A Functional Similarity between Bimanual Coordination and Topic/Comment Structure

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1. Introduction

- Topic / Comment structure is a universal and unique feature of human language, not found in animal communication (or nobody has looked so far).

1. a. [Top This talk] [Con is rather speculative].
1. b. [Top This talk.] [Con I don’t feel competent about.]

- Manual lateralization, leading to asymmetric bimanual coordination, is a central feature of human actions, more pronounced than in other species (disregarding lobsters).

- This talk explores a possible connection between asymmetric bimanual coordination and T/C structuring. It is argued that the similarities are striking enough to warrant an investigation whether T/C structuring is grafted on bimanual coordination, perhaps by preadaptation.

2. T/C Structure in Communication

2.1 Characterizations of T/C structure

Georg von der Gabelentz (1869): psychological subject ≠ grammatical subject

2. b. Offenbar ist es [dies], dass ich erst dajenige nenne, was mein Denken anregt, worüber ich nachdenke, mein psychologisches Subjekt, und dann das, was ich darüber denke, mein psychologisches Prädicat,

(370f.)

“Evidently I first mention that which animates my thinking, that which I am thinking about, my psychological subject, and then that, what I am thinking about it, my psychological predicate.”

Paul (1880) reinterprets this as a hearer-directed way of optimizing communication:

2.3 Das psychologische Subjekt ist (…) das, worüber der Sprechende den Hörenden denken lassen, worauf er seine Aufmerksamkeit leiten will, das psychologische Prädikat dasjenige, was er darüber denken soll.

“The psychological subject is that which the speaker wants the hearer to think about, to which he wants to direct his attention, the psychological predicate that what he should think about it”

Marty (1884) relates this to the subject-predicate structure in classical logic but questions whether all sentences are structured this way. He distinguishes “categorical” sentences for which this is the case from “thetic” sentences that do not have a constituent identifying a psychological subject. But even thetic sentences may have a psychological subject that is just not realized:


“The psychological subject is not expressed in the sentence es brennt ‘there’s fire’. But it would be wrong to believe that there is none. In this case we find a combination of two ideas as well. On the one hand there is the realization of a concrete phenomenon, and on the other the notion of burning and fire which already rests in the soul and under which the phenomenon can be subsumed.”

The notion of T/C was prominently introduced by Hockett (1958) into American linguistic thinking:

5. 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. […] In English […] topics are usually also subjects and comments are predicates: so in John | ran away. But this identification fails sometimes in colloquial English, regularly in certain special situations in formal English, and more generally in some non-European languages.

It played a central role in the tradition of the Prague School (Firbas 1964, Daneš 1970, Sgall e.a. 1987), which identified the notion of topic with “old” information, and the notion of comment (or focus) with “new” information:

6. Taking for granted that in the act of communication an utterance appears to be, in essence, an enunciation (statement) about something (questions should be treated separately), we shall call the parts theme (something that one is talking about, topic), and rheme (what one says about it, comment).

Following the other line, linking up utterance with the context and/or situation, we recognize that, as a rule, one part contains old, already known or given elements, functioning thus as a ‘starting point’ of the utterance, while the other conveys a new piece of information (being thus the ‘core’ of the utterance). But, as in most cases, the two aspects coincide, we shall, in our following discussion, disregard the said distinction. (Daneš 1970).

Another proponent of this identification of T/C with given/new is Chafe (1976). However, the identification is problematic: the topic may be “new” in case of contrastive topics, and the comment may contain “old” parts, cf. Halliday (1970).

7. A: What do your siblings do?
B: [Top My SISTEr] [Con is working in a hospital],
[Top my BROTher] [Con is studying physics]?

8. a. [Top Mary] [Con always goes to TOWN on Sundays].
b. [Top Mary] [Con always goes to town on SuNdays].

Reinhart (1982) proposes a dynamic theory of T/C structuring: Communication consists of adding propositions to the common ground; these propositions are stored in relation to conceptual entities, like in a file-card system. The topic of a sentence identifies the conceptual entity at which the information should be stored. See Jäger (1996), Portner & Yabushita (1998) for theoretical models in Discourse Representation Theory.
(9) The propositions admitted in a context are classified into subjects of propositions, which are stored under defining entries. (…) NP sentence topics, then, will be referential entries under which we classify propositions in the context set and the propositions under such entries in the context set represent what we know about them in this set. (Reinhart 1982)

T/C structuring plays a major role in linguistic reasoning today, both in functional and formal approaches (Gundel 1988, Lambrecht 1994, Dik 1978, Sasse 1987, Erteshik-Shir 1997, Zubizarreta 1998, SFB 632 University of Postdam / Humboldt University Berlin on Information Structure). Terminology and its application is not very clear; Jacobs (2001) shows that this is partly due to different notions of topics, among those the following:

- **Addressing:**
  - X is an address and Y is an entry if X marks the point where the information carried by Y has to be stored within the speaker-hearer knowledge at the moment of the utterance. (cf. Reinhart).
- **Frame setting:**
  - X sets the frame if it determines the domain within which a predication holds.

(10) a. As for his health, John is fine.
    b. Barkassenmässig ist heute nichts los. ‘As for barks, there’s nothing today’ (when inquiring about visiting Hamburg Harbour)

- **Semantic predication:**
  - X is the highest argument of a predication.

(11) Mary resembles her grandmother.

### 2.2 T/C structure and predication

T/C structuring may be the precursor of Subject/ Predicate structure (see discussion of topic-prominent languages and subject-prominent languages in Li & Thompson 1976).

(12) a. Simple association between two ideas:
    - Berry – Bitter / Bitter – Berry
    b. T/C structure: This berry – Bitter!
    c. Predication: This berry is bitter.

Predication is a prerequisite for truth conditions, the hallmark of “human” semantics (cf. Nehaniv 2000). Among others, this enables true lying (contrasted with deception).

But T/C structure is not restricted to assertions:

(13) a. This fruit is juicy.
    b. This fruit, is it juicy?
    c. This fruit, give it to me!

### 2.3 Expressing and interpreting T/C

T/C structure can be expressed in a number of ways. Often, more than one marking strategy applies.

- **Left dislocation, with or without resumptive pronoun:**

(14) a. This guy I have met _ somewhere before.
    b. This guy, I have met _ him somewhere before.

- **Movement into a topic position, e.g. in German in front of higher-order adverbials Frey (2004):**

(15) A: Was ist denn heute in der Küche passiert?
    B: Heute hat sich in der Küche _ leider jemand mit einem Messer geschnitten.
    ‘What happened in the kitchen today?’

- **Special topic constructions:**

(16) As for Bill, he won’t be able to make it to the reception.

- **Morphological topic markers in languages like Korean, Japanese:**

(17) Kuroda (1972):
    a. Inu ga hasitte iru. ‘The / a dog is running.’
    b. Inu wa hasitte iru. ‘The dog (mentioned) is running.’

- **Realisation as a subject, either by passives or directly (e.g., locative subjects, occurring in English but more widespread in e.g., Bantu):**

(18) a. Ellen was awarded a prize by the academy.
    b. This room sleeps ten persons.

- **Deaccenting, indicating givenness, which is characteristic of topics (e.g., Haliday 1967):**

(19) a. [Sign in front of escalators.] Dogs must be CARRied.
    b. [Sign in front of restaurant.] SHOES must be worn.

(20) Reinhart 1982:

Kracauer’s book is probably the most famous ever written on the subject of the cinema. Of course, many more people are familiar with the book’s catchy title than are acquainted with its turgid text.

- **Topic accent, in particular for contrastive topics:**

(21) A: How are your children doing?  
    B: Fine. My _ son is studying _ medicine, and my _ daughter has founded a _ company.

- **T/C structure by ordering, even in mathematical language:**

(22) a. The murderer _ is the gardener.
    b. f(x) = 2x^2 + 3x – 7x + 9

T/C structuring has distinct semantic effects:

- **Existence of topics presupposed (Strawson 1964):**

(23) a. The king of France visited the exposition.
    b. The exposition was visited by the king of France.

- **Domain of quantification as topics, conservativity of quantifiers:**

(24) Most children play in the sand.

Truth value can be judged by looking at children only.

### 2.4 Is T/C necessary for communication?

T/C structure is so pervasive in human communication that it may appear a virtual necessity for communication and/or for the storage of information. However, this is not so.

**The simple picture: Restriction of common ground**

Simplest picture of communication (e.g., Stalnaker 1974):

- An information state is a set of situations or possible worlds (which are compatible with the description of the information state).

- **Updating of information state restricts this set; no identification of topics necessary.**

(25) c + Mary bought a new car

= \{ w | w \in c \land \text{Mary bought a new car in } w \}

Similar with classical discourse theory, e.g. Kamp (1981), which assumes discourse referents, but without distinguishing topical from non-topical discourse referents.

Integration of T/C structures actually lead to a complication of the nature of an information state (cf. Reinhart 1982, Portner & Yabushita 1998).

### Data storage and retrieval in data bases

**Example of storage of information not structured by T/Cs:**

**Databases**

(26) **Relational database (here, employees)**

<table>
<thead>
<tr>
<th>name</th>
<th>b. date</th>
<th>address</th>
<th>employed</th>
<th>function</th>
<th>phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Lee</td>
<td>30.5.1963</td>
<td>Elm Street 2</td>
<td>22.5.2001</td>
<td>engineer</td>
<td>324356</td>
</tr>
<tr>
<td>Will Kleve</td>
<td>22.7.1965</td>
<td>Oak Street 7</td>
<td>17.3.2000</td>
<td>secretary</td>
<td>456839</td>
</tr>
</tbody>
</table>

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It is tempting to assign topichood to the names, as they are unique. But nothing in the concept of a relational database forces this interpretation. E.g., database queries like the following can be expressed with equal ease (e.g., in a querying language like SQL or Prolog).

(27) a. Give me the birthdate(s) of Mary Lee.
   Query: name = 'Mary Lee', birth = X
   Result: X = 30.5.1963

b. Give me name(s) and birthdate(s) of the engineers.
   Query: function = 'engineer', name = X, b.date = Y
   Result: X = 'Mary Lee', Y = 30.5.1963
   X = 'Kenn Ross', Y = 19.5.1997

In data bases like the following, listening to volcanoes, their eruptions, and their explosivity index, it is clear that there is no distinguished column with unique entries.

(28) Relational database (volcanoes and their eruptions)

<table>
<thead>
<tr>
<th>Volcano</th>
<th>Eruption</th>
<th>Expl. Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinatubo</td>
<td>7460 BC</td>
<td>6+</td>
</tr>
<tr>
<td>Sakura-Jima</td>
<td>3550 BC</td>
<td>4</td>
</tr>
<tr>
<td>Karymsky</td>
<td>2500 BC</td>
<td>5</td>
</tr>
<tr>
<td>Pinatubo</td>
<td>3550 BC</td>
<td>6</td>
</tr>
<tr>
<td>Sakura-Jima</td>
<td>2900 BC</td>
<td>4</td>
</tr>
</tbody>
</table>

Lack of T/C structure in animal communication

There is no evidence for T/C structure in communication of animals, at least those close to humans. (Bee communication may be a case in point, T. Fitch, pers. comm.: Bee presents a quantity of pollen (= topic), and indicates where to find more of it (= comment)).

(29) Tomasello and Zuberbühler (2002):

“…virtually no ape gestures are referential in the sense that they indicate an external entity (i.e., there is no pointing in the human fashion).”

While not all such pointing is topical, identification of a topic seems to presuppose the ability to point.

Animal communication is rather similar to thetic sentences about the situation the animal is in, e.g. “Birds of prey!”, or perhaps even: “Birds of prey over there!”, never “Over there – birds of prey!”.

3. Asymmetric Bimanual Coordination in Human Action

3.1 Manual Laterality

One of the striking features of human behavior: limb laterality, in particular with respect to forelimbs (aka hands).

- In all human populations, most people use their hands in different ways for a number of tasks like throwing objects, manipulating objects, writing, etc. that have led us to speak of a dominant hand a non-dominant hand.
- In all human populations, for most people the right hand is dominant for most activities considered. Statistics are unreliable because different tasks were considered, and vary between 5% and 20% left-handers. There is a genetic factor involved that is still little understood, as monozygotic twins can exhibit different handedness (but see Annett 2002, Corballis 2003 for genetic explanations).

For non-human primates there is evidence of asymmetry in hand use, but it is considerably weaker, and even debated:

- MacNeillege (1984, 1990) collects evidence for a successive development in primates:
  - Prosimians have a left-hand preference for manual prehension; the right hand is used for clinging to branches, no separate control for fingers, no real manipulation or bimanual coordination.
  - Monkeys have a weaker left-hand preference for grasping, right-hand preference for manipulation.
- Apes show these tendencies even clearer: left-hand preference for tasks that make strong visuospatial demands, like prehension; right-hand preference for manipulations, like joystick-controlled computer games.
- Explanation: Development from mouth predation to hand predation. First left-hand predation by right-hand clingers, then right-hand predation after clinging was given up, possibly because of stronger right side developed by clinging.

- For communication: right-hand preference for initiation of chest-beating in gorillas (Schaller 1963); predominant use of right hand in pointing and gestures of captive chimpanzees (Hopkins e.a. 2005).

Evidence for laterality in human prehistory

- Judges 20: 15-16: Army consisting of about 2,6% left-handed sling-throwers.
- Evidence for paleolithic tools made for the right hand, hand silhouettes of the left hand drawn by the right hand, etc. (see Bradshaw and Nettleton 1981).

3.2 Manual Laterality and Brain Laterality

Ancient discovery of lateral effects of brain damages, in particular left-cerebral dominance for speech (Galen; Broca 1865).

Relation of left-cerebral dominance for speech to dominant right-handedness was already suspected by Broca (1865), and is supported by various types of evidence:

- Rasmussen and Milner (1977): left handedness positively related to right-cerebral dominance for speech, using brain damage data.
- Knecht and e.a., (2000): left cerebral activation during word generation positively related to degree of right-handedness.

Suspected role of manual laterization in the evolutionary development of speech:

- Annett (2002), McManus (2003): The same genetic mutation is responsible both for handedness and brain lateralization, enabling human language; this arguably was then the most important genetic event in human speciation.
- There is evidence for left-hemispheric dominance of vocalization in a wide range of animals. Corballis (2003) argues for human language to be preceded by a gestural language; evidence include function of homologue of Broca’s area in apes (F5, mirror neurons, use for perception and production of manual action and grasping).

3.3 Asymmetric Bimanual Coordination

The traditional view of a dominant / non-dominant hand dismisses the differential function of the two hands in bimanual action. Both hands have similarly important functions in many tasks. E.g. in the 8 items used by Annett (1967) for determining handedness, five refer to bimanual acts (like sweeping, shoveling, striking a match, using scissors, threading a needle). Even for apparently monomanual tasks the non-dominant hand is important, e.g. balancing when throwing objects. For example, Athènes 1984 showed that the speed of handwriting reduces by 20% when subjects are instructed not to use the non-dominant hand for holding the paper.

The Frame-Content Model of MacNeilage e.a. (1984)

MacNeilage e.a. (1984): The non-dominant hand provides “frames” into which the dominant hand inserts “contents”. MacNeilage (1986) argues that this is a homologue to the frame/content organization of speech, in particular organization of syllables (frames) and segments (contents), syntax (frames) and words (contents). Evidence for the model comes from speech errors (spoonerisms) consisting of putting wrong contents in given frames.
Aspects of speech control have developed from a system originally evolved for bimanual coordination (SMA – supplementary motor area).

Freedom of environmental constraints in language and in bimanual manipulation

Frame/content model of bimanual coordination and of hierarchical structuring of language guarantees rapid, well-controlled output.

The Kinematic Chain Model of Guiard (1987)

Guiard (1987) argues for a differentiated role of hands seen as “motors” that form a “kinematic chain”, following three principles:

- Spatial reference to manual motion. Motion of the dominant hand typically finds its reference in the results of motion of the non-dominant hand. Nondominant hand keeps position of an object stationary, dominant hand manipulates it (e.g., threading a needle, positioning paper in writing, handling cue in billiard).
- Spatial-temporal scale of motion. Non-dominant hand produces motions on a more coarse-grain scale of time and space, motions of dominant hand are quicker and more precise (experimental evidence by pointing, finger tapping, tracing of points with cursor.) This corresponds to the postural role of the non-dominant hand and the manipulative role of the dominant hand.
- Precedence of non-dominant hand in action. The contribution of the left hand to a bimanual action starts earlier than the contribution of the right hand. Reason: The object manipulated on must first be fixed in place.

Kinematic chain model: the two hands act as motors that work in series: the output of one (the non-dominant hand) is the input of the other (the dominant hand).

Other examples that fit the kinematic chain model: the system arm + hand.

One linguistic application of kinematic chain model suggested: duality of patterning (Hockett, 1960): Sequence of meaningless phonemes make up meaningful morpheme. (Cf. also MacNeiIage).

4. Bimanual Coordination and T/C Structuring

4.1 Similarities between Bimanual Coordination and T/C Structuring

Asymmetric bimanual coordination, as in Frame/Content and Kinematic Chain Model, corresponds to T/C structuring in communication:

Frame setting topic and Frame/Content Model (MacNeiIage)

- The frame-setting topic identifies a frame for which a statement holds, within which it is to be interpreted. This corresponds to the frame-setting role of the non-dominant hand.
- The statement is to be interpreted within the frame. This corresponds to the content-contributing role of the dominant hand.

Aboutness topic and the Kinematic Chain Model (Guiard)

- The aboutness topic “picks up” or identifies an entity, typically in the common ground of speaker and hearer, or something that is uncontroversially assumed. This corresponds to the preparatory, postural contribution of the non-dominant hand.
- The comment adds information about the topic. This corresponds to the manipulative action of the dominant hand.

The file-card metaphor of Reinhart (1982) is quite telling: Speaker takes out and holds the file card with non-dominant hand, writes down information on it with dominant hand. Specific points of similarity:

- Spatial reference: Identifying a topic is static, it does not change the information state but prepares a change. Adding a comment is dynamic, it changes the information state.
- Scale of motion: Topic is deaccented, prosodically weak; Comment is accented, prosodically strong.
- Precedence: Topic tends to precede comment.

4.2 Hand Dominance in Sign Languages

If there is a relation between hand dominance and T/C structure, we should expect to find evidence in sign languages, which use hands to communicate.

Non-dominant hand in sign languages, Sandler (2005), on Israeli Sign Language:

- Non-dominant hand plays a minor role in lexical representation, largely redundant, restricted to a small set of handshapes.
- For bimanual signs, non-dominant hand is a “place of articulation”; dominant hand moves towards non-dominant hand.
- Nondominant hand may function as a classifier (e.g. HUMAN, ANIMAL, VEHICLE), e.g. APPROACH (dominant hand: pointed finger) + PERSON (non-dominant hand: imitation of walking): ‘A person is approaching.’
- Nondominant hand may indicate prosodic boundaries (nondominant hand spread).
- Nondominant hand may track a topic throughout a discourse segment.


- Discusses examples of bimanual parallel signing of T/C structures in which the topic is identified and maintained by the non-dominant hand.

(30) HOUSE nd HOUSE
dh TREE (be-located-behind)

“HOUSE is (…) topicalized. The informant holds the sign for house with his non-dominant hand to maintain the referential status of the topicalized constituent. HOUSE is normally articulated with two hands, as in the initial sign. A one-handed version of the normally two-handed sign TREE also occurs with this segment. The signer articulates this with his dominant hand, thus indicating that this has assumed higher informational status (i.e., this is new information) than the preceding constituent, HOUSE.”

5. Conclusion

Relations between the development of hand laterality and brain laterality which is crucial for language are discussed by many authors. One aspect of hand laterality overlooked (except by MacNeiIage 1986) is the differential role of the hands in bimanual coordination. This feature of manual action might be a precursor – perhaps even a cognitive preadaptation – of the manipulation of information: As the non-dominant hand can grab an object and hold it in order for the dominant hand to operate on it, so human information processors can identify an entity or class and ascribe a property to it, or change properties ascribed to it before.

In a cognitive perspective, the possibility of asymmetric bimanual coordination may have led to a different representation of the environment. Many objects can be picked up and positioned properly so that they can get acted upon. In a similar way, pieces of mental representations can be picked up and acted upon.
6. References


