this is not the only way how information can be organized, cf. e.g. file cards vs. relational database.

Volcano	Year	Strength
Pinatubo	7460 BC	6+
Sakura-Jima	3550 BC	4
Karymsky	2500 BC	5
Pinatubo	3550 BC	6
Sakura-Jima	2900 BC	4

Relational database
about volcano eruptions



File cards
about volcanoes



File cards
about years

Topic-comment structure in animal communication?

- ▶ as far as I know, does not exist
- ▶ e.g., apes do not point (Tomasello & Zuberbühler 2002), probably a prerequisite for drawing attention to a topic.

A surprise connection: Topic/comment structure and bimanual manipulation

Asymmetry in hand use:

- ▶ Human hands are symmetric, but are used in different ways:
 - ▷ About 90%: right hand to throw a stone, to eat with a spoon, to write with a pen etc.
 - ▷ This dominance is evident from fragments for stone tools, from hand paintings etc. for > 20,000 years (Faurie & Reymond 2004, Steele & Uomini 2009) and is certainly much older (e.g., Neanderthals; Uomini 2011)



Explanation of asymmetry:

- ▶ MacNeilage e.a. (1984), MacNeilage (1998): Frame-Content model, non-dominant hand creates a frame into which the dominant hand adds content.
- ▶ Guiard (1987): Kinematic chain model, the motions of the dominant (right) hand find its spacial reference in the results of the motions of the non-dominant (left) hand:



A precursor for topic/comment: bimanual manipulation

Krifka (2008) proposes a functional similarity of topic/comment and non-dominant/dominant hand in bimanual actions:

- ▶ Basic similarity:
 - ▷ **Non-dominant hand** fixates an object, dominant hand operates on it and changes it.
 - ▷ **Topic** expression identifies a concept, comment modifies it by adding information.
- ▶ Temporal sequencing:
 - ▷ **Non-dominant hand** acts first by grasping an object, followed by dominant hand to operate on the object (kinematic theory, Guiard)
 - ▷ **Topic** expression identifies a concept first, modification by comment follows, hence topic-comment sequence.
- ▶ Coarseness of operations:
 - ▷ **Non-dominant hand** performs more coarse-grained operations, **dominant hand** is able to perform finely controlled movements.
 - ▷ **Topics** are typically shorter, less complex, deaccented; **comments** are more complex, prosodically more prominent.

Topics and hand use in metaphor / grammaticalization: *take*

The verb *take* can be grammaticalized as a discourse topic marker:

- ▶ *I don't think that people will like this kind of food.*
Take John. He is a vegetarian.

This use of 'take' verbs is not well recognized:

- ▶ Not mentioned in Heine & Kuteva, *World lexicon of grammaticalization* (2002)
- ▶ May be widespread – perhaps including 'take' as marker for definite objects, e.g. Chinese *ba*.

Analysis:

- ▶ 'Take' verbs basically denote grasping an object.
- ▶ One purpose for grasping an object is to modify it.
- ▶ A topic-comment structure consists in an instruction to identify an object and assign information to it.
- ▶ The identification of the object can be categorized as a taking of the object.
- ▶ Commands of the form 'take x' can grammaticalize to instructions to make x a topic.

Topic/Comment and Hand Use Asymmetries: Sign

Sign languages:

- ▶ Liddell (2003): so-called “buoys”, signs that structure discourse, by non-dominant hand, so-called “theme buoys” for non-dominant hand.



Figure 8.23 The THEME buoy directly ahead of the signer's chest

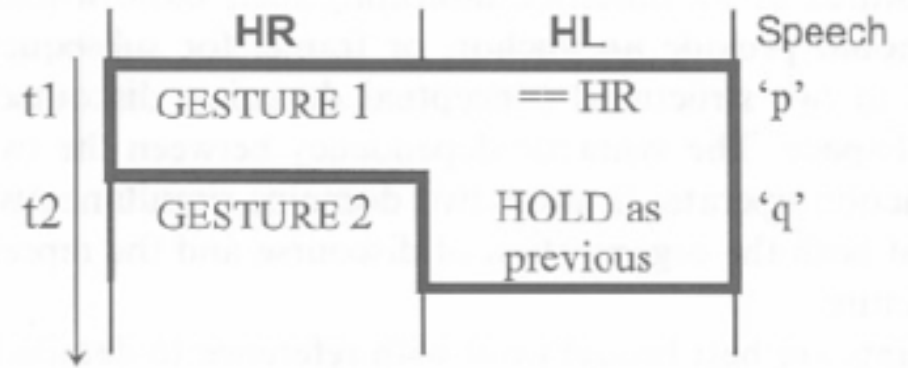


Figure 8.24 The reappearance of the THEME buoy during the first part of the compound verb THINK^CONTACT^[DURATIONAL]

Topic/Comment and Hand Use Asymmetries: Gesture

Gesture in spoken language:

- ▶ Enfield (2004), gestures in speech of Laos fishermen describing their traps:
 - Non-dominant hand keeps holding information,
 - while dominant hand adds new information



The 'half-T' shape (in bold line) of a symmetry-dominance construction



And they place it in the rice fields also



Now when a fish is going to go down (into it)



when a fish is going to go down into it ...



it goes in and is inserted there

Asymmetric hand use in iconic gesture

SaGA corpus, SFB Alignment in Communication, University of Bielefeld
thanks to Florian Hahn, Insa Lawler, Hannes Rieser,
cf. Lücking e.a. 2010.

- ▶ Subjects describe how to navigate a car through a (virtual) environment.
- ▶ Here:
*There is a sculpture in the middle of the roundabout,
you drive [right hand] towards it, [left hand]
you circle around it on the right side,
and then you go on straight.*

Hand use in iconic gestures



Hand use in iconic gestures

*There there is on a grey pedestal, which is about half a meter,
and on top of it [left hand]
there are red tubes [right hand]
they look like pretzels.*

Hand use in iconic gestures



Hand use in iconic gestures

*There is a T-crossing [left hand]
and there is a chapel,
and you drive like towards the tree,*

...

Hand use in iconic gestures



Hand use in iconic gestures

*So, you walk into the street [right hand]
and then where is then sculpture,
is it on the left side, on the right side [left hand]*

...

Hand use in iconic gestures



Hand use in gestures

Research question:

- ▶ Do signers sign topic-related information more often with their non-dominant hand?

Possible type of evidence:

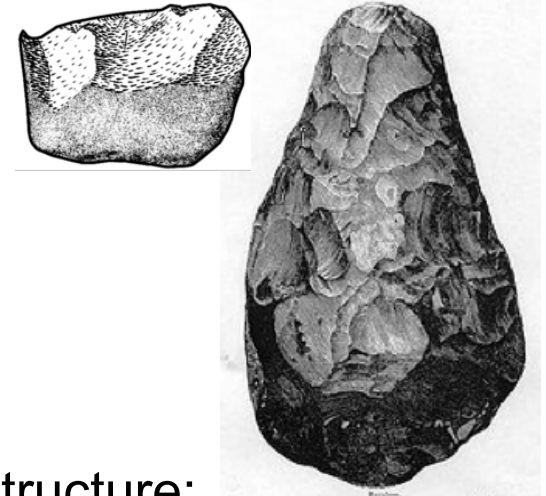
- ▶ Corpus data with elicited iconic gestures
- ▶ Experimental data with elicited tasks, e.g. topic pointing / comment pointing:
Take this chair [topic] and put it there [comment]



Bimanual coordination → Topic/Comment in language evolution?

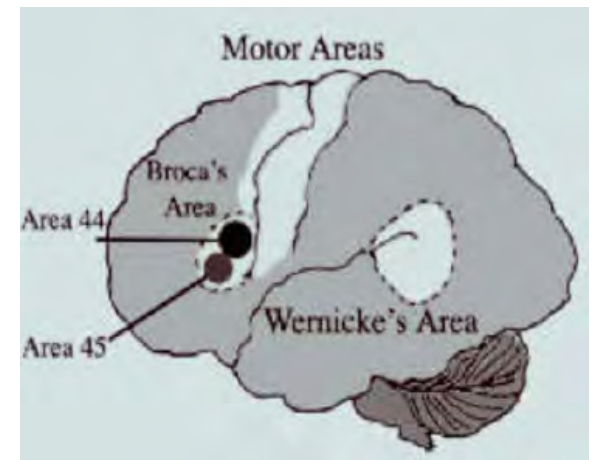
Time depth of asymmetric bimanual manipulation to produce artifacts:

- ▶ Australopithecus species (4 – 2 million years),
Homo habilis, Homo ergaster (2,3-1,3 million years)
tools: stone flakes (choppers) made by hitting a core (Oldowan)
- ▶ Homo erectus (1,8 million years – 150,000 years):
tools that were successively formed
by “adding” features to an object (Acheulean)
 - ▷ hand axes
 - ▷ sharpened blades



Bimanual manipulation as pre-adaptation for topic/comment structure:

- ▶ Increasing lateralization of hands for asymmetric bimanual work
- ▶ concomitant lateralization of brain,
development of specialized brain area for manipulation
- ▶ this area was co-opted for the development
of topic/comment structures in communication
- ▶ Broca area controls object combination
and word combination (Greenfield 1991),
is “the action-orchestrating area of the brain” (McNeil 2005),
is related to tool making (Stout e.a. 2008, 2012)



Bimanual manipulation and compositionality:

- ▶ Topic/comment structure as a particularly simple case of compositionality
- ▶ Springboard for other cases of compositionality.

Wrapping up

- ▶ Compositionality as an essential feature for human language
- ▶ Topic/Comment structuring is an elementary instance of compositionality.
- ▶ One important human action pattern consists in grasping / holding an object and modifying it; this was argued to be a functional analogue to topic-comment structure.
- ▶ Grasping and holding the object is done by the non-dominant hand, modifying the object is done by the dominant hand.
- ▶ Hence:
 - Lateralization of hand use a prerequisite for manipulating objects,
 - this in turn a prerequisite for topic-comment structures.

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