Functional Similarities between Bimanual Coordination and Topic/Comment Structure

Manfred Krifka[1]

Humboldt-Universität zu Berlin
& Zentrum für Allgemeine Sprachwissenschaft, Berlin
krifka@rz.hu-berlin.de
21.08.2006

Human manual action exhibits a differential use of a non-dominant (typically, left) and a dominant (typically, right) hand. Human communication exhibits a pervasive structuring of utterances into topic and comment. I will point out striking similarities between the coordination of hands in bimanual actions, and the structuring of utterances in topics and comments. I will also show how principles of bimanual coordination influence the expression of topic/comment structure in sign languages and in gestures accompanying spoken language, and suggest that bimanual coordination might have been a preadaptation of the development of information structure in human communication.

1. Introduction

While language is presumably unique to humans, there are possible pre-linguistic features that developed in the course of human evolution which predate features of language, and might have even been essential for its evolution. A number of such possible preadaptations for human language have been discussed, like the permanent lowering of the larynx, the ability to control one's breath, or the inclination of humans to imitate. In this paper I would like to point out another candidate for a preadaptation, namely the functional differentiation of the hands and the way in which they cooperate in manual actions.

To be sure, a number of researchers have tried to establish a relation between (a) the fact that humans show lateralization in their forelimb use to a greater degree than other primates, and (b) the development of the human language faculty, which is characterized by a pronounced lateralization of the brain. For example, MacNeilage (1986) proposed a relation between the form/content structure of human language and bimanual action, and Annett (2002) argues that a manual lateralization required a cerebral lateralization that, once established, laid the foundation for the development of language. Here I would like to point out a possible connection not seen so far, namely between the pervasive topic/comment structuring that we find in human language and the functional asymmetry of the hands in bimanual tasks.

I will first remind the reader that topic/comment structuring is indeed an essential and well recognized feature of human language, and characterize its function in human communication.

Secondly, I will summarize findings on bimanual coordination which show that the two hands play quite different roles in many tasks that involve both hands. Then I will identify a number of functional similarities between these seemingly widely divergent domains of human behavior, and I will show that these similarities show up when the hands function as organs of communication, as in gesture and sign language. I conclude with a possible scenario according to which asymmetric bimanual coordination played a role in the rise of the topic/comment structures in communication.

2. Topic/Comment Structure in Communication

2.1 Topic/Comment Structure in Linguistics

The structuring of utterances into a topic part and a comment part is a pervasive phenomenon in human language well known to language scholars over the last centuries. It has been identified by medieval Arab grammarians in their distinction between *mubtada* 'beginning' and *xabar* 'news' as differing from the grammatical subject/predicate distinction, cf. Goldenberg (1988). It was introduced into modern European thinking about language by Weil (1844) as *le point du depart* and *l'énonciation*, and by Gabelentz (1869) and Paul (1880) as *psychologisches Subjekt* and *psychologisches Prädikat*, respectively. It is worthwhile to read the initial attempts to define this fundamental distinction:

> There is then a point of departure, an initial notion which is equally present to him who speaks and to him who hears, which forms, as it were, the ground upon which the two intelligences meet; and another part of discourse which forms the statement (*l'énonciation*), properly so called. This division is found in almost all we say. (Weil 1844/1978: 29)

> 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. (von der Gabelentz 1869, 370f., author's translation)

> 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. (Paul 1880, author's translation).

Marty (1884) questions whether all sentences are structured this way (cf. later Kuroda 1972, Sasse 1987). 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 as part of the utterance because it is given in the situation of utterance. Marty's remark also suggests a wider notion of potential topics including situations and events.

> 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. (Marty 1884, §91, author's translation).

The notion of topic and comment were prominently introduced into American linguistic thinking by 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.

It played a central role in the tradition of the Prague School (Firbas 1964, Daneš 1970, Sgall e.a. 1986), which tends to use the terms *theme* and *rheme* and identifies them with "old" and "new" information, similar to the influential article by Chafe (1976). However, even though this correlation of Topic and Comment to entities mentioned before or expressions used previously, and to entities being introduced and new expressions holds in many cases, it is not a necessary one. Halliday (1967) showed that the comment can contain given expressions, and Reinhart (1982) showed that topichood, while strongly correlated with old information, cannot be reduced to it.

Reinhart (1982) also elucidated the notion of topic in terms of a formal model of information and communication. Information can be modelled as a set of file cards that identify an entity and list properties of that entity and its relations to other entities. A topic expression identifies a file card by naming the entity it collects information about, and a comment expression adds information to it. This notion has been made more precise in the framework of file change semantics (Heim 1983) by Portner & Yabushita (1998). Thus, while the two sentences in (1) are true under the same circumstances, they carry different information under normal prosody: while (a) is an utterance about Jacqueline Kennedy, (b) is an utterance about Aristoteles Onassis.

(1) a. Jacqueline Kennedy married Aristoteles Onassis.
     b. Aristoteles Onassis married Jacqueline Kennedy.

Various authors have pointed out phenomena that are now subsumed under the notion of contrastive topics (cf. e.g. Jacobs 1984, 1996; Lambrecht 1994; Molnár 1998; Büring 1998). What is special about contrastive topics is that they do not only identify an entity about which a comment is made, but in addition signal that, at the current point of discourse, there are other entities about which a comment could have been made which would have resulted in a coherent contribution. Hence contrastive topics indicate that the speaker chooses among a number of alternative topic candidates.

The notion of "topic" has been used in a wide variety of ways, including reference to presupposed information and contextually given expressions, which arguably are phenomena of a different nature. Chafe (1976) and more recently Jacobs (2004) have argued that one should differentiate between a notion of topic that identifies the entity about which a comment is made (the aboutness topic), and another notion that sets the frame for which a proposition holds (the frame setting topic). The following sentence is clearly about Onassis, so *Onassis* is its aboutness topic. The predication is restricted to financial aspects, indicating that Onassis may not be fine altogether; so *financially* is the frame setting topic. However frame setters can be analysed, they are clearly different from aboutness topics.

(2) Financially, Aristoteles Onassis is doing well.

Frame setters might set a temporal frame (*last year*), a local frame (*in Greece*), a hypothetical frame (*if he had won the election*), and other types that are not easy to generalize about but apparently have important aspects in common.

It is safe to say that the notion of topic/comment structuring, with a number of modifications, refinements and clarifications, has withstood the test of times better than most other linguistic notions, even quite fundamental ones like subject and object, or noun and verb. It is a powerful concept that has been used to explain a wide range of phenomena, from case marking patterns (see e.g. DuBois 1987) to quantification (see e.g. Partee 1991). While it is disputed whether all human

languages have a grammaticalized subject/predicate structuring, there is not a single language for which the topic/comment structure has been claimed to be irrelevant.

2.2 Properties of the topic/comment structure

While topic/comment structure has turned out to be an important feature of human languages, the forms in which this feature can be realized in particular languages are quite diverse (cf. e.g. Gundel 1988).

In many languages there are specialized syntactic constructions that indicate topics, like the English *as for* construction, cf. (3). Japanese and Korean are well known to have postpositions *wa* and *nun* to mark topics, cf. the Japanese example in (4).

(3) As for the elections, people hope to see more candidates to support these goals.

(4) Sakana wa   tai ga   ii
     fish TOP   red snapper NOM   excellent
     'As for fish, red snapper is excellent.'

Also, we frequently find dedicated syntactic positions for topics. The examples in (3) and (4) above illustrate this, as the topic phrases obligatorily occur as sentence-initial, in fact pre-clausal phrases (cf. the ungrammaticality of **People, as for the elections, hope to see...*). But frequently, topic positions have been identified in which an expression receives a topical interpretation without any additional marking. In English, left-dislocated phrases, and generally non-subject phrases at the left periphery, are interpreted as topics provided they have no focus accent, as in (5).

(5) a. The Romans, they are crazy.
     b. The next day, we went down to the village.

Left-dislocation is a common way to mark topics (cf. Lambrecht 2001), but there are also languages with grammatical topic positions within the clause. For example, Szabolcsi (1997) identified a sentence-initial topic position in Hungarian that differs from cases like (5.b) as it also can identify subjects as topics. Also, Frey (2000) argues for a topic position in the front of the German middle field. What all these findings have in common is that topics tend to occur early within the sentence or within the clause.

Interestingly, this tendency for topic initiality can also be found in the formal language of mathematics. For example, equations are typically given in the form illustrated in (6). In spite of the commutativity of the equality relation, this is a statement about f(x), the value of x when f is applied to it, hence this sign typically occurs at the beginning of the equation.

(6) a. $f(x) = x^2 + 3x + 1$ (usual order)
     b. $x^2 + 3x + 1 = f(x)$ (unusual order)

A topic need not assume a grammatical function such as subject or object, witness examples (3), (4) and (5.b). However, there is a strong statistical correlation between subjects and topics in running texts (cf. the seminal collections in Li (1976) and Givón (1985)) that suggests that subjects emerged as grammaticized combinations that prototypically combine topichood and some semantic role, like agenthood. The tendency for sentence-initial realization of topics then explains why most human languages have, in their basic word order, subjects that are sentence-initial. With the creation of subjects as grammatical pivots, a new device of topic marking becomes available: passive voice, which raises objects to subject position.

Topics typically refer to an entity that already has been mentioned in the previous discourse, is supposed to be part of the common background knowledge of speaker and hearer, or at least construable from known entities, as e.g. *the next day* in (5.b). Indefinites may occur as topics in generic sentences, then it can be argued to specify the restrictor set of a generic quantifier, which in itself is topical. For example, (7.a) is a statement about potatoes in general, and bare plurals and mass nouns as in (7.b) have been analyzed as names of kinds in Carlson (1977) (see Krifka e.a. 1995 for discussion).

(7) a. A potato contains vitamin C, amino acids, and thiamine.
     b. Potatoes contain vitamin C, amino acids, and thiamine.

If the topic is a non-generic indefinite, which may happen, then it is construed as specific, as an entity that can be identified, but not necessarily by the addressee, as in (8).

(8) One of my friends had a car accident yesterday.

But many languages disallow indefinite topics altogether, as for example Chinese (cf. Li & Thompson 1981), where indefinite subjects in most cases cannot be sentence-initial.

That topics are given, and hence presupposed, is also the reason for an asymmetry observed by Strawson (1964), who reported his intuition that (9.a) has no truth value in our world because the king of France does not exist, whereas (b) is simply false.

(9) a. The king of France visited the exhibition.

     b. The exhibition was visited by the king of France.

Turning to quantified NPs, such as *every friend of mine*, it has been observed (by Barwise & Cooper 1981) that all natural-language quantifiers have the property that it is sufficient for verifying them to look at the extension of their noun (here: *friend of mine*), and to the VP extension only insofar as it intersects with the noun extension.

(10) Every friend of mine has sent me a birthday present.

Quantified statements can be seen as topic/comment structures, where the quantifier – here *every* – indicates the degree to which a predication holds – here, a total degree (cf. Löbner 2000). The observed asymmetry has been called "conservativity". The statement can be verified by first identifying the set of friends of mine, and then checking whether all of them have the property of having sent me a birthday present.

As a consequence of the fact that they refer to given or construable constituents, topics are typically expressed in a prosodically weak way – they are deaccented. This is illustrated in the following contrastive pair of examples. In the context suggested in (11.a), *my purse* is not a topic, and it gets an accent; in (b), it is a topic, and it cannot get an accent.

(11) a. A: What happened? B: My púrse was stolen!

      b. A: What happened to your purse? B: My purse was stólen!

Deaccentuation may signal topics even in cases in which, for grammatical reasons, they occur in other positions than sentence-initially. One case is the following small text, from Reinhart (1982).

(12) Kracauer's book is probably the most famous ever written on the subject of the cinema. Of course, many more people are familiar with <u>the book</u>'s catchy title than are acquainted with its turgid text.

The second sentence is about Kracauer's book. Notice that the topic phrase *the book* is clearly deaccented in this case.

Topics are often pronominalized, as in *it was stolen!* , and in many languages they may be not realized phonologically at all, as e.g. in Chinese. There is one case in which topics receive an accent, namely with contrastive topics. Here, accent indicates that the speaker selects one topic out of a set of several topic candidates. But even in this case the topic does not carry the main accent of the sentence (in the following, ` represents secondary accent, and ´ represents primary accent).

(13) A: How are your parents doing?
      B: My mòther is still wórking, but my fàther has retíred.

Another phenomenon concerning the encoding of topic and comment has been pointed out by Jacobs (2004), who captured frequent findings about topic/comment structuring by claiming that topics and comments cannot be informationally "integrated". On an observational level, this means that topic and comment form distinct phonological phrases. If a sentence like *the train arrived* is meant to be an assertion about the train, it is realized as in (14.a), with two phrases each carrying an accent, not as in (14.b), with one phrase carrying just one accent.

(14) a. (the tràin) (arríved)
      b. (the tráin arrived)

Jacobs interprets this as indicating that in the first case, the meaning of *the train* and *arrived* are addressed independently, and then they are combined. In the second case, a simple thought, that an arrival of the train happened, is expressed.

2.3   Is topic/comment structuring necessary for communication?

Topic/comment structuring is so ubiquitous in human communication it may appear a virtual necessity for communication and/or for the storage of information. However, this is not so.

There are simplifying, but quite far-reaching theories of linguistic communication that work without any notion of topic. For example, Stalnaker (1974) suggested a theory of communication in which an information state is a set of situations or possible worlds (the worlds that are compatible with the description of the information state), and updating of this state consists in restricting this set. No notion of topic is necessary. Similarly, even though classical discourse representation theory as developed by Kamp (1981) assumes discourse referents in addition to possible worlds, the notion of topic is not required. Of course, there are suggestions how to include topic/comment structuring in the theory developed by these authors, such as Reinhart (1982), Jäger (1996), or Portner & Yabushita (1998). But the point is that they are not essential for the theoretical reconstruction of what happens in communication according to theories like Stalnaker's or Kamp's.

Also, in theories of storing and retrieving information in a database, the notion of topichood is superfluous. Consider the following relational database of vulcanoes, dates of their eruptions, and strengths of the eruptions:

(15)

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

Is there a "topic column" in this table? It is tempting to consider the names of the vulcanos as such, but observe that names can occur multiple times, just as years and strengths. Also, in database queries there is no dedicated topic:

(16) a. When did Pinatubo erupt?
　　　Query: name = 'Pinatubo', year = X
　　　Result: X = 7460 BC, 3550 BC

　　 b. Which volcano erupted around 3550 BC?
　　　Query: name = X, year = '3550'
　　　Result: X = Sakura-Jima, Pinatubo

Typically, a query specifies the values of certain features, while leaving the values of others open. But the constant parts are not in any way topics in the query language. For example, there is no necessity to formulate a query in which items that stay constant come first. The way in which search algorithms work, e.g. for the programming language PROLOG, is blind for the order of specification; the query "year = X, name = 'Pinatubo'" will give the same result as (16.a).

In animal communication, topic/comment structuring also seems to be lacking. Animals do not identify an object and then comment on it. It is even questionable whether they can refer to objects in the first place. Tomasello and Zuberbühler (2002) state: "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)." The warning calls of Vervet monkeys signal, for example, "danger from above / an eagle", or "danger from the ground / a snake" (cf. Struhsaker 1967), but they do not first identify a particular region, or a certain type of animal, and then say something about it. Tomasello (2003) notices that chimpanzees produce attention-getting gestures but appear to have no strategy of a combination of such gestures with ones that communicate more specific semantic content that could be seen as precursors of topic/comment structures. The only instance remotely comparable to topic/comment structuring I am aware of occurs in species that are very far removed from humans (T. Fitch, pers. comm.). There is some justification to see a topic/comment structure in bee communication, as they bring some pollen to the hive (the topic) and indicate with their dance the direction and distance where more of it can be found (the comment).[2]

This contrasts drastically with human communication, for which topic/comment structuring is an essential feature. There is also evidence that topic/comment structuring occurs early and effortlessly

---

[2]　This case was suggested to me by Tecumseh Fitch.

in the process of language acquisition; for example, De Cat (2002) adduces evidence that French children use topic/comment structures early on in their second year.

2.4 Topic/Comment structure and predication

One well-recognized, but still little-understood semantic property of human language is that it consists, to a large part, of predications that have truth values. For example, a minimal sentence like *Mary left* consists of a predicate, *left*, that is combined with a name; the result can be true or false in a given situation. The standard semantic model for this, going back to Frege (1892), is that the predicate is a function that maps entities, supplied by names, to the truth values True or False. As far as I can see, there is no predication in animal communication (cf. also Nehaniv 2005). A Vervet monkey performing a warning call for a snake does not say something like: *Over there, there is a snake*, but rather announces *Snake!*, or *Beware of Snake!*, which triggers a particular behavior in the addressees. Humans can lie by claiming that a predicate applies to an argument, yielding True, where in fact they know it yields False. Animals cannot lie, they only can deceive, e.g. by uttering a warning call where there is actually no warrant for it. To appreciate the difference, consider a house owner who warns a prospective thief by: *I have a dog*. This is a lie if there is no dog. Now consider a house owner who warns by: *Beware of the dog!* This is not a lie, it is a deception.

How did predication develop from animal signalling systems? Surprisingly, this is a question that has hardly ever been asked, let alone answered. Nehaniv (2000, 2005) has suggested that predication emerged from the simple symmetric association of two ideas via a stage in which one idea has a topic role, and the other one is a comment. The genealogy of predication can be sketched as follows, where "a + b" denotes symmetric association of ideas a, b, and a ← b denotes that an idea b is commented on an idea a.

(17) Stage 1: association between ideas: *Berries + Sweetness, = Sweetness + Berries.*

     Stage 2: topic/comment structure: *Berries ← Sweetness*, or *Sweetness ← Berries.*

     Stage 3: predication: *Berries are sweet*, or *Sweetness is berryish.*

The starting point is the simple association of two ideas, which denotes that the two referents often occur together, in whichever way. In our example, berries occur where sweetness occurs, and sweetness occurs where berries occur. This is how Hume conceived of association through contiguity (cf. Hume, *An Essay concerning Human Understanding*). This association is essentially symmetric. In a topic/comment structure, a first element of asymmetry arises: One term refers to an entity given, the other expresses something new. We can say that one idea is "about" another one. In our example, we identify the concept of berries and add the concept of sweetness to it, or vice versa. The relation is easily reversible. It gets solidified in the case of predication, where one idea refers to an object, and the other is predicated about it, for example when we say that berries are sweet. Now the relation is not easily reversible anymore. Typically, we must make use of a grammatically marked nominalized form of a predicate if we want to make it subject, as in *Sweetness is berryish.* Languages might differ quite drastically in how well developed a predication relation they have. There are topic-prominent languages that do not have a well-established subject relation (cf. Li & Thompson 1976), and there are languages in which the distinction between nouns and verbs, the typical categories suited for topics and comments, is less clear, if present at all (cf. Sasse 1991).

Granted that this scenario still does not tell us where truth values came from. But at least it provides a road map for the asymmetry that is essential for truth values. If the combination of two ideas α, β

leads to a truth value, and if the one idea is simple, then the other one must be conceived of as containing one element that does the combining and mapping to a truth value. As indicated above, the topic/comment structures can be seen as the source of predication.

The claim that there is no predication in animal communication might be questioned on the basis of the evidence for the suggestion of Hurford (2003) that a functional precursor or neurological equivalent of the predicate-argument structure might exist in the visual processing.[3] Researchers have long identified a dorsal stream that identifies the location of objects, corresponding to arguments (or more specifically, to argument variables, or deictically identified entities), and a ventral stream that identifies the qualities of objects, corresponding to predicates. While this structure might be a functional precursor of both predicate/argument structure and asymmetric bimanual communication, I would like to point out that the proposal here differs from Hurford (2003) insofar as it concerns communication, and not simple categorization. Communication is seen as an action that dynamically changes the information content of the common ground, just as manipulation is an active process that changes the properties of entities in the environment. Categorization, on the other hand, is a more passive in that it adjusts the information state of an individual to its environment.

Nevertheless, there is an obvious connection here: The way how the common ground is changed may reflect the predicate-argument structure rooted in more elementary features of categorization. In the hypothetical development of (17) we have assumed, with Hume, that it all starts with a symmetric association of ideas, like *Berries + Sweetness*. This may be wrong if one "idea" is deictically identified, as in *This is sweet*. A paraphrase like *Sweetness is this-ish* is impossible. Even the periphrase *Sweetness is berryish* is strange, as we normally use nouns in a deictic function.

2.5   Recursivity of topic/comment structure

The way how asymmetric bimanual action was characterized so far does not allow, in a straightforward way, for recursivity, as humans only have two hands for manipulation, with at most ancilliary functions assigned to the feet.[4]. Topic/comment-structure in communication is also typically non-recursive. For example, it has been observed that *wa*-marked NPs rarely occur in embedded clauses in Japanese. However, we do find cases that can be understood as recursive topic/comment structures, as in the following example:

(18) As for my siblings, my sister lives in Lithuania, and my brother lives in Armenia.

Here, *as for my siblings* constitutes the general topic, and *my sister* and *my brother* constitute subtopics. The comment to *as for my siblings* is the rest of the sentence, which itself consists of two topic/comment structures.

Such topic/comment structures and the way how they structure human discourse of have been investigated by a number of researchers, such as van Kuppevelt (1995), Roberts (1998) and Büring (1998, 2002). Typically, the topics in such cases are related to each other, e.g. the referent of *my sister* is a part of the referent of *my siblings*.

---

[3] Thanks to an anonymous reviewer for making me aware of this connection.

[4] As the anonymous reviewer points out, this is different with non-human primates.

While recursivity of topic/comment structures may not directly follow from manual action, it is evident that once it is established in communication, the general feature of human language of allowing for recursivity (cf. Hauser e.a. 2002) can affect topic/comment structures as well. In this sense, recursivity of topic/comment structures does not contradict the idea that it is originally derived from a non-recursive process.

3.   Bimanual Coordination in Human Action

3.1   The Evolution of Manual Laterality and Language

One of the striking features of human behavior is the differential use of the hands. In all current human populations, most people use their hands in distinct ways for a great number of tasks, like throwing stones, removing a tick, eating with a spoon, or writing with a pen. This has led us to speak of a dominant hand and a non-dominant hand. In all human populations, most people will prefer to use the right hand for such tasks, and this can even be reconstructed for much of human history (cf. Faurie & Raymond 2004, who give an overview and report results, in particular, of hand prints at paleolithic cave sites). Statistics about handedness are surprisingly unreliable because different tasks were considered; they vary between 5% and 20% of left-handers in given populations. There is a genetic factor involved that is still little understood, as monozygotic twins can exhibit different handedness (see Annett 2002, Corballis 2002, 2003 for genetic explanations).

For non-human primates there are reports about asymmetry in hand use, but it is considerably weaker, and there is ongoing debate about this issue. MacNeilage (1984, 1990) finds evidence for a successive development in primates: Prosimians have a left-hand preference for manual prehension, whereas the right hand is used for clinging to branches. There is no real bimanual coordination yet. Monkeys appear to have a weaker left-hand preference for grasping, and a right-hand preference for manipulation, presumably acquired because clinging to trees became less important and freed the right hand for other tasks to some degree. Apes show this tendency even more pronounced: The left hand tends to be used for prehension or other tasks that make strong visuospatial demands, whereas the right hand is preferred for manipulations like joystick-controlled computer games. Schaller (1963) reports that gorillas prefer the right hand to initiate chest-drumming, which functions as a dominance signal. Hopkins e.a. (2005) found that captive chimpanzees predominantly use the right hand in pointing to desired objects that they cannot reach without help by the eperimenter. But Palmer (2002) criticizes research on handedness in apes quite generally as inconclusive. In any case, it seems clear that the lateralization of hand use is considerably farther developed in humans than in non-human apes.

Manual lateralization has been related to the other well-known lateralization in humans, the location of speech in the brain. A causal link between these domains was suspected already by Broca in 1865, and is supported by various types of evidence. For example, Rasmussen and Milner (1977) have shown that left handedness is positively related to right-cerebral dominance for speech, and Knecht e.a. (2000) have shown that left cerebral activation during word generation is positively related to the degree of right-handedness. Manual lateralization has been implied in the evolution of language. Annett (2002) and McManus (2003) assume that the same genetic mutation is responsible both for handedness and brain lateralization, thus enabling the development of human language; also, MacNeilage e.a. (1984) consider manual lateralization a precursor of the brain lateralization necessary for the development of human language. Furthermore, there is evidence that the homologue of Broca's area in monkeys and apes (area F5) contains mirror neurons that are important for the perception and interpretation of manual actions and grasping, which Corballis (2002, 2003) took as evidence for a gestural language that predates spoken language in humans, an hypothesis previously advanced by Kendon (1991), Kimura (1993), Rizzolatti and Arbib (1998) and

McNeill (2005). In addition, there is evidence that the dominant hand is used more frequently when gesturing, in particular when gestures accompany speech (cf. Kimura 1973). This even holds for apes; see Vauclair (2004) for a recent overview of research results.

3.2 Asymmetric Bimanual Coordination

There is a general shortcoming in the traditional view of manual laterality, which assumes that one hand is doing the job and the other is just an appendix that is used for ancillary tasks in case a second hand seems useful. This view dismisses the differential function of the two hands in bimanual action. As a matter of fact, both hands have similarly important functions in many tasks. Even in the eight tasks used by Annett (1967) to determine handedness, five refer to acts like sweeping, striking a match, using scissors or threading a needle that crucially require an intricate coordination of the activities of both hands. Even for apparently monomanual tasks the non-dominant hand is important, for example in throwing an object, where it is crucial for balancing the body. The role of the non-dominant hand can also be seen in handwriting, perhaps the classical test for handedness. Athènes (1984) could show that the speed of handwriting reduces by 20% when subjects are instructed not to use the non-dominant hand for fixating and repositioning the paper on which they wrote.

Surprisingly, there are relatively few studies that investigate the importance of coordination of both hands. Perhaps the first one is the Frame/Content Model of MacNeilage, cf. MacNeilage e.a. (1984). According to this model, the non-dominant hand holds an object, and the dominant hand acts upon it. That is, the non-dominant hand provides the "frame" 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), and of syntax (frames) and words (contents). However, MacNeilage (1998) distances himself from this explanation. He argues that no conceivable adaptation regulating hand movements could have been transferred to the vocal system, and suggests instead that the opening and closing movement of the mouth was a precursor to syllable structure. While it is certainly possible to make a strong argument for mandibular motion related to CV (Consonant-Vowel) syllable structure, the frame/content structure relates to other levels of linguistic organization as well that are not directly related to the phonetic realization of language, such as the slot-and-filler structure in syntax and semantics. (In this structure, an intransitive verb like *snore* opens a slot for a subject, and a verb like *hit* opens two slots, one for the agent, and one for the patient). For structures of this sort the cyclic mandibular motion doesn't seem a more likely precursor than bimanual coordination as sketched above. This holds in particular as there is growing evidence that the supplementary motor area (SMA) close to Broca's area is involved both in the planning of hand movements and in speech production; also, as mentioned above, the physiological homologue of this area in the monkey brain, F5, contains neural networks relating to manual actions such as grasping and manipulating an object, as well as the corresponding mirror neurons (cf. Rizzolatti and Arbib 1998, Alario e.a. 2006).

A second study stressing the specifics of bimanual coordination is Guiard (1987). In his Kinematic Chain Model, he argues for a differential role of hands seen as "motors" that form a "kinematic chain", following three principles:

(a) Spatio-temporal reference of motion. The motion of the dominant hand typically finds its frame of reference[5] in the results of motion of the non-dominant hand. For example, the nondominant

---

[5] Note that this notion of reference is different from the one used before, of referring to an object.

hand fixes the position of an object, whereas the dominant hand manipulates it. Examples are threading a needle, positioning paper in writing, or handling the cue in billiard. Notice that these observations correspond to the frame/content model of MacNeilage.

(b) Spatio-temporal scale of motion. The non-dominant hand produces motions on a more coarse-grained scale in time and space, whereas motions of the dominant hand are quicker and more precise. Experimental evidence for this includes pointing, finger tapping and tracing of points with a cursor. This is consonant with the postural role of the non-dominant hand and the manipulative role of the dominant hand.

A particularly interesting example is playing the violin: In spite of the high additional demand on finger coordination, it is the nondominant hand that is used for holding the violin, thus providing a frame of reference for the bow held in the dominant hand, in addition to providing a frame of reference for its own fingers. This follows from (a). But the conventional way of holding a violin runs against (b), as the finger movements of the non-dominant hand are more rapid and more precise than the bow movements of the dominant hand. This might be tentatively interpreted by stating that frame issues are more important than issues of speed and precision, as far as hand alignment is concerned.

(c) 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. The non-dominant object first has to prehend the object before the dominant hand can start manipulating it. In addition, during the action, the non-dominant hand often repositions the object while the dominant hand pauses and gets into action only after the object is in the desired position.

Viewed in this way, bimanual coordination shows surprising similarity to topic/comment articulation, to which we turn in the next section.

4.   Bimanual Coordination and Topic/Comment Structuring

4.1   Similarities between Bimanual Coordination and Topic/Comment Structuring

It turns out that there are a number of similarities between topic/comment structuring and asymmetric bimanual coordination, as seen in the Frame/Content model or the Kinematic Chain model.

This is quite obvious for frame-setting topics and the Frame/Content model, whose very name captures this similarity. As we have seen, a frame-setting topic identifies a temporal, local or other frame, to which a statement is added that is supposed to hold in this frame, as discussed in example (2). This corresponds strikingly to the way in which the frame/content model viewed the interaction of the two hands, one providing a frame into which another adds content.

There is also a natural interpretation for aboutness topics from the viewpoint of the Kinematic Chain model. As we have seen, the aboutness topic "picks up" or identifies an entity that is typically present in the common ground of speaker or hearer, or whose existence is uncontroversially assumed. This corresponds to the preparatory, postural contribution of the non-dominant hand when it reaches out and "picks up" an object for later manipulation. The comment then adds information about the topic, which in turn corresponds to the manipulative action of the dominant hand. The file-card metaphor of Reinhart (1982) expresses this similarity nicely: The speaker, as it were, takes out the file card with the non-dominant hand, and writes down information on it with the dominant hand.

This description of topic selection and comment attribution is compatible with the fact that sometimes new information is added when selecting a topic, as in the following example:[6]

(19) A: Did I tell you about my new neighbour?
    B: Who is it?
    A: Well, she / the bastard is a professor of Oxford.

Choice of *she / the bastard* as topic expressions add new information, about the gender of the referent or the attitude of the speaker to the referent. However, this added information is clearly to be accomodated, and not part of the main message. For example, if B says: *No, that's not true*, then B denies that the referent is a professor of Oxford, not the gender or attitude information.

Beyond these general aspects of similarity, there are a number of more specific points. One concerns the temporal sequence of hand movements and topic/comment structures. As we have seen, the actions of the non-dominant hand typically precede the corresponding motions of the dominant hand in bimanual manipulations. This directly corresponds to the typical temporal order in which topic/comment-structures are serialized, with the topic being mentioned first, and then elaborated by the comment. A second point of similarity concerns the scale of motion. We have seen that the motions of the non-dominant hand are more coarse-grained, whereas the motions of the dominant hand tend to be on a more fine-grained scale, both spatially and temporally. In addition, the movements of the dominant hand are more frequent, and generally expend more energy. This is related to the realization of topic/comment structure, where the topic tends to be de-accented, and the comment typically bears more pronounced accents. Furthermore, notice that the prehension of an object by the non-dominant hand is, in a sense, static, as it does not affect the internal nature of the object. This is only done by the manipulation of the object by the dominant hand. Quite similarly, identifying a topic does not change the information state yet, but only prepares a change; the change itself is executed by the comment.

4.2   Hand Dominance in Sign Languages and Gesture

If there is a relation between hand dominance in bimanual action and topic/comment structure, we should expect to find evidence for it in sign languages, which use hands to communicate, and also in gestures that accompany spoken language. Unfortunately, only few studies in these two active fields of research have recorded the hand dominance of subjects, let alone have formed hypotheses about differential roles of the dominant and the non-dominant hand in communication.

For sign languages, Sandler (2005) summarizes findings about the differential role of dominant and non-dominant hand. The non-dominant hand appears to play a rather minor role in lexical representation. It is largely redundant, but plays a supporting role in a restricted number of handshapes. In particular, for bimanual signs it often forms a "place of articulation"; the dominant hand moves towards the non-dominant hand. This is very similar to what we find in manipulative bimanual coordination. The nondominant hand may also function as a classifier that signals the semantic class of a participant, for example in the combinations of the signs APPROACH (dominant hand: pointed finger) + PERSON (non-dominant hand: imitation of walking). Again, this can be related to the frame/content distinction, with the more general classifier providing for a frame. Furthermore, the non-dominant hand marks prosodic boundaries by the so-called hand spread that is quite similar to intonational phrasing in spoken languages.

---

[6] As suggested by the anonymous reviewer.

In addition to the functions mentioned above, the non-dominant hand is used to express discourse coherence. Gee and Kegl (1983) observe that a classifier signed by the non-dominant hand can be maintained while the dominant hand signs new information which is understood to be focused. Emmorey & Falgier (1999) describe such a case in American Sign Language in which a classifier is signed with the non-dominant hand as a kind of backgrounded discourse topic:

(20) My friend has a fancy car, a Porsche.
      [Sign: Classifier for car, non-dominant hand, kept throughout the following.]
      (She) drives up and parks. (She) enters a store, does errands, and when finished, she gets back to her car and zooms off. [Classifier signed with non-dominant hand moves away.]

Leeson & Saeed (2002) report related cases from Irish Sign Language, in which the topic sign is maintained by the non-dominant hand. Consider the following example, where nd and dh refers to the nondominant hand and the dominant hand, respectively.

(21) 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."

Liddell (2003) devotes a whole chapter to what he calls "buoys", signs produced by one hand that are kept constant, serving as conceptual landmarks while the other hand continues to sign. This includes signs that structure discourse, like the "list buoy" used to list a number of elements in a discourse sequence, a "theme buoy" by which the non-dominant hand identifies a topic of discourse, and a "pointer buoy" that points at objects that are of longer-lasting interest for a stretch of discourse and seem to be commented upon in the discourse. It is, not surprisingly, always the non-dominant hand that signs buoys.

Something quite similar has been reported for gesture accompanying spoken language by Enfield (2004). This article describes a gestural sequence called "symmetry-dominance" in the description of fish traps by Lao fishermen that may turn out to be much more widespread, if not universal. The sequence consists of two parts. In the first part, a bimanual symmetrical gesture describes the shape of an object (here, a particular type of fish trap). In the subsequent second part, one hand holds the position, representing topical information, and the other hand executes a new gesture that represents new or focal information, that is, the comment. Consider the following example for illustration:

(22)

HR (dominant)	HL (non-dominant)	Speech
Depicting trap move forward as if being placed.	= HR	'And (they) place it in the rice fields, also.'
fish swimming into trap	HOLD as previous	'Now, when a fish is going to go down (into it) … it goes in and is inserted there
fish coming out of trap, hold outside trap		'and it can't get back.'
fish going inside trap, with repeated movement of 'jamming', holding inside		'(It) goes in and gets jammed in there.'

trap		

The hand that holds the position quite evidently sets a frame in which the information that corresponds to the other hand has to be interpreted. Interestingly, it is always the non-dominant hand that keeps the position, and is associated with that frame-setting function.

It should be stressed that while there are highly relevant cases of asymmetric use of the hands in signing and gesturing, hands movements are very often symmetric, and often only one hand is used, especially if the other engages in other, non-communicative abilities. Hence effects of topic/comment structure on signing and gesture will be subtle, and carefully designed experiments will be necessary to establish or refute this association between gesture/signing and information structure. It might also be that information structure plays a role in symmetric gestures that correspond thetic utterances which cannot be differentiated in topic and comment parts, as in spontaneous expressions of joy, amazement, fear, defense, etc., which often appear to be symmetrical.[7]

4.3   Bimanual Coordination as a Preadaptation for Topic/Comment Structuring?

The similarities between asymmetric bimanual coordination and topic/comment structuring, and the different roles of the two hands in gesturing, suggest that the manual coordination typical for humans and perhaps higher primates may be a preadaptation that facilitated the development of topic/comment structure in communication. The basic idea is this: Humans and their immediate ancestors have acquired or refined, possibly over several millions of years, the ability to manipulate small objects by grasping and positioning them with the non-dominant hand, and modifying them with the dominant hand. Once established, this way of handling objects in the real world was the model of the treatment of objects in communication. Here again, topics were picked up freely, to be modified by comments.

This hypothesis is particularly plausible if one assumes a gestural predecessor of human language, as the same organs, the hands, would have been used both for object manipulation and for communication, and we have seen evidence for a differentiated role of the hands in gesturing and signing even today. That there is such evidence is encouraging, as few researchers have explicitly looked at the differential role of the hands in gesture and signing in relation to topic/comment structuring. Investigations aimed at this issue directly might very well unearth further phenomena that point towards a relation between handedness dominance and the manual expression of information structure.

It should be stressed that the hypothesis is not tied to the assumption of a gestural stage in the development of human language. We could also imagine that the way of manipulating objects had led to a particular way of conceptualizing objects as things that can be picked up, held constant, and modified, which then served as a model for communication.

As for the neurological part of the hypothesis, there is evidence that the precursor of (parts of) the Broca area was specialized for bimanual action, in particular the sequencing of actions (cf. references cited earlier, and McNeill 2005). Topic/comment structuring is a special case of

---

[7] Thanks to the anonymous reviewer who pointed this out.

sequencing, and so a general adaptation designed for the sequencing of manual actions might well have been adopted for this purpose. It would be interesting to find out whether, in addition to the sequencing function, there is evidence for special neural circuitry responsible for the differential use of the two hands in bimanual manipulations, which then might have been co-opted by the newly acquired tasks of the the Broca area, communication.

On a symbolic level, the similarities between bimanual coordination and topic/comment structuring are quite striking. Just as *homo habilis* can selectively pick up an object, position it appropriately, and modify it in various ways, *homo loquens* can selectively pick up a topic matter and modifying it by adding, changing or subtracting information about it. This is quite different from how most animals deal with the objects in their environment, and it is very different from how they communicate.

5. References

Alario, F.-Xavier et al. (2006), "The role of the supplementary motor area (SMA) in word production", *Brain Research* 1076, 129-143.

Annett, Marian (1967), "The binomial distribution of right, left and mixed handedness", *Quarterly Journal of Experimental Psychology* 327-333.

Annett, Marian. (2002). *Handedness and brain asymmetry. The Right Shift Theory*, Psychology Press, Sussex.

Athènes, S. (1984), Adaptabilite et developpement de la posture manuelle dans l'ecriture: Etude comparative du droitier et du gaucher, Unpublished memorandum, Université de Aix-Marseilles III.

Barwise, Jon & Robin Cooper (1981), "Generalized quantifiers and natural language", *Linguistics and Philosophy* 4, 159-219.

Büring, Daniel (1998), *The 59th Street Bridge Accent*, Routledge, London.

Büring, Daniel (2002), "On D-trees, beans, and B-accents", *Linguistics and Philosophy* 39-61.

Carlson, Greg N. (1977), "A unified analysis of the English bare plural", *Linguistics and Philosophy* 1, 413-456.

Chafe, Wallace L. (1976), "Givenness, contrastiveness, definiteness, subjects, topics and point of view", in Charles N. Li, *Subject and Topic*, Academic Press, New York, 27-55.

Corballis, Michael C. (2002), *From hand to mouth: The origins of language*, Princeton University Press, Princeton.

Corballis, Michael C. 2003. "From hand to mouth: Gesture, speech, and the evolution of right-handedness." *Behavioral & Brain Sciences* 26. 199-260.

Danes, Frantisek (1970), "One instance of the Prague school methodology: Functional analysis of utterance and text.", in P. Garvin (ed.), *One instance of the Prague school methodology: Functional analysis of utterance and text*, Mouton, Paris, The Hague.

De Cat, Cécile (2002), "Syntactic manifestations of very early pragmatic competence", in R. Bok-Bennema, B. Hollebrandse, Kampers-Manhe & P. Sleeman, *Romance languages and linguistic theory*, 17-32.

DuBois, John W. (1987), "The discourse basis of ergativity", *Language* 63, 805-855.

Emmorey, K. & B. Falgier (1999), "Talking about space with space: Describing environments in ASL.", in E.A. Winston, *Story telling and conversations: Discourse in deaf communities*, Washington D.C, Gallaudet University Press, 3-26.

Enfield, Nick J. (2004), "On linear segmentation and combinatorics in co-speech gesture: A symmetry-dominance construction in Lao fish trap descriptions", *Semiotica* 149, 57-123.

Faurie, Charlotte & Michel Raymond (2004), "Handedness frequency over more than ten thousand years", *Proc. R. Soc.Lond. B (Suppl)* 271. 43-45.

Firbas, Jan (1964), "On defining the theme in functional sentence analysis", *Traveaux Linguistique de Prague* 1, 267-280.

Frege, Gottlob (1892), "Über Sinn und Bedeutung", *Zeitschrift für Philosophie und philosophische Kritik, NF* 100. 25-50.

Frey, Werner (2000), "A medial topic position for German", *Linguistische Berichte*

Gee, James Paul & Judy Kegl (1983), "Narrative/story structure, pausing, and American Sign Language", *Discourse Processes* 6, 243-258.

Givon, T. (ed.) (1985), *Topic Continuity in Discourse: a Quantitative Cross-Language Study*, John Benjamins, Amsterdam, Philadelphia.

Goldenberg, G. (1988), "Subject and predicate in Arab grammatical tradition", *Zeitschrift der deutschen morgenländischen Gesellschaft* 138, 39-73.

Guiard, Yves. (1987). "Asymmetric division of labor in human skilled bimanual action: The kinematic chain as a model." *Journal of Motor Behavior* 19, 486-517.

Gundel, Jeanette K. 1988. "Universals of topic-comment structure." *Studies in Syntactic Typology*. Eds. Hammond, Michael Edith Moravcsik, Jessica Wirth. John Benjamins, Amsterdam, 209-239.

Halliday, M. A. K. (1967), "Notes on transitivity and theme in English, Part 2", *Journal of Linguistics* 3, 199-244.

Hauser, Marc D., Noam Chomsky & W. Tecumseh Fitch (2002), "The faculty of language: What is it, who has it, and how did it evolve?", *Science* 298, 1569-1579.

Heim, Irene (1983), "File change semantics and the familiarity theory of definiteness", *File change semantics and the familiarity theory of definiteness*, Walter de Gruyter, Berlin, 164-190.

Hockett, Charles (1958), "Two models of grammatical description". *Readings in Linguistics*, University of Chicago Press, Chicago.

Hopkins, William D. et al. (2005). "The distribution and development of handedness for manual gestures in captive chimpanzees (Pan troglodytes)." Psychological Science 16. 487-493.

Hurford, James. (2003), "The neural basis of predicate-argument structure", *Behavioral and Brain Sciences* 26: 261-283.

Jacobs, Joachim (1984), "Funktionale Satzperspektive und Illokutionssemantik", *Funktionale Satzperspektive und Illokutionssemantik*, 25-58.

Jacobs, Joachim (1996), "Bemerkungen zur I-Topikalisierung", *Sprache und Pragmatik* 41, 1-48.

Jacobs, Joachim (2001), "The dimensions of topic-comment", *Linguistics* 39, 641-681.

Jäger, Gerhard. (1996). *Topics in Dynamic Semantics*. Ph.D. thesis, Humboldt University Berlin. CIS-Bericht 96-92, Centrum für Informations- und Sprachverarbeitung, Universität München.

Kamp, Hans. (1981). "A theory of truth and semantic representation." *Formal Methods in the Study of Language*. Eds. Groenendijk, J.A.G. T.M.V. Janssen, M.B.J. Stokhof. Amsterdam: Mathematical Centre Tracts 135. 277-322.

Kendon, Adam (1991), "Some considerations for a theory of language origins", *Man* 26, 188-221.

Kimura, Doreen (1973), "Manual activity during speaking. I. Right-handers.", *Neuropsychologia* 11. 45-50.

Kimura, Doreen (1993), *Neuromotor mechanisms in human communication*, Oxford University Press. Oxford.

Knecht, S. e.a. (2000). "Handedness and hemispheric language dominance in healthy humans." Brain 123. 2512-2518.

Krifka, Manfred et al. (1995), "Genericity: an introduction", in Greg N. Carlson & F. J. Pelletier, *The generic book*, Chicago, London, The University of Chicago Press, 1-124.

Kuroda, S.-Y. (1972), "The categorical and the thetic judgment, Evidence from Japanese syntax", *Foundations of Language* 153-185.

Lambrecht, Knud (1994), *Information structure and sentence form. Topic, focus, and the mental representation of discourse referents*, Cambridge University Press, Cambridge.

Lambrecht, Knud (2001), "Dislocation", in Martin Haspelmath, Ekkehard König, Wulf Österreicher, & Wolfgang Raible, *Language typology and language universals Vol. 2*, Berlin, Mouton de Gruyter.

Leeson, Lorraine, and John I. Saeed. (2002). "Windowing of attention in simultaneous constructions in Irish Sign Language (ISL)". *High Deserts Linguistic Society* 5, Ed. Cameron, Terry. University of New Mexico, Albuquerque.

Li, Charles & Sandra Thompson (1981), *Mandarin Chinese: A functional reference grammar*, University of California Press, Berkeley.

Li, Charles N. (ed), *Subject and Topic*, Academic Press, New York.

Li, Charles N. & Sandra A. Thompson. (1976). "Subject and Topic: A new typology of language", in Ch. Li (ed.), *Subject and Topic*, Academic Press, New York.

Lidell, Scott K. (2003), *Grammar, Gesture, and Meaning in American Sign Language*, Cambridge University Press, Cambridge.

Löbner, Sebastian (2000), "Polarity in natural language: predication, quantification and negation in particular and characterizing sentences", *Linguistics and Philosophy* 23, 213-308.

MacNeilage, Peter F. (1986). "Bimanual coordination and the beginnings of speech." Eds. Lindblom, Björn & Rolf Zetterstrom, Precursors of Early Speech, New York: Stockton Press.

MacNeilage, Peter F. (1990). *Grasping in modern primates: The evolutionary context.*   Norwood: Ablex.

MacNeilage, Peter F. (1998), "The frame/content theory of evolution of speech production", *Behavioral and Brain Sciences* 21, 499-546.

MacNeilage, Peter F. et al. (1984). "Functional precursors to language and its lateralization." *American Journal of Physiology (Regulatory, Integrative and Comparative Physiology)* 15, 912-914.

Marty, Anton (1884), "Über subjektslose Sätze und das Verhältnis der Grammatik zu Logik und Psychologie", *Vierteljahresschrift für wissenschaftliche Philosophie.*

McManus, Chris. (2003). *Right hand, left hand. The origins of asymmetry in brains, bodies, atoms and cultures.* Phoenix House.

McNeill, David (2005), *Gesture and thought*, University of Chicago Press, Chicago.

Molnár, Valéria (1998), "Topic in focus", *Acta Linguistica Hungarica* 45, 89-166.

Nehaniv, Chrystopher L. (2000). "The making of meaning in societies: Semiotic & information-theoretic background to the evolution of communication." Society for the Study of Artificial Intelligence and Adaptive Behavior. 73-84.

Nehaniv, Chrystopher L. (2005), "Open problems in the emergence of evolution of linguistic communication: A road map for research", *Proc. Second International Symposium on the Emergence and Evolution of Linguistic Communication,* 86-93.

Palmer, A. Richard. (2002). "Chimpanzee Right-Handedness reconsidered: Evaluating the evidence with funnel plots." *American Journal of Physical Anthropology* 118, 191-199.

Partee, Barbara H. (1991), "Topic, focus and quantification", in St. Moore & A.Z. Wyner, *Proceedings of SALT I*, Cornell, 159-188.

Paul, Hermann (1880), *Prinzipien der Sprachgeschichte*, Leizpig.

Portner, Paul & Katsuhiko Yabushita (1998), "The semantics and pragmatics of topic phrases", *Linguistics and Philosophy* 21, 117-157.

Rasmussen, t. & B Milner. (1977). "The role of early left-brain injury in determining lateralization of speech functions." *Annals of the New York Academy of Sciences* 299, 355-369.

Reinhart, Tanya (1982), *Pragmatics and linguistics: An analysis of sentence topics*, Indiana University Linguistics Club, Bloomington, Indiana.

Rizzolatti, Giacomo & Michael Arbib (1998), "Language within our grasp", *Trends in Neuroscience* 21, 188-194.

Roberts, Craige (1998), "Focus, the flow of information, and universal grammar", in Peter W. Culicover & Louise McNally, *Syntax and semantics. The limits of syntax(29)*, San Diego, London, Boston, Academic Press, 109-160.

Sandler, Wendy. (2005). "Phonology, phonetics and the nondominant hand." *LabPhon* 8. See also http://www.ling.yale.edu:16080/labphon8/Talk_Abstracts/Sandler.html

Sasse, Hans-Jürgen (1987). "The thetic/categorical distinction revisited", *Linguistics*, 511-580.

Sasse, Hans-Jürgen (1991), "Predication and sentence constitution in universal perspective", in Dietmar Zaefferer (ed.), *Semantic universals and universal semantics*, Berlin / New York, Foris. 75-95.

Sgall, Peter, Eva Hajicová & Jarmila Panevová (1986), *The meaning of the sentence in its semantic and pragmatic aspects*, Reidel, Dordrecht.

Stalnaker, Robert (1974), "Pragmatic presuppositions", in Milton K. Munitz & Peter K. Unger, *Semantics and Philosophy*, New York, New York University Press, 197-214.

Strawson, Peter (1964). "Identifying reference and truth value". In D. Steinberg & A. Jakobovitz (eds.), *Semantics. An interdisciplinary reader*. Cambridge University Press.

Struhsaker, T.T. (1967), "Auditory communication among vervet monkeys (*Cercopithecus aethiopis*).", in S. A. Altmann, *Social communication among primates*, Chicago, Chicago University Press. 281-324.

Szabolcsi, Anna (1997), "Strategies for scope taking", in Anna Szabolcsi, *Ways of scope taking*, Dordrecht, Kluwer, 109-154.

Tomasello, Michael & Zuberbühler. 2002. "Primate Vocal and Gestural Communication." Eds. Bekoff, Marc Colin Allen, Gordon M. Burhgardt, *The Cognitive Animal,* MIT Press, Cambridge, Mass.

Tomasello, Michael (2003), "The pragmatics of primate communication", in Jef Verschueren, *Handbook of pragmatics*, Amsterdam, John Benjamins.

Van Kuppevelt, Jan (1995), "Discourse structure, topicality, and questioning", *Journal of Linguistics* 31, 109-147.

Vauclair, Jacques (2004), "Lateralization of communicative signals in nonhuman primates and the hypothesis of the gestural origin of language", *Interaction Studies* 5, 365-386.

von der Gabelentz, Georg. (1869). "Ideen zu einer vergleichenden Syntax." *Zeitschrift fur Völkerpsychologie und Sprachwissenschaft* 6, 376-384.

Weil, Henri (1844), *De l''ordre des mots dans les langues anciennes comparées aux langues modernes*, Joubert, Paris. Translated by Ch. W. Super, *The order of words an the ancient languages campared with that of the modern languages.* 1978, Amsterdam, John Benjamins

Wilson, Frank. (1998). *The Hand. How its use shapes the brain, language, and human culture.* Pantheon Books.