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Preface

In 1956, a small research group on structural linguistics was established at the Academy of Sciences of the former GDR. Within a few years, and in spite of many practical and political problems, the *Arbeitsstelle 'Strukturelle Grammatik'* gained an international reputation, and some of its publications, such as Manfred Bierwisch's *Grammatik des deutschen Verbs*, became paradigmatic for the grammatical analysis of German. Political pressure increased toward the end of the sixties, and in 1973 the *Arbeitsstelle* was closed by the authorities. When the Max Planck Society decided last year to set up, as a part of our Institute and under the direction of Manfred Bierwisch, a linguistic research group in Berlin, it was only natural to call it *Arbeitsgruppe 'Strukturelle Grammatik'*. This does not imply a total return to the research topics of the *Arbeitsstelle*; linguistics has changed since, and this will be reflected in the work program of the new *Arbeitsgruppe*, which will have a strong orientation toward cognitive linguistics. A first report will be given in the next Annual Report.

In August 1991, the Cognitive Anthropology Research Group started its work under the direction of Stephen Levinson. Since this group is independent of the Institute in its research program but integrated with it technically and administratively, we have decided to present its work in a separate chapter of this Annual Report (Chapter 5), but to consolidate information about its personnel, publications, etc. with that of the Institute (cf. Section "Organization" and Chapter 6, where Group members are marked with an asterisk). As

in preceding years, the research report of the Institute in the narrower sense is divided into four sections, reflecting the four long-term administrative groups: Language Production, Language Comprehension, Language Acquisition, and Language Disorders. It should be kept in mind, however, that research concentrates on a number of Institute Projects that cut across group boundaries. At present, these projects are:

- Lexical access in language production
- Computational modeling of the mental lexicon
- Neurocognition of language processing
- Reference to space and time
- The acquisition of syntax
- The acquisition of phonology
- The role of input in second language acquisition
- Aphasia in adults

This dual organization raises certain problems of presentation. In particular, we have chosen to include the entire project "Reference to space and time" in the chapter on language acquisition, even though only part of the project deals with acquisition. Other linguistic research related to work done by acquisition group members is also contained in this chapter.

Wolfgang Klein

Organization of the Institute and the Cognitive Anthropology Research Group* in 1991

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Secretarial Staff of the Cognitive Anthropology Research Group:

- *E. Sjoerdsma, head
- *N. v. Eenennaam
- *G. de Groen (software assistant)

Research in Progress

1. Language Production

Research on adult language production is represented in three of the Institute's projects this year: Lexical Access, Neurocognition of Language Processing, and Reference. The Lexical Access Project is mainly concerned with the selection of lexical elements, the retrieval of phonological forms, the computation of phonetic shape, and the timing of connected speech. The production work within the project Neurocognition of Language Processing is concerned with pupil dilation measures as indicators of attentional effort during speech planning. This chapter summarizes the research of the Lexical Access Group, the production work of the project Neurocognition of Language Processing, and work on adult language production not directly linked to any of the Institute projects. The Reference Project, which includes production work on the expression of spatial and temporal concepts, is summarized in Chapter 3.

1.1 Lexical access in production

A word's representation in the speaker's mental lexicon involves three aspects: its meaning, its syntax, and its form. In the Lexical Access Group a model is being developed that captures these three aspects. It is a network model with three strata. The top, conceptual stratum represents the senses of words. For each word there is a lexical concept node; its sense is comprised of the network of labeled semantic relations between that node and other concept nodes. The second, syntactic stratum represents the syntactic properties of words. At

this level a word is represented by a so-called “lemma” node, with labeled connections to nodes that represent syntactic category, gender, etc. For every lexical concept node there is one lemma node and vice versa. The bottom, sound-form stratum represents the phonological properties of words. At this level a word is represented by a so-called “lexeme” node. A word’s phonological properties, such as its segmental composition, are represented by a network of relations between the lexeme node and segment nodes, metrical nodes, etc. Each lemma node is connected to one lexeme node, but the reverse does not necessarily hold. Homophones have two lemma nodes connected to one lexeme node.

These levels of lexical representation and the flow of information between them have been topics of study in the Lexical Access Project. In addition, several members of the project (M. Bierwisch, W. Levelt, A. Meyer, A. Roelofs (MPI and U. Nijmegen)) were involved in the preparation of a special issue of *Cognition* (1992) on lexical access in speech production, edited by Levelt. Here are some of the project’s results.

1.1.1 The conceptual level: The semantic category effect

It has long been known, especially through the work of Judy Kroll, that it takes longer to name a target picture when it is preceded by pictures of objects from the same semantic category than when it is preceded by pictures from different categories. J. Jescheniak ran a series of experiments to locate this so-called semantic category effect in the above stratification. First he replicated Kroll’s findings in a picture naming task with two conditions. In the homogeneous condition, subjects named pictures from the same semantic category, e.g., they encountered a block of fruit pictures followed by a block of

tool pictures and so on. In the heterogeneous condition, the same pictures were rearranged in mixed blocks composed of pictures from different categories. As expected, naming latencies were longer in the homogeneous than in the heterogeneous condition. To determine the level at which this effect arises, Jescheniak ran two further experiments. In one, subjects performed a gender decision task for the same pictures and conditions. (Dutch has two genders; subjects responded by pushing one of two buttons.) This task involves lemma access, but not phonological access. The semantic category effect remained, which shows that it does not arise at the level of phonological encoding. In a further experiment, subjects performed a matching task in which they judged whether objects shown in two successive pictures – e.g., two different types of airplanes – were instances of the same concept. This is presumably a task entirely at the conceptual level, i.e., it does not involve lemma access. The semantic category effect remained, showing that it does not involve the lemma level. The obvious explanation is that there is spreading of activation among the conceptual nodes of members of the same category. This, in turn, diminishes the ratio of activation between the target node and the response alternatives, which slows down the response.

In the same set of experiments a word-frequency variable was introduced. This variable influenced naming latencies but not gender decision latencies. This supports the notion that the word-frequency effect in production (frequent words are produced faster than infrequent ones) originates at the third stratum, i.e., the level of phonological encoding. A new set of experiments has been designed by Jescheniak and Levelt to further investigate this issue.

1.1.2 Selecting lemmas

According to Roelofs' theory of lexical selection (see Annual Report 1990), the probability of selecting a particular lemma at any moment is the ratio of the lemma's activation and the total activation of all lemmas involved (i.e., the Luce ratio). With this rule, and a precise definition of the conceptual and syntactic strata of the lexical network, Roelofs was able to predict not only some of the critical picture-naming latency data in the literature but also the naming latencies obtained in experiments of his own.

Like almost all previous work on picture naming, these results involved speakers' production of nouns. To further corroborate his non-decompositional theory of lexical access, Roelofs investigated whether the theory could be generalized to verbs, again utilizing the picture-word interference paradigm. Subjects had to name pictured actions with verbs, ignoring written distractor verbs superimposed on the pictures. According to the theory, semantic inhibition should be obtained for distractor verbs that are the names of other actions pictured in the experiment. For example, it should take longer to say *laugh* for a laughing person if the distractor is *cry* than if it is *sing*, if actions of crying and singing also have to be named. By contrast, semantic facilitation should be obtained if hyponyms of the picture names are used as distractors. For example, it should take less time to say *laugh* if the distractor is *chuckle* than if it is *yodel*. Both predictions were empirically confirmed.

Whereas these findings support the non-decompositional theory, they are problematic for a number of decompositional theories. In particular, decompositional theories that try to resolve the hyperonym problem (see Annual Report 1990) by positing an inhibitory channel in the mental lexicon between

a hyponym (*chuckle*) and its hyperonyms (*laugh*, etc.) would have predicted semantic inhibition by the hyponym distractors, but facilitation in fact was found.

1.1.3 TOT states: Evidence for facilitation or for inhibition among word forms?

A tip-of-the-tongue (TOT) state (i.e., the feeling of knowing a word without being able to retrieve its form) may represent either the momentary inhibition of an otherwise accessible word form or the weak activation of an otherwise inaccessible word form. A. Meyer and K. Bock (U. Illinois) carried out three experiments to discriminate between these alternatives. Subjects were presented with definitions of infrequent words (e.g., *medieval forerunner of chemistry* for the target *alchemy*). The definitions were accompanied by cues that were related to the targets in meaning, sound, or neither. Meyer and Bock recorded how often subjects correctly retrieved the targets, and how often they experienced tip-of-the-tongue states. In two experiments, they found that related cues facilitated lexical retrieval more than unrelated cues, and that sound cues were more effective than meaning cues. This goes against a previous conclusion by Jones (1989, *Memory and Cognition*, 17), who found inhibitory effects of related cues. In a third experiment, Meyer and Bock showed that the data on which Jones' conclusion was based came from a small group of unusually difficult target definitions. Meyer and Bock's results are more consistent with a facilitatory view of lexical retrieval, according to which word forms are selected when they have accrued more activation than alternative forms, than with an inhibitory view, according to which highly activated word forms are selected only when they have also suppressed their competitors.

1.1.4 Phonological encoding

Are segments labeled for syllable position?

Speech error analyses and experimental findings (e.g., Meyer, 1991; Meyer & Schriefers, 1991) have shown that word forms are not retrieved from the mental lexicon as units, but are built out of phonological segments and perhaps certain segment sequences. To insure the correct ordering of segments within syllables, many models of phonological encoding postulate that at the phonological stratum of the mental lexicon most consonants have two distinct representations: one for their appearance in the syllable onset and another for their appearance in the coda. This assumption is supported by the so-called syllable-position constraint in speech errors: the tendency for displaced segments to move from their target positions to corresponding positions in new syllables (typically from one syllable onset to another) rather than to different positions. To test whether there are separate representations of onset and coda consonants, A. Meyer and S. van Coillie (U. Nijmegen) carried out a series of picture-word interference experiments. Subjects named pictures while hearing distractor words that were either unrelated to the corresponding targets or phonologically related in specific ways. In the related conditions, distractor and target shared one consonant that appeared either in the same position in both words (as in the distractor-target pairs pen-pot and hat-pot) or in different positions (as in tan-pot and cap-pot). If onset and coda consonants are independent units in the mental lexicon, there should be a priming effect (i.e., shorter reaction times in the related than in the unrelated condition) when the shared segment appears in the same position in distractor and target, but not when it appears in different positions. In fact, however, priming

effects were obtained in all related conditions. This suggests that each consonant has only one representation, which is used in both syllable positions. Earlier results from tongue twister experiments point in the same direction (see Annual Report 1988).

During his stay at the Institute, T. Berg (U. Oldenburg) began to analyse a corpus of Arabic slips of the tongue collected by Hassan Abd-El-Jawad and others in Jordan and Saudi Arabia. The most exciting result is that the syllable-position constraint observed in English and German speech error corpora is not obeyed in the Arabic corpus. Errors respecting this constraint occur at chance level. What almost exclusively determines the interaction of phonological segments is their linear distance: the closer together they are, the more likely they are to interact. This finding suggests that the segment serialization strategy in Arabic is quite unlike the hierarchical strategy typically assumed for Indo-European languages.

Phoneme production monitoring

Evidence from phoneme monitoring experiments in speech perception suggests that the latency to respond to a target is determined by a race between two processes: bottom-up phoneme detection based on analysis of the incoming speech stream and top-down phoneme inference based on stored knowledge of a word's sound form (e.g., Frauenfelder, Segui, & Dijkstra, 1990, *Journal of Experimental Psychology: Human Perception and Performance*, 16). It has further been suggested that stored knowledge becomes available only after a word has been uniquely selected. Similarly, Levelt et al. (1991) have argued that during speech production only

selected (not merely activated) lemmas trigger phonological spellout. The motivating idea for the research to be described is that phoneme inference in speech perception might be based on phonological spellout, and that the time course of this process might therefore be traced through use of a monitoring task in production.

Levelt and L. Wheeldon devised a translation task to elicit words from subjects. The subjects' task was to listen to an English word, silently translate it into Dutch, and monitor the Dutch word for a prespecified target phoneme. The first experiment was designed to replicate the finding that a word's constituent phonemes are made available "from left to right" (Meyer, 1990, *Journal of Memory and Language*, 29; Meyer, 1991). Phoneme targets occurred either word initially or second-syllable initially, and each target occurred in each syllable position matched for stress (e.g., /t/ and /k/ in *toekomst* (future) and *kantoor* (office)). A strong left-to-right-effect was observed, with faster monitoring latencies for word-initial targets than for second-syllable-initial targets. It is possible, however, that subjects' responses were based not on an internal representation of the Dutch word's constituent phonemes but on subvocal articulation of the word. To rule out this possibility, the experiment was repeated with a concurrent articulatory suppression task. Subjects were required to count quietly but audibly from one, starting before they heard the English word and finishing after they had responded. While both error rates and latencies increased significantly, error rates were less than 10% and the pattern of results was the same as in the previous experiment. Hence, subjects' responses were clearly based on some internal representation of word form rather than on overt speech. Current experimentation exploits the monitoring task to examine phoneme retrieval

within syllables and to test for sensitivity to syllable structure during retrieval.

Do speakers have a mental syllabary?

As phonological segments are spelled out “from left to right”, speakers group them into phonological syllables according to universal and language-specific rules. The domain of such syllabification is the phonological word (not the lexical word). (Phonological words have one main stress but may consist of more than one lexical word; for example, *have it* is normally produced as one phonological word, [hævɪt].) Phonological syllables may be access codes to a mental syllabary, where for each phonological syllable there is a detailed phonetic specification, i.e., a description of the articulatory gestures that will generate the target syllable. In last year’s Annual Report Levelt and Wheeldon reported some evidence for the existence of an independent syllabary. The time taken to produce a word is affected not only by its frequency of occurrence but also by the frequency of occurrence of its constituent syllables, and the effects of word frequency and syllable frequency are additive. The original experiment tested two-syllable words. While these words were matched as closely as possible for number of phonemes, there were some differences in syllable structure between words with low and high syllable frequencies. In particular, words with low frequency syllables tended to have more complex second syllables than words with high frequency syllables. A further experiment looked for possible effects of second syllable complexity on production latencies, using word pairs matched for word and syllable frequency (e.g., *ge-mis* (lack) vs. *ge-schreeuw* (shouting)). No effect of complexity was observed. It is thus the frequency rather than the complexity of a word’s first syllable that matters in naming

latency. Further experiments on the syllable frequency effect are under way.

Metrical planning within words

From the speech error literature there is evidence that a word's metrical structure is spelled out independently of its segmental structure. Levelt's present view is that a word's stored metrical structure consists of information about the number of syllables or sonoric peaks, as well as its organization into feet (the heads of which bear accents). This metrical information is essential for the composition of phonological words (over which syllabification takes place). The speech error evidence with respect to segmental spellout has been confirmed and extended by segmental priming experiments (see above). But the process of metrical planning has never been subjected to a priming approach. P. Meyer and Levelt set out to test whether a word's metrical structure is stored in the lexicon and whether this structure is retrieved independently from segmental information. The picture-word interference paradigm, in which subjects named pictures while hearing words, was again used. Some acoustic distractors shared both word onset and metrical structure with the picture names (double similarity distractors), some only word onset (onset distractors), some only metrical structure (metrical distractors), and some neither property (unrelated distractors). The stimulus onset asynchrony (SOA) of word and picture was varied, such that the word onset preceded the picture onset (early SOAs), coincided with it, or followed it (late SOAs).

In the first experiment, only disyllables were used and metrical structure similarity between picture name and distractor was defined as having lexical stress on the same syllable. Only double similarity distractors facilitated the naming of

the pictures. Distractors that resembled the target on only one dimension (onset or metrical structure) did not differ from unrelated distractors in their effect on naming latency. Approximately the same pattern of results was obtained at all SOAs.

In a further experiment, metrical structure was defined in terms of the number of syllables (lexical stress was not varied). For instance, in the double similarity condition the distractor had the same word onset and same number of syllables as the target, while in the unrelated condition the distractor and target differed in word onset and number of syllables. On the early SOAs, double similarity distractors yielded faster reactions than onset distractors, while on the later SOAs, double similarity distractors yielded faster reactions than metrical distractors. Compared to unrelated distractors, onset distractors inhibited naming on the early SOAs but facilitated it on the late SOAs.

The results of these experiments support the following theoretical notion. Metrical structures of words are stored in the lexicon and are retrieved independently of segmental information about words. The metrical structures are grouped into phonological words. As segments are retrieved, they are associated to these metrical structures of phonological words. The results of the second experiment show that metrical retrieval slightly precedes segmental spellout. Hence, metrical priming will have an effect on naming latency only when the slowest process, segmental spellout, is also primed. And that is what was found in the first experiment.

Metrical planning between words

A. Meyer, together with M. Baumann (U. Cologne), continued her research on how speakers plan the metrical structure

of utterances (see Annual Report 1990). Selkirk (*Phonology and syntax*, 1984) and others have proposed that the stress pattern and timing of a sentence should be represented in a metrical grid. In such a grid, one abstract timing unit (a so-called demi-beat) is assigned to each unstressed syllable; two demi-beats are given to stressed syllables, and extra demi-beats are allotted to syllables at the end of a phonological word, phrase, or utterance. Ferreira (in prep.) has suggested that at a given speech rate each demi-beat corresponds to a fixed length of time. The number of demi-beats assigned to a given syllable thus determines its "slot" – the time period associated with the syllable itself plus any following pause. Since, according to Ferreira, the duration of a slot depends only on a syllable's position in the prosodic structure and not on its segmental content, short syllables should be followed by longer pauses than long syllables. This prediction was confirmed in Ferreira's experiments with speakers of American English. In contrast, in experiments with Dutch and German speakers, Meyer and Baumann found that a syllable's slot depended on *both* its segmental content and its position. Slots for syllables beginning with phonetically long consonants were longer than slots for syllables beginning with short consonants, and slots for syllables with long vowels were longer than slots for syllables with short vowels. In both cases, pauses following long and short syllables were equal in length. However, when syllable length was varied by using different types of coda consonants (stops vs. nasals), short syllables were followed by longer pauses than long syllables. Thus, pause durations were apparently adjusted to compensate for variations in the duration not of the entire syllable, but only of the coda. Further experiments are needed to determine why Ferreira's findings were not replicated, and to derive a model of how speakers

plan the durations of words and pauses.

Comparing lexical access in production and comprehension

A. Meyer and P. Zwitserlood, together with M. van Turenout (U. Leiden), investigated similarities and differences in language production and comprehension at the level of representation of phonological forms. In production experiments carried out by Meyer and Schriefers (1991), subjects named target pictures while hearing distractor words that were related to the targets in form (as in the distractor-target pair *stoep-stoel* (sidewalk-chair)) or unrelated (as in *kat-stoel* (cat-chair)). Provided that the distractor and target presentation were appropriately timed, naming was faster in the related than in the unrelated condition. The materials from these experiments were adapted for use in a series of comprehension experiments. Instead of pictures, subjects saw written words, either to be named aloud or for lexical decision. In neither of these tasks were reliable differences obtained between the conditions with related and unrelated distractors. In a second comprehension experiment, a new variable was introduced: the presence or absence of mismatching information between distractor and target. In Meyer and Schriefers' production experiments and in the comprehension experiment just described, related distractors and targets matched in certain segments and mismatched in others. In the second comprehension experiment, in contrast, subjects heard either related distractors that included both matching and mismatching information (as in *stoep-stoel*) or word fragments that included only matching but no mismatching information (as in *stoe-stoel*). Unrelated words and fragments served as control stimuli. In this experiment, facilitatory effects were obtained

from related distractors, but only in the condition using word fragments. Further experiments are needed to determine why mismatching information in related distractors affects the production and comprehension of words differently.

1.2 Pupillometry and language production

B. Hoeks, A. Haasen, and W. Levelt are exploring whether measures of pupil size can be used to assess attentional effort during language production. In one experiment, subjects were asked to name the size, the shape, or both the size and the shape of visually presented figures, or simply to say “yes” as soon as they saw a figure. Pupil dilation was measured and used to calculate the attentional effort in each experimental condition. The least effort was measured in the condition using the simplest (“yes”) task, and the most in the condition using the most complex task (naming size and shape of the figure). Naming the shape of the figures involved more effort than naming their size. In another experiment these findings were corroborated by measurements of the subjects’ response latencies under the same conditions.

1.3 Subject-verb agreement

H. Schriefers (F.U. Berlin), A. Friederici, and K. Bock (U. Illinois) conducted research on number agreement between subject and verb in German. Their experiments were based on previous experiments by Bock on agreement in English, in which subjects were asked to repeat short phrases they had just heard and to add to them in order to form full sentences. Bock’s work showed that phrases like *the baby on the blankets*, in which the two nouns do not agree in number, elicit signif-

icantly more agreement errors (e.g., *the baby on the blankets were...*) than do phrases like *the baby on the blanket*, in which the two nouns agree. Similar errors in German may indicate whether people mistake the noun directly preceding the verb (e.g., *blankets*) for the subject. The experiments were specifically designed to explore the role of subject-marking (nominative) morphology. In German, a plural noun following a preposition that governs the accusative case (as in 1 below) has the same article and inflection as the nominative plural form of all nouns. In contrast, a plural noun following a preposition that governs the dative case (as in 2) has a different article and inflection.

- (1) der Brief an die Mütter
(the letter to the mothers)
- (2) der Brief von den Müttern
(the letter from the mothers)

Phrases like (1) elicited more agreement errors (i.e., plural verb forms in the completion of the sentence) than phrases like (2). Agreement errors were also more frequent when the singular subject noun was feminine than when it was masculine or neuter. The article of a feminine subject noun (*die*) is the same as the nominative plural article used for all genders, whereas the article of a masculine or neuter noun (*der* and *das*, respectively) is different from the nominative plural. The results suggest that agreement errors in German are promoted by a combination of two factors: the presence of an accusative plural noun in the prepositional phrase with the same form as a nominative plural, and the presence of an article for the singular subject noun that is also a potential plural article. The implication is that spurious nominative morphology enhances the likelihood of errors.

1.4 Language use

During his sabbatical year at the Institute, H. Clark (Stanford U.) continued work on a monograph on language use. The idea is that language use is a joint activity engaged in by two or more people. The participants in a conversation – or any discourse – have to work closely together in order to coordinate not only what they say and do but also the processes by which they achieve this. The goal of language use, ultimately, is to complete certain joint actions. The principles Clark proposes are based on theories of coordination, convention, joint action, completed action, and shared information. These principles account for aspects of speaking and listening from the level of segments and timing to the level of discourse organization.

Clark also prepared for publication a collection of his previous papers on common ground, collaborative processes, audience design, and coordination of meaning in language use. As part of that collection, he wrote a new chapter with E. Schaefer on dealing with overhearers. Clark and Schaefer argue that speakers design their utterances differently depending on what they want overhearers to understand. By their choice of design, they can disclose, conceal, or disguise what they are saying, or merely be indifferent. The logic for the design of their utterances changes radically with each different attitude, and speakers exploit these different attitudes for a variety of purposes. Clark and Schaefer argue, then, that formulating utterances requires speakers to take into account not only their addressees and what they know, but also any overhearers and what they know.

1.5 “Arithmetic” errors

During his stay at the Institute, D. Vorberg (T.U. Braunschweig) analyzed a large corpus of multiplication and division errors. The data were collected in an experiment in which subjects were presented visually with simple multiplication and division problems (e.g., 3×4 , $18:3$) and asked to give oral responses. A qualitative analysis of the error patterns suggests that most errors are due to problems in accessing the meaning of the numbers presented, or to interference between the presented numbers and the response numbers. Few errors seem to be purely arithmetic, i.e., due to retrieval of inaccurate or inappropriate arithmetic information. Using statistical techniques based on Goodman’s notion of quasi-independence (see Fienberg, 1989, *The analysis of cross-classified categorical data*), Vorberg showed that different error sources were independent of each other, and that perception errors and speech errors could be separated from genuinely arithmetic errors.

2. Language Comprehension

Much of the research on language comprehension is concentrated in two large Institute Projects. The first, which has the special status of a Max-Planck-Nachwuchsgruppe, studies the structure of the mental lexicon through computational modeling, experimentation, and the use of lexical statistics. The second uses event-related brain potentials to investigate psycholinguistic issues of semantic and syntactic processing and of comprehension deficits in aphasia. Outside these projects, work has continued on morphology, phonology and phonetics, text and discourse processing, logographic writing systems, and other topics.

2.1 The Nachwuchsgruppe on computational modeling of the mental lexicon

The project of the Nachwuchsgruppe aims to construct psychologically motivated computational models of lexical representation and process based on the systematic comparison of three data sources: lexical database analyses, computer simulations, and psychological experiments. Two important aspects of lexical processing received attention during the second year of the project: the speech processing responsible for extracting the intermediate representation(s) used in lexical access and the nature of lexical representations – in particular, the way morphologically complex forms are represented and accessed.

2.1.1 Lexical processing

An important objective of ongoing research has been to characterize the representation(s) computed from the speech signal and used to locate entries in the mental lexicon. P. Wittenburg continued his efforts to build a speech analyzer using recurrent neural networks. Together with R. Couwenberg (U. Twente), he constructed several speech recognition modules that take real speech as input and produce phoneme-like outputs to be used by the lexical modules. A series of simulation experiments tested how well the network could generalize its recognition of stop consonants to different following vowels (e.g., from /pa:/ to /pi:/), to different vocalic contexts (e.g., from /pa:/ to /a:p/), and to different speakers. The excellent recognition performance obtained in these simulations paved the way for current efforts to integrate different modules into one system.

J. Zandhuis, together with Couwenberg, implemented part of a hierarchically-organized speech recognition model based on two-dimensional self-organizing feature maps (SOFMs). SOFMs have the attractive property of mapping from a high-dimensional input to topology-preserving two-dimensional feature maps with unsupervised training – that is, without provision of a target output. Similar inputs are represented by overlapping bubbles of activity in the feature map. The model consists of several levels (phonemic, syllabic, lexical). Each level is made up of two connected layers: the first (C-layer) classifies the important features of the input data, and the second (T-layer) serves as a memory trace that retains the information from the C-layer and its order. A new technique was developed to represent the temporal order of incoming events (i.e., segments) as a path of activity in the T-layer fea-

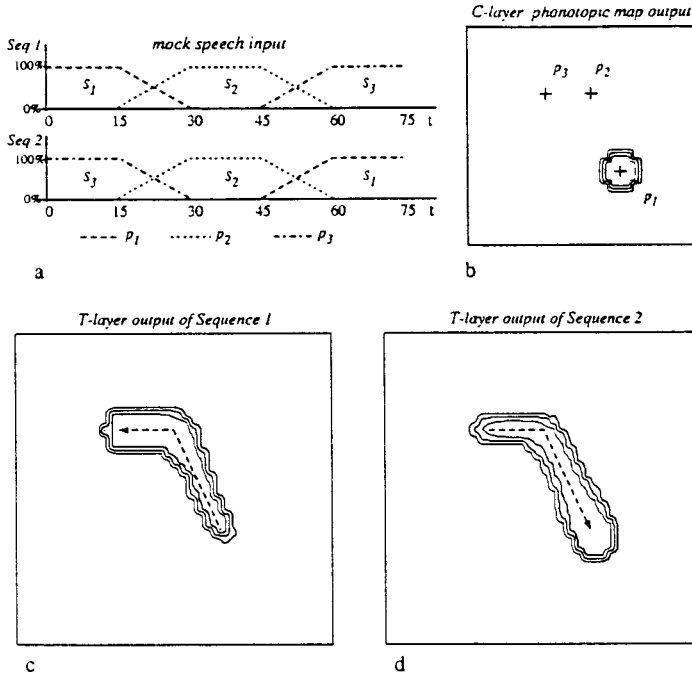


Figure 1: a: The percentage of maximum vector length (i.e., strength) of overlapping segments (s_1 , s_2 , s_3) over time (t) for two reversed sequences (Seq 1, Seq 2) used as mock speech input; b: C-layer phonotopic map showing the bubble shaped activity (p_1) of the steady-state part of an input segment (s_1) and the position (p_2 , p_3) of two other steady-state segments (s_2 , s_3); c and d: T-layer representations of the overlapping mock speech inputs for the two reversed sequences (Seq 1, Seq 2).

ture map. The amount of activity, or, more precisely, the size of the bubble for each segment, codes the temporal sequence. Old bubbles shrink and ultimately vanish when new data is added to the path. To understand the temporal behavior of the T-layer, Zandhuis conducted a mathematical analysis of the behavior of a single sigmoidal neuron with linear feedback from the output. Figure 1 illustrates both the sequential mock speech input used in a simulation and the input's representation in the C- and T-layers.

A series of psychological experiments was conducted to determine which sublexical levels of representations should be incorporated into the models of word recognition under construction. On the basis of earlier syllable monitoring experiments, the syllable has been proposed as a major perceptual processing unit in several languages, including Dutch. In these experiments, CV- and CVC-syllables (e.g., [po:] and [po:r]) were detected faster when they matched the first syllable of the carrier word than when they did not match. For instance, [po:] was detected faster in *po·rie* (pore) than in *poor·ten* (gates) and the reverse was true for [po:r] (cf. Annual Report 1990). U. Frauenfelder, T. Rietveld (U. Nijmegen), and A. van Til (F.U. Amsterdam) carried out a new series of monitoring experiments to determine the processing locus of this so-called syllable effect. Subjects again had to detect CV- and CVC-strings in carrier words beginning with CV- and CVC-syllables, but the carrier words had been cross-spliced so that the carrier word *poorten* included the sequence [po:r] from *porie* (for example), and the carrier word *porie* included the sequence [po:r] from *poorten*. The syllable effect was not replicated; in fact, in some conditions a reverse syllable effect was obtained. This demonstrates that information in the signal determined the subjects' responses, and suggests a phonetic locus of the syllable effect. The results appear to rule out explanations according to which listeners consult either the syllable structure of phonological representations stored in the mental lexicon or phonological rules of syllabification. (See Section 2.3.1 for further research on the syllable effect.)

The function of the human lexical processing system is to map the sensory input onto a meaning interpretation. A central question in the study of this system is how and when the phonological and semantic information stored in the lexicon

becomes available for higher-order processing. J. van Berkum started his dissertation research on the time course of auditory word recognition. It is generally assumed that semantic and phonological information about a word only becomes available after the “magical moment” – the so-called recognition point (RP) – at which the word has been unambiguously identified. It has recently been proposed, however, that the recognition process is more continuous, with semantic and phonological information gradually becoming available before the system has converged on a single best match. Van Berkum has begun to explore various experimental paradigms that could be used to test the different predictions about timing that follow from these two views.

J. Bölte conducted an auditory priming experiment with lexical decision to investigate the extent to which word recognition is a discontinuous process that is dependent upon the recognition point (RP). The RP was operationalized in terms of the amount of sensory information required by subjects to correctly guess the target word in a gating task. In the lexical decision experiment, subjects received trials consisting of two sequences, a target word or nonword preceded by a prime that was or was not phonologically related to the target. The amount of information contained in the phonologically related primes was varied in three different conditions: less than the RP, equal to the RP, and the entire word. In the three unrelated conditions, primes with no phonological overlap with the targets were used. The results revealed significant priming in all three related conditions as compared to the corresponding unrelated conditions, but also a relatively constant increase in facilitation for primes of increasing length. The facilitation obtained for the shortest primes suggests that some phonological information about the target becomes available

before the RP; further, the significant increase in the amount of priming between the second and third conditions indicates that not all the phonological information has become available by the recognition point.

R. Goebel (T.U. Braunschweig) and Frauenfelder continued their efforts to construct a hierarchical trainable auditory word recognition model. As a first step, Goebel developed a model that combines a sequential recurrent network with an attractor recurrent network. The sequential recurrent network analyzes the temporal properties of an input stream, e.g., the transitions within a sequence of phonemes. At each time step it sends hypotheses about likely sequences to the attractor network, which settles over time to a fixed-point attractor (a stable pattern of activity) representing the best matching sequence, e.g., a word. Using the backpropagation-through-time algorithm, the network was trained in a special training regime consisting of three different tasks: recognition, prediction, and production. Simulation studies with sets of 20 words demonstrated that the network could learn to recognize noisy sequences. It could also align temporally shifted sequences to stored representations and segment a continuous input stream into learned words. In the future the model will be applied to a larger training corpus in order to analyze its ability to go beyond a toy lexicon.

R. Miiikkulainen (U. Texas) participated in the development of alternative neural net models based on self-organizing feature maps. This involved examining different ways of accounting in such models for psycholinguistic phenomena like the time course of word recognition and the effects of noise and frequency on recognition latencies.

2.1.2 Lexical representation and morphological productivity

Listeners can understand novel regular morphologically complex lexical forms without apparent difficulty. This ability indicates that some morphological parsing mechanism is available in lexical access. The dominant serial search model of lexical access assumes that the recognition of prefixed words involves obligatory parsing of the prefix prior to lexical look-up. The extra costs of backtracking required for pseudo-prefixed words (i.e., nonprefixed words that start with a sequence identical to a prefix) are assumed to be compensated for by an increase in the processing efficiency of the perceptual system as a whole. However, a detailed analysis of the CELEX lexical databases of Dutch and English (see Section 6.2) carried out by H. Baayen and R. Schreuder revealed that substantial proportions of the word tokens beginning with what could be a prefix are in fact pseudo-prefixed words: from 20% to 90% in English, depending on the prefix, and from 4% to 20% in Dutch. This finding is fatal for any model that assumes obligatory prefix stripping. Indeed, Baayen and Schreuder showed that the search efficiency of such models is significantly lower than that of search models without obligatory prefix stripping.

A promising alternative to serial search models may be offered by dual route models that incorporate both a parsing component and a direct route without morphological decomposition. Since morphological parsing is not obligatory in such models, the parser can be sensitive to the degree of productivity of a prefix. Determining the speed and efficiency of the parsing route for a given prefix requires a quantitative measure of the morpheme's productivity. Such a measure has been developed by Baayen. Under the simplifying assumptions of the urn scheme as a statistical model for word frequency dis-

tributions, the appropriate statistical formulation of the linguistic notion of productivity seems to be the growth rate of the morphological category, specified as $\mathcal{P} = E[n_1]/N$, with n_1 the number of types occurring once only and N the total number of tokens.

Frauenfelder and Schreuder proposed a dual route model, termed the morphological race model, in which the winning route depends indirectly on differences in the productivity of the affixes of the words being recognized. How quickly the direct and the parsing routes process a particular morphologically complex word depends on the relative activation levels of the full form of the word and of its component morphemes. These activation levels are determined through past experience: the activation level of a full form is a function of the surface frequency of the word, while the activation levels of its component morphemes depend on how often the parsing route has successfully parsed this word or morphologically related words in the past. The success rate of the parser depends on properties of the word such as its phonological transparency and semantic coherence. Experimental tests of specific predictions of the model are in progress.

Baayen examined whether degree of productivity is in fact highly correlated with the activation levels of the access representations of affixes. To do so, he developed an estimate of activation levels using corpus-based frequency counts. Assuming that activation levels increase on each successful parse and decrease on each unsuccessful parse of a sufficiently low frequency word, Baayen found that the most productive affixes obtained the highest activation levels. In contrast, totally unproductive affixes had negative activation levels, which suggests, as expected, the absence of an affixal access representa-

tion.

This processing approach to the quantification of productivity can be supplemented with a statistical analogue. While the measure of degree of productivity given above is a conditional probability based on the structuralist notion of the morphological category, a non-conditional probability expressing the growth rate of the morphological category as it appears in the corpus as a whole can be given as $P^* = E[n_1]/N'$, where N' is the corpus size. P^* is a means for directly evaluating what Baayen, in collaboration with R. Lieber (U. New Hampshire), has called the global productivity of a word-formation process. It is a productivity measure that complements the conditional growth rate \mathcal{P} and the categorial vocabulary size V .

Morphological productivity has been neglected in theories of word recognition and lexical access, in large part because experimental work has focused narrowly on a few typologically similar languages (English, French, Dutch, Italian), all of which have a relatively impoverished morphological structure. To obtain a picture of morphological processing in languages with highly productive morphologies, the processing of Turkish has been explored. Frauenfelder, J. Hankamer (U. California, Santa Cruz), J. Kornfilt (Syracuse U., N.Y.), and S. Ozsoy (Boğaziçi, U. Istanbul) have completed a series of phoneme monitoring experiments examining the time course of the morphological analysis of agglutinated words (i.e., words consisting of a root and a series of bound affixes). These experiments demonstrated that there is early activation not only of the phonological representation of the root (see Annual Report 1990), but also of the suffixes. Target phonemes in true suffixes were detected faster than those in pseudo-suffixes, which suggests that suffixes are activated on-line during the mor-

phological analysis of the input string. This research demonstrates the importance of the parsing route in the processing of languages with complex morphologies.

Finally, in the area of lexical statistics, Baayen, together with R. Chitashvili (A. Razmadze Mathematical Institute, Tbilisi, Georgia) studied and implemented three statistical models for word frequency distributions (Carroll's lognormal model, Sichel's generalized inverse Gauss-Poisson law, and Orlov and Chitashvili's extended generalized Zipf's law). The three models were found to be roughly equivalent with respect to goodness of fit. Even though excellent fits to empirical data were obtained, the extrapolated estimate of the theoretical vocabulary size was found to be inaccurate. This inaccuracy can be traced to the incorrect assumption common to all three models that words appear independently of each other in texts.

For certain bodies of data – for example, lists of the vocabularies of children of different ages – there is no information on the frequency with which individual words were used. P. Indefrey, in collaboration with Baayen, developed a simple method to estimate word frequencies on the basis of dispersion data – i.e., the number of subcorpora a word appears in. Frequencies can be estimated on a probabilistic basis when the subcorpora are equally large. The resulting estimates are independent of the absolute size of the total corpus and of the size of the subcorpora. The method was applied to existing corpora and found to provide accurate lower boundaries for the observed frequency ranges.

2.2 Neurocognition of language processing

The Institute Project “Neurocognition of Language Processing” is made up of two subprojects. The first, carried out by W. Levelt, B. Hoeks, and A. Haasen, uses pupillometry to investigate processing load in speech production. This work is reported in Section 1.2. The second, covered in the present section, investigates various aspects of language comprehension with a method that is relatively new to psycholinguistics: the registration of event-related brain potentials. This project is sponsored by two grants from the Dutch Science Foundation (NWO) and one from the Volkswagen Stiftung. It is headed by C. Brown and P. Hagoort, and the following researchers participate: R. de Bruin, D. Chwilla, A. Deckers, J. Groothusen, and T. Swaab.

2.2.1 Electrophysiological correlates of semantic processing

During 1991 this part of the project focused on the processing characteristics of the N400. The N400 is a negative deflection in the ERP-waveform that reaches its maximal amplitude at approximately 400 ms after stimulus onset. This component is a manifestation of semantic processes of language comprehension. The main question was whether the N400 priming effect (that is, the amplitude difference between the N400 elicited by words preceded by semantically related vs. unrelated primes) should be attributed mainly to automatic or controlled processes. Chwilla, Brown, and Hagoort investigated the effects of controlled processes on the N400 by varying the proportion of associatively-related word pairs in a word priming paradigm. Increasing the proportion induces subjects to generate an expectancy set for related targets. Differential effects as a func-

tion of relatedness proportion are assumed to reflect an influence of controlled processes.

Two lists of word pairs were used, one with 80% related word pairs, (high proportion list) and one with 20% related word pairs (low proportion list). Two tasks were used: a lexical decision task and a silent reading task. Reaction times in the lexical decision task were measured concurrently with ERPs.

The lexical decision times showed the classical relatedness proportion effect: 1) the priming effect was larger overall in the high than in the low proportion list; 2) there was a significant interference effect for unrelated targets in the high proportion list; 3) but not in the low proportion list. Both the lexical decision and the silent reading ERP-data showed a significantly larger amplitude of the N400 for unrelated than for related targets. However, the priming pattern varied as a function of the task. In the lexical decision task a proportion effect was found: the effect of relatedness on the N400 was largest for the high proportion list. This suggests that controlled processes do influence the N400. In the reading task no effect of proportion was found, suggesting that expectancy effects were only induced by the lexical decision task.

2.2.2 ERPs related to syntactic and semantic processing

This research, carried out by Groothusen, Deckers, Brown, and Hagoort, focuses on the integration of the syntactic and semantic properties of words into a meaningful whole within sentential contexts. As a first step in this research program, efforts during 1991 concentrated on establishing an ERP-correlate of syntactic processing. An experiment was performed in which subjects read sentences containing one of three dif-

ferent kinds of violations of the syntactic constraints of Dutch. The following sets illustrate each kind of violation, with the word that renders the sentence ungrammatical underlined:

- (1) Violations of number agreement between subject NP and finite verb:
Het verwende kind gooien het speelgoed op de grond.
(The spoiled child throw the toys on the floor.)
- (2) Violations of phrase structure (transpositions of adverbs and adjectives in Adv-Adj-N sequences):
De echtgenoot schrikt van de emotionele nogal reactie van zijn vrouw.
(The husband is upset by the emotional rather reaction of his wife.)
- (3) Violations of subcategorization for intransitive verbs:
De goed geklede man schuilt een paraplu tijdens de regenbui.
(The well dressed man shelters an umbrella during the shower.)

The ERP-results provide evidence for a distinct electrophysiological response that is related to syntactic processing. This response is qualitatively different from established ERP-responses to semantic processing. Members of the research group refer to the electrophysiological manifestation of parsing as the Syntactic Positive Shift.

The Syntactic Positive Shift was observed in an experiment in which no task demands were imposed on the subjects other than to read the input. The pattern of responses to the different kinds of syntactic violations suggests that the Syntactic Positive Shift occurs when the parser is unable to assign the preferred structure to an incoming string of words. The

Syntactic Positive Shift seems to be robust, reflecting parsing difficulties related to quite different syntactic structures (i.e., it was observed both when number agreement and when phrase structure were violated). The existence of the Syntactic Positive Shift in addition to ERP-responses to semantic processes (i.e., the N400) suggests that during the process of language understanding a separate level of syntactic representation is computed.

2.2.3 ERPs as a measure of comprehension deficits in aphasia

Swaab, Brown, and Hagoort are investigating the nature of the comprehension deficits in Broca's and Wernicke's aphasics, and are attempting to pinpoint the functional locus of these deficits. In a first series of experiments, ERP-data were collected to test whether associative word priming and non-associative semantic word priming occur in Broca's and Wernicke's aphasics. This issue is relevant for establishing whether lexical-semantic deficits stem from a structural loss in the lexicon, or rather from a processing deficit in accessing lexical-semantic knowledge. The reason for comparing associative and semantic priming is that it has been claimed that associative priming effects could arise from accidents of contiguity, and thus do not necessarily reflect aspects of the semantic lexicon. Priming effects for non-associative, semantically related targets cannot be ascribed to contiguity effects.

Eight Broca's, four Wernicke's, and fourteen neurologically unimpaired, age-matched control subjects were tested. All subjects heard two lists of 166 word pairs. One list contained associatively related pairs, the other contained only non-associatively, semantically related pairs. The subjects were instructed to listen attentively to the words. No further

task demands were imposed.

The four Wernicke's patients showed no significant N400-effects. This absence of effects cannot, however, be interpreted yet, given the small number of subjects. The neurologically unimpaired subjects and the Broca's patients showed sensitivity to both associative and purely semantic relationships. These results show that Broca's patients are unimpaired in the process of lexical integration, at least as long as the information to be integrated is restricted to two words. The fact that the results were obtained in a no-task situation opens interesting possibilities for investigating aphasic subjects without having to use interfering tasks. Finally, the presence of an N400-effect for both the associative and the purely semantic lists suggests that the processing of associative relations shares core characteristics with the processing of semantic relations. These include access to lexical-semantic information in the mental lexicon.

2.2.4 ERPs and the processing of connected speech

Deckers, Brown, and Hagoort are investigating whether the ERP method can be applied to research on spoken language comprehension, using naturally produced, connected speech.

Two experiments have been run. In the first, subjects listened to naturally produced sentences, some of which ended in a semantically incongruous word. These incongruous words elicited a broad and sustained negativity, compared to the final words of control sentences without any incongruity. The morphology and cortical distribution of this negativity closely resemble the electrophysiological profile of the N400. In a second experiment the same incongruities as in the first experiment were presented in sentence-medial positions. Again, a significant negative shift was observed for the incongruous words.

Taken together, these experiments demonstrate that despite the intrinsic variability of the speech signal, and despite the problem of overlapping ERP-components, clear N400-effects can be obtained with connected speech as input.

The research on ERPs and connected speech benefitted from a month's visit by F. Rösler (U. Marburg). During his stay, a number of issues concerning the time-locking between lexical processing and ERPs was discussed, as well as more technical issues relating to digital filtering, eye movement correction procedures, and statistical tests of topographic cortical differences.

2.3 Morphology

2.3.1 Syllabic and morphological factors

P. Zwitserlood continued her research on the role of syllables and morphemes in the recognition of spoken words. In an earlier monitoring experiment (see Annual Report 1990), two sets of morphologically complex words had been used: derivations and compounds. Each stem was combined with two derivational affixes, one that required resyllabification and one that did not. For instance, for the stem *buig* (bend), the derived forms *buig-zaam* (flexible) and *bui-ging* (bow) were used. Detection times for target strings depended on the syllable structure of the carrier words. A target string was detected faster when it corresponded to the carrier word's initial syllable than when it did not. Thus, *bui* was detected faster in *bui-ging* than in *buig-zaam*, and *buig* was detected faster in *buig-zaam* than in *bui-ging*. A different pattern of results was obtained for compounds such as *bieraccijns* (beer tax) and *bierbrouwer* (beer brewer). Whereas Dutch syllabification rules would predict *bie* to correspond to the first syllable of *bieraccijns* and *bier*

to the first syllable of *bierbrouwer*, *bier* was detected faster than *bie* in both compounds. This indicates that resyllabification is blocked at the boundary between the two words of a compound.

In a new experiment, cross-spliced versions of carrier words were used in which the first parts of the carrier words were exchanged. Thus, the *buig* part in the cross-spliced version of *buigzaam* was taken from the spoken word *buiging*; and the *buig* part in *buiging* was taken from the spoken word *buigzaam*. With these materials the earlier results for derived words were reversed: *bui* was now detected faster in *buigzaam* than in *buiging*, while the reverse was true for *buig*. In the compound condition, cross-splicing had no effect: as with the intact words, faster responses were obtained for targets corresponding to the first word of the compound. The results of this study clearly indicate that subjects' responses are based on information contained in the sensory input, not on a more abstract level of representation.

2.3.2 Orthographic and morphological overlap

Together with G. Voost and E. Drews (T.U. Braunschweig), Zwitserlood continued to investigate the effects of morphological and orthographic factors in visual word recognition (see Annual Report 1990). Regularly inflected or derived words sharing a stem morpheme (e.g., *walking* and *walks*) overlap both morphologically and orthographically. The aim of this project is to distinguish the effects of these two kinds of overlap. A series of primed lexical decision experiments was conducted in Dutch and German. In one Dutch experiment using open class words as targets, primes and targets were either orthographically similar but morphologically unrelated (as in *uit-wi* (out-onion)), or both orthographically and morpholog-

ically related (as in *uien-ui* (onions-onion)). In the baseline condition, prime and target were unrelated (as in *oren-ui* (ears-onion)). Compared to the baseline, primes that were both orthographically and morphologically related facilitated target recognition, while primes that were only orthographically related inhibited target recognition. The same pattern was found in a study using German compounds as primes: for example, *Spätherbst* (late autumn) and *Herbstmode* (autumn fashion) facilitated the recognition of *Herbst* (autumn), but inhibited the recognition of *herb* (tart). Interestingly, when closed-class words were used as targets no interference effect was found. Compared to unrelated primes, both related open-class primes (such as *Wiese* (meadow) for the target *wie* (how)) and related closed-class primes (such as *wieviel* (how much) for *wie* (how)) produced facilitation.

The same pattern of facilitation and inhibition was found not only with fully readable primes but also with masked primes of which subjects had no conscious perception. An experiment using long-lagged repetition priming, in which a number of words intervened between prime and target, also showed reliable priming in the morphological + orthographic condition; an inhibition effect in the orthographic condition was not statistically significant. Finally, when the subjects' task was changed to naming the target, orthographically related primes no longer inhibited open-class targets but instead facilitated them.

Taken together, these results indicate that visual word recognition is affected differentially by the morphological and orthographic features of a word. The different patterns found in lexical decision vs. naming tasks, as well as for open- vs. closed-class words, suggest a specific locus of the inhibition effect: the level of lexical-semantic (lemma) representations.

2.3.3 Processing particle verbs

A. Bolwiender and Zwitserlood, together with Drews and U. Heuer (T.U. Braunschweig), continued their crosslinguistic research on complex verbs, which is sponsored by the Deutsche Forschungsgemeinschaft (DFG). The focus is on the lexical representation and processing of particle verbs, i.e., verbs consisting of a verb stem and a separable particle. Semantically, these verbs fall into two categories: transparent verbs, whose meaning is derived from the combined meaning of verb stem plus particle (e.g., Dutch *opvangen* (to catch)), and opaque verbs, for which there is no transparent relationship between the meaning of the complex verb and its components (e.g., Dutch *aanvangen* (to begin)). When particle verbs were presented as primes and their corresponding stem verbs as targets in a lexical decision experiment, a stronger priming effect was obtained for transparent than for opaque verbs. This difference was reliable at the level of item statistics in the German but not in the Dutch experiments, which indicates that the Dutch materials were semantically more heterogeneous. In particular, in Dutch, unlike in German, many opaque verbs also have a literal, transparent meaning; e.g., *uitroeien*, containing the simple verb *roeien* (to row), has a prominent non-literal meaning, 'to exterminate', but it can also be used compositionally with the meaning 'to finish a boat race'.

To investigate Dutch complex verbs in more detail, an experiment was conducted with spoken sentences as primes and both types of particle verbs, as well as their corresponding simple verb, as targets. Quadruples of priming sentences were constructed, three with a semantic bias toward the meaning of (1) the simple verb, (2) the transparent complex verb, or (3) the semantically opaque verb, and one an unrelated sentence (4) to serve as a baseline. For example, for the triplet of target

words *roeien* (to row), *wegroeien* (to row away), and *uitroeien* (to exterminate), the priming sentences (in translation) were the following:

- (1) Last Sunday, the students had a pleasant time on the lake.
- (2) During the regatta, the Dutch four left the competitors far behind.
- (3) Before the people got fire arms, there were many more tigers on Java.
- (4) Next to the town hall, there is a fish-and-chips cafeteria.

Each of the three target verbs was presented visually at the offset of each of the four spoken priming sentences in a lexical decision experiment. Reliable priming was obtained for target verbs of all types after sentences of types (1) and (2), but only opaque verbs showed priming after sentences of type (3). Analyses of a subset of opaque verbs that had no additional transparent meanings showed a different pattern: a reliable priming effect was obtained only with sentences of type (3), which bias toward the meaning of the opaque verb; there was a weak but unreliable priming effect from the other sentence types. Semantic transparency thus seems to be a graded phenomenon in Dutch; its effects will be further investigated.

2.3.4 Processing Italian pronominal enclitics

G. Flores d'Arcais continued his study of the processing of words with pronominal enclitic suffixes in Italian *prendetene* (take some of it)). Pronominal enclitics follow the same compounding principles as other suffixes, except that they do not induce primary stress shift. However, they differ from other suffixes in that they have the status of a syntactic category:

they specify an argument of a verb. In previous work Flores d'Arcais found that when cliticized words are processed in isolation, enclitics behave much like other inflectional or derivational suffixes. In 1991 he carried out a series of experiments to determine whether pronominal enclitics are processed differently from other suffixes when they appear in sentences.

In one experiment, sentences containing a word with either a derivational suffix or an enclitic were read word-by-word. Reading times for the critical word and the word following it were longer for the sentences with enclitics. Similar results were obtained in an experiment that required speeded detection of errors (syntactic anomalies). Thus, Italian pronominal enclitics appear to require more processing time than other suffixes, probably because they require the reader to compute the underlying sentence structure.

2.3.5 Interpreting noun-noun compounds

R. Meyer finished his dissertation research, in which he developed a formal model to explain the ambiguity and underdeterminacy of novel noun-noun (NN) compounds in isolation and the determination of their meanings in context. Isolated NN-compound meanings are underdetermined in two ways. First, each constituent noun can denote a family of concepts rather than a single concept; in a certain context, however, the nouns denote a subset of their concept family, usually only one concept. Second, more than one relation can hold between the two nouns, depending on what the nouns themselves denote.

Meyer's model explains how the interpretation of the relation between the two nouns of a compound depends on what the constituent nouns denote, and how contextual factors lead language users to arrive at a particular interpretation. In accordance with the basic ideas of Two-Level Semantics (Bier-

wisch, 1989, *Event nominalizations*), the model maps context-invariant lexical representations into conceptual representations to determine the set of possible denotations (i.e., the concept family) of these nouns. Candidate relationships between the nouns are then determined by applying the following three considerations, in order:

- (1) If the lexical representation of the head noun includes a two-place relation (e.g., a kinship term), and if the modifying noun meets the selectional restrictions on the relation's internal argument, it can be interpreted as this argument. For example, *Soldatenbruder* (soldier brother) is interpretable as 'brother of a soldier'; *Computerbruder* (computer brother), however, cannot be interpreted in this way; it must receive its interpretation via (3).
- (2) If the lexical representation of the head noun includes a two-place relation, and if the modifier meets the selectional restrictions on the relation's external argument, it can be interpreted as this argument. For example, suppose that the lexical representation of German *Museum* (museum) includes the two-place relation '(to) exhibit'. Since a museum can exhibit anything, there are no selectional restrictions on the external argument, so any noun modifying *Museum* in a compound (e.g., *Schiff* in *Schiffsmuseum* (ship museum)) could be interpreted as specifying what the museum exhibits.
- (3) The concepts denoted by the constituent nouns are located in a concept network in which relations holding among more general concepts can be passed on to more specific concepts. Links in this network can be used to derive interpretations, as follows. If the head noun of the compound *Schiffsmuseum* (ship museum) denotes

the concept of a museum collection (as opposed to, say, a museum building), and if the modifier denotes the concept of a ship, which is a physical object, then any relationships holding between the higher-order concepts of collections and physical objects may be relevant. For example, *Schiffsmuseum* could mean 'museum collection located on a ship', since the concept of a museum collection belongs to the concept family denoted by *Museum*, collections are typically located in some sort of container, and the concept of a ship can instantiate the concept of a container.

Before the relationship between the nouns of a compound can be determined, a decision must be made about the concept denoted by the head noun. (The concept denoted by the modifier is completely determined by selectional restrictions on the relation identified as holding between the two nouns.) In a text about a stereotypical event – e.g., a restaurant visit – the head noun of a NN-compound will typically be taken to refer to an object involved in this event. Alternatively (or in addition), if there is a lexical item governing the whole compound, it may have selectional restrictions that the head noun must satisfy. Finally, if a text provides anaphoric links between the constituent nouns of the compound and antecedent nouns, information about the antecedents can also be used to determine the relation between the constituent nouns.

Interpretations derived according to procedures (1) or (2) do not require contextual clues. If NN-compounds have interpretations not based on (1) or (2), either the intended relation is explicitly given in the text or it can be inferred from information in the discourse representation (the text representation constructed according to principles of Discourse Representation Theory – Kamp, 1981, in Groenendijk, Janssen, & Stock-

hof, *Formal methods in the study of language, Vol. I*). Meyer's dissertation gives general inference rules based on an analysis of NN-compounds found in German magazine articles. The context-sensitive processing algorithm developed by Meyer for interpreting NN-compounds in texts demonstrates the general productiveness of combining the principles of Two-Level Semantics and Discourse Representation Theory to get insight into the complex relationships between conceptual structures and discourse representations.

2.4 Phonology and Phonetics

2.4.1 Representation of phonological features

A. Lahiri and W. Marslen-Wilson (1991) proposed that the phonological representation of words in the mental lexicon is abstract and not fully specified. Further research on sibilants in Bengali and Dutch has brought more support to this hypothesis. In Bengali there is one underlying sibilant whose default phonetic shape is [ʃ], which has the phonological feature [−anterior]. In the context of a dental [t_n] (which is underlyingly unmarked for place) the sibilant becomes a [+anterior] [s]. Since the sibilants are noncontrastive, the representation is unspecified for place ([S] for convenience). The underlying contrasts are:

S	p	S	t	S _n	S	k
	[labial]		[−anterior]			[dorsal]

Thus, if any [−anterior] sibilant noise is heard, it can be interpreted as a [t] only if such a word is present in the lexicon. On the other hand, any [+anterior] sibilant can be interpreted as either [ʃ] or [s], depending on the distribution of the words in the language. In a gating task, subjects were presented

with fragments of bisyllabic words incrementally increasing in information. The critical sibilant clusters were always intervocalic. On hearing 40 ms of frication, about 80% of the subjects responded with [t] words, whereas if there were no words with [St] clusters, there was a large number of [s] responses for the same gate; in fact, the distribution of the responses was exactly the same as that for a word with [s]. The results suggest strongly that the sibilants are indeed underspecified in the lexicon and that access to the lexicon is via features. Had this not been the case, the extraction of [−anterior] from the sibilant would not have induced large numbers of [−anterior] [t] responses.

In Dutch there are also two phonetically different sibilants, but the distribution is different. Again there is only one underlying sibilant, which surfaces as default [s] but becomes [ʃ] in the context of the diminutive marker [j], which is [−anterior]. Here, the response patterns are similar to those obtained in the study of the English nasals reported in Lahiri and Marslen-Wilson (1991). Like the English nasal consonants, the assimilated [−anterior] sibilant is overwhelmingly responded to by words with [ʃj]. Responses to [+anterior] [s] (unmarked in the phonological representation) reflect the distribution of the two sibilants in Dutch, similar to the responses to the unmarked oral consonants in English, and to the responses to the [s] in Bengali mentioned above.

2.4.2 French liaison and surface neutralization

Lahiri, in collaboration with D. Bradley (Monash U.), investigated the acoustic properties of liaison /t/ in French. In simple sentences of the form *C'est un ADJNOUN* (It's a ADJ NOUN) (using the adjectives *grand* (big), *excellent* (excellent), and *petit* (small)), obligatory liaison environments were cre-

ated when the noun slot was filled with a vowel-initial nonword, e.g., *enius*. These were contrasted with non-liaison cases created by matched /t/-initial nonwords, e.g., *tenius*. Under liaison conditions, the postlexical syllabification would lead to [gran-tenius], similar to the situation where the second word begins with a real [t]. In a forced-choice discrimination task run in Bradley's laboratory, it was shown that non-native listeners (university students of French) can differentiate to some extent between a liaison-resyllabified [t] and an underlying [t]. Acoustic measurements made by Lahiri and Bradley on the same stimuli showed that non-liaison /t/ was produced with significantly longer closure duration and longer VOT than liaison /t/, although plosive energy did not differ between the two. The traditional analysis in prosodic phonology proposes that in liaison situations, resyllabification leads to similar structures for vowel-initial and /t/-initial words. This research suggests that phonological resyllabification does not always lead to such surface phonetic neutralization. However, this preliminary study used nonwords to allow comparison of exact minimal pairs; ongoing work addresses the question of surface neutralization in real words.

2.4.3 Metrical phonology

The Germanic Foot

Dresher and Lahiri (1991) have claimed that the Germanic Foot is quantity sensitive, binary, and left-headed, and that its head must dominate at least two moras. In further research, Lahiri has found additional evidence for this analysis in words of Old Dutch, where final high vowels delete when they are in the weak branch of the foot, leading to alternations like *fac* - *facu*, but *wort* - *wortu* > *wort*. In later stages of all Germanic

languages, the final stressless vowels became reduced to schwa [ə], which obliterated the effects of high vowel deletion and of the different morphological classes. Compare, for instance, Old English words like *talū* (sg.) and *tala* (pl.) with the related word *talə* in Middle Dutch.

After vowel reduction, stressed vowels in open syllables became long in Middle Dutch, a process traditionally known as open syllable lengthening. A similar process in Middle English has been attributed to compensatory lengthening of the initial vowel as a result of the loss of the final schwa: e.g., *talə* > modern English *tale* [teyl] (Hayes, 1989, *Linguistic Inquiry*, 20). A comparison of some modern Dutch (NL) forms with Old English (OE) forms might lead one to the same conclusion for Dutch:

OE: talu sunu lagu nosu haca nama

NL: taal zoon laak neus haak naam

Counter to what would be predicted by the compensatory lengthening hypothesis, however, heterosyllabic words, in which the final syllable was not lost, also underwent lengthening. Compare derived and underived heterosyllabic words in OE and Middle Dutch (MNL):

OE: vogel dagas (pl.) talu (sg.) holu (pl.) fīþere nacod

MNL: vo:gel da:che taal ho:len ve:dere na:ket

This is clearly not a case of compensatory lengthening; rather, the initial stressed vowel – i.e., the vowel in the head of a foot – was lengthened in an open syllable. The fact that words like singular *talə* became *taal* resulted from a general rule of apocope that deleted final schwas in the singular.

Why then do the words in Middle English look as if they underwent compensatory lengthening? In Middle English, both lengthened and short vowels can be found randomly in the Germanic words, indicating analogical shift. Lahiri hy-

pothesizes that this shift was possible because of an independent process of trisyllabic shortening. Trisyllabic shortening gave rise to alternations like *wa:ter* - *wateres*, where the initial vowel either was originally long or was lengthened by open syllable lengthening. One member of such a pair was taken to be the base form. In some cases the short vowel survived (Old English *bro:dor* > *brother*) and in others the long vowel (Old English *bea:cen* > *beacon*). The lack of lengthening in some bisyllabic words is therefore not due to compensatory lengthening not applying, but rather to the base taking the short vowel of the alternating pair.

Thus, due to the reduction of the final vowel, evidence for the Germanic Foot became opaque, which led to a change in the metrical system. Rules like open syllable lengthening reconstituted the two-mora requirement of the foot to that of the level of a stressed syllable.

Catalexis

During his one-month stay at the Institute, P. Kiparsky (Stanford U.) established that some languages systematically allow prosodic constituents to be “filled out” by phonologically unrealized metrical elements at the right edge. He proposed a theoretical analysis of this phenomenon, catalexis, which is the converse of extrametricality. This analysis allows metrical theory to be tightened and simplified in several important ways.

2.5 Processing idioms

G. Flores d'Arcais continued his work on the processing of idioms. According to certain theories of the representation of

words in the mental lexicon, an idiomatic phrase is represented as a single multi-word lexical entry. On this view, idiomatic phrases need not undergo syntactic analysis when encountered in a sentence. To test this notion, Flores d'Arcais conducted an experiment involving speeded detection of various types of errors such as misspellings and syntactic violations in sentences containing idiomatic phrases. The results showed that idiomatic phrases always undergo full syntactic analysis.

Although both familiar and relatively unfamiliar idiomatic phrases undergo syntactic analyses, their processing differs in other respects. In a word-by-word reading experiment Flores d'Arcais showed that unfamiliar idioms require additional processing at the point of "idiom uniqueness" – i.e., the point at which it is clear that the phrase can no longer be interpreted literally. In contrast, highly familiar idioms are processed just as rapidly as corresponding phrases with literal interpretations.

Together with M. Van de Voort (U. Nijmegen), W. Vonk investigated the relationship between compositionality and syntactic flexibility in accessing the meaning of idioms. Although the semantic interpretation of idioms is generally assumed to be noncompositional, idioms do in fact vary in their degree of compositionality (i.e., the extent to which the meanings of the individual words can be linked to the figurative meaning of the expression as a whole). For instance, in the idiom *pop the question*, *pop* conveys the notion of 'ask suddenly' and *the question* is a marriage proposal, so the idiom has a rather high degree of compositionality. In *kick the bucket*, in contrast, it is not possible to specify the contribution of the individual words to the meaning of the idiom as a whole, so the idiom has a low degree of compositionality.

Idioms also vary in their syntactic flexibility – i.e., whether

they can undergo syntactic modification without losing their idiomatic meaning. For example, the internal modification in *He popped the long-awaited/inevitable/dreaded question* does not affect the idiomatic status of the expression, whereas an analogous modification in *He kicked the last bucket* makes the idiomatic reading impossible.

Compositionality and syntactic flexibility are relevant to the two main hypotheses about the representation of idioms. According to the Lexical Representation Hypothesis (Swinney & Cutler, 1979, *Journal of Verbal Learning and Verbal Behavior*, 18), an idiom is represented in the mental lexicon as a single item; that is, its meaning can be accessed without retrieval of the meanings of its constituent words. But this hypothesis cannot explain why some idioms allow syntactic modification.

According to the Decomposition Hypothesis (Wasow, Sag, & Nunberg, 1982, *Proceedings of the 13th International Congress of Linguistics, Tokyo*), an idiom's degree of compositionality is related to its syntactic flexibility: compositional idioms are syntactically more flexible than noncompositional idioms. This hypothesis seems plausible: since individual words in noncompositional idioms are semantically empty, their meanings cannot be modified. Building on Wasow et al.'s claim, Vonk and Van de Voort propose the following hypothesis: access to the idiomatic meaning of idioms with an internal syntactic modification is direct for compositional idioms, but not for noncompositional idioms.

Vonk and Van de Voort's experimental paradigm was based on the finding that a word is processed faster in an idiomatic than in a nonidiomatic context (Estill & Kempen, 1982, *Journal of Psycholinguistic Research*, 11). It was assumed that if a certain syntactic modification makes subjects unable to in-

interpret a candidate idiom idiomatically, it should take them longer to make a lexical decision about a target word in a modified idiom than in its unmodified counterpart. Stimulus materials included three versions of each idiom: one without modification (e.g., *He kicked the bucket*), one with internal modification of the target noun by an adjective (*He kicked the last bucket*), and one with external modification (*Yesterday he kicked the bucket*). External modification was used as a control because, like internal modification, it involves (in Dutch) inserting a modifier into the string, but, unlike internal modification, it changes the meaning of the idiom as a whole rather than the meaning of a single word. Both compositional and noncompositional idioms were used.

Lexical decision times were slowed by internal but not by external modification, relative to no modification. Apparently the meaning of the individual words of an idiom must be accessed in arriving at the meaning of the idiom as a whole. Counter to Vonk and Van de Voort's hypothesis, results for compositional idioms and noncompositional idioms did not differ. Internal syntactic modification thus affects access to the meaning of an idiom regardless of whether it is compositional.

2.6 Processing pronouns

L. Frazier (U. Massachusetts, Amherst) and G. Flores d'Arcais continued a project on processing pronouns in Dutch. The singular masculine pronoun *hij* may take as its antecedent either a noun for an animate (usually human) male, or a noun for an inanimate object, provided that this noun takes *de* (as opposed to *het*) as its definite article.

Frazier and Flores d'Arcais' study examined whether a sen-

tence is processed differently depending on whether the antecedent of *hij* is a noun for an animate or inanimate object. Consider sequences (1) and (2):

- (1) Henk vertrok. Hij (Henk left. He)
- (2) De vork brak. Hij..... (The fork broke. He)

When presented with such sequences the language processor will construct both a conceptual and a linguistic representation of the antecedent of *hij*. If the conceptual representation is accessed before or at the same time as the linguistic representation, (1) should be easier to process than (2) because the referent of *Henk* is “naturally” male, whereas that of *vork* is not. In contrast, if the linguistic representation is used to determine the initial set of candidate antecedents for the pronoun, there should be no processing advantage for (1). The results of several experiments showed an advantage for animate antecedents as in (1). However, this effect seems to arise during the interpretation of the output of the language processor rather than during the selection of the antecedent.

2.7 The role of speech disfluencies in comprehension

In two experiments on the comprehension of spontaneous speech using a monitoring task, J. Fox Tree (Stanford U.) found that word recognition is helped by some speech disfluencies and hindered by others. Repetitions seem to facilitate word recognition. For instance, the word *heart* was recognized faster in the spontaneously produced utterance “It looks like a like a heart” than in edited versions in which the repetition of “like a” was taken out, both when the repetition was replaced with silence and when it was edited out completely,

resulting in a fluent phrase. In contrast, fresh starts seem to hinder word recognition. For instance, the target *bottom* was recognized more slowly following a spontaneously produced fresh start (as in “It has – The bottom is round”) than when the disfluency was replaced with silence or excised entirely. The experiments suggest that listeners make use of all the information given by speakers, even information that would be excluded from a ‘correct’ version of the speaker’s utterance.

2.8 Text processing

2.8.1 Theme-shift marking

In experiments carried out with L. Hustinx (U. Nijmegen) on markers of theme-shift in written texts, W. Vonk showed that when a referring expression is more specific than is needed to establish unambiguous reference, this expression can function to mark a theme shift in structuring the reader’s mental representation of the content of the text (Annual Report 1989). In these experiments, subjects read a short text about a single protagonist. A sentence in which this protagonist was specified with a pronoun was followed by a target sentence in which he or she was again specified, either with a pronoun or with a nominal. This sentence either was or was not continuous with the content of the preceding sentence. After the target sentence, subjects had to decide whether a probe word had appeared in the preceding text. The decision took longer in the nominal than the pronominal condition. This suggests that readers interpret an overspecified referring expression (i.e., the nominal) as introducing a new theme, which makes the material preceding the target sentence less available. This material was also less available following continuous than discontinuous content.

In 1991 Vonk used this probe recognition task to investigate whether the influence of an overspecified referring expression extends beyond the target sentence in which it appears. She found that the overspecification had no remaining influence after two intervening sentences. In contrast, the content shift introduced in the discontinuous condition still reduced the availability of pre-target information after two sentences. Apparently, then, subjects are able to recover from the theme-shifting effects of an inappropriately specific referring expression, as long as the content that comes after it is continuous with what preceded it.

In all these experiments pronouns served as the unambiguous referring expressions and names plus appositions (e.g., *Johnson, a professor of medicine*) as the overspecifications. In a subsequent experiment, names alone were used as overspecifications. Unexpectedly, the pre-target information tapped by the probe word was found to be more available after a name than a pronoun. Apparently there are additional determinants of whether readers experience a referring expression as an overspecification, thereby causing them to assume a shift of theme. In the last pre-target clause in this experiment, the protagonist was not in focus. Subjects may therefore have interpreted a name in the target sentence as indicating that the protagonist was again foregrounded, rather than – as had been expected – that the theme had shifted. To investigate this possibility, Vonk conducted a probe recognition experiment with three-sentence texts in which the pre-target sentence kept the protagonist in focus. Now, as had originally been predicted, the pre-target information tapped by the probe word was less available after a name than after a pronoun.

Vonk has proposed the following explanation for the contrasting experimental results. In the first two experiments the

protagonist was not in focus in the pre-target sentence. Thus, readers may have interpreted a relatively light overspecification (name only) in the target sentence as merely refocusing the protagonist rather than introducing a theme-shift. To get a theme-shift interpretation under these conditions, a relatively heavy overspecification (name plus apposition) may be necessary. In the third experiment, the protagonist remained in focus throughout, so even a light overspecification (name only) was sufficient to induce a theme-shift interpretation.

2.8.2 Message content and semantic/syntactic disambiguation

In previous research Vonk showed that in listening, but not in reading, the message content of a sentence immediately affected the interpretation of an ambiguous word in the next sentence (Annual Report 1990). The ambiguous word, which could be either a nominalized verb or a plural noun (e.g., *schatten* (estimating or treasures)), was followed by a disambiguating finite verb (*is* (is) or *zijn* (are)) that was the target in a naming task.

It was unclear why the content of the prior sentence had no effect in the reading condition. But perhaps this was due to differences between the two conditions in the time available for processing the ambiguous word: in the listening condition the word's average presentation duration was 619 ms, whereas in the reading condition it was only 200 ms. To test this possibility, Vonk lengthened the ambiguous word's presentation time to 600 ms in a machine-paced reading experiment. Naming latencies for the target were still not affected. In a further experiment, subjects were allowed to pace themselves, and reading times instead of naming latencies for the target were measured. The mean reading time for the ambiguous word

was about 616 ms. There was again no effect of the content of the prior sentence on the time it took to read the target, or the first unit following it. It is unlikely, then, that the differences in the results from the reading and listening conditions in the earlier experiments were due to differences in the processing time allowed for the ambiguous words.

2.9 The recognition of Chinese characters

G. Flores d'Arcais continued his project on the recognition of Chinese characters. One part of this project focuses on the activation of graphemic, phonological, and semantic information during the recognition of a Chinese character. Since words written in Chinese characters can be understood without activation of phonological information, it has been proposed that reading Chinese characters involves different processes than reading words in an alphabetic system. One of the questions asked by Flores d'Arcais is whether readers of Chinese characters obligatorily and automatically activate phonological information. The results of a number of experiments conducted together with H. Saito (U. Nagoya) (both in previous years and in 1991) indicate that this is the case.

Two experiments carried out in 1991 concerned the time course of the activation of the semantic and phonological information. Many complex characters are composed of two radicals, one providing information about the character's meaning and the other about its pronunciation. In two experiments, the two radicals were presented with some onset asynchrony so that either the semantic or the phonological radical appeared first. Replicating their earlier results, Flores d'Arcais and Saito found that when the phonological radical was presented first, naming latencies were significantly shorter than

when the two radicals were presented at the same time. This facilitatory effect was more pronounced for a SOA (Stimulus Onset Asynchrony) of 180 ms than of 60 ms. When the semantic radical was presented first, there was a slight facilitatory effect at the SOA of 60 ms and a slight inhibitory effect at the SOA of 180 ms. Flores d'Arcais interpreted these results as indicating early activation of both phonological and semantic information. At the longer SOA, the semantic radical produces some inhibition, probably because a set of alternative candidate words is activated.

In a third experiment, the radical presented shortly before the whole character was part of the complex radical given as the target, and had a meaning either similar to or different from it. Again it was pre-exposed for either 60 ms or 180 ms. The results showed that graphemic information was activated before semantic and phonological information.

Several other studies were started in which the same issues are investigated with different techniques, the most promising of which is a radical migration technique. In this approach, subjects are shown pairs of complex characters very briefly and asked to name them. Subjects often report having seen characters in which parts of the original characters are recombined, showing that the phonological or semantic radical of the characters can migrate independently. (An analogous error in an alphabetic system would be for subjects who have seen *LINE* and *PACE* very briefly to report that they have seen *PINE* and *LACE*.) Future research will explore whether the phonological or the semantic radical is more likely to migrate. The answer will help to determine processing priorities in the word recognition system.

3. Language Acquisition

The main work on language acquisition is represented in four projects: Reference to Space and Time (Section 3.1), Acquisition of Syntax (Section 3.2), Acquisition of Phonology (Section 3.4), and Input in Second Language Acquisition (Section 3.8.1). Outside these projects, work continued on the development of morphology, lexicon, and discourse, among other topics.

3.1 Reference to space and time

This project brings together a number of theoretical, descriptive, crosslinguistic, and developmental studies on the expression of space and time. Information on its background and goals is given in the Annual Reports of 1989 and 1990.

3.1.1 Spatial reference

Anaphoric reference to space

V. Ehrich completed her project on spatial and temporal deixis. Her *Habilitationsschrift*, accepted by the University of Cologne, summarizes the results. Most findings have been reported in earlier annual reports. One new domain of investigation, however, concerned the semantics of temporal adverbs like *vorhin* (just), *jetzt* (now), and *gleich* (immediately), and temporal connectives like *dann* (then), *da* (there), and *danach* (thereafter).

Following Bierwisch's analysis of spatial adverbs, Ehrich uniformly represents temporal adverbs as one-place topological prepositions predicated of event arguments. Semantic oppositions between different items are represented on the level of Semantic Form (SF) in terms of different order relations (anteriority, posteriority, and temporal coincidence) and different topological specifications (immediate proximity, peripheral proximity, and distality). In addition, preferences for interpreting particular adverbs in certain ways are specified at the level of pragmatics, which is seen as a subsystem of conceptual structure (CS). Ehrich bases this part of her analysis on the concept of Generalized Conversational Implicature, as it has been applied to semantic scales by Horn (1985, in Shiffrin (Ed.), *Meaning, form and use in context: Linguistic applications*) and Levinson (1987, in Verschueren & Papi (Eds.), *The pragmatic perspective*). She argues that in the scale $\langle x, y \rangle$, the semantically weaker term y , which is neutral with respect to a given semantic dimension, tends to adopt a value opposite to the value of the non-neutral stronger term x . This explains why, for instance, *jetzt* (now) and *gegenwärtig* (at present) often have different conceptual interpretations, even though they both express temporal coincidence between the time of a thematic event and a given Reference Time R (the time of the reference event).

In terms of their Semantic Form, *jetzt* and *gegenwärtig* can be represented as locating the time of the thematic event within the proximal neighbourhood of the Reference Time:

- (1) SF *jetzt*: λx [Temp (x) \subseteq PROX (R)]
- (2) SF *gegenwärtig*: λx [Temp (x) = PROX (R)]

Applied to the event argument of a verb, representation (1) yields a structure like (3), from which (4) can be obtained by λ -conversion:

- (3) Hans tanzt jetzt. (John is dancing now.)
 Tanz (Hans, e_i) & λx [Temp (x) \subseteq PROX (R)] (e_i)
 (4) Tanz (Hans, e_i) & Temp (e_i) \subseteq PROX (R)

According to (1) and (2), *jetzt* and *gegenwärtig* may both be used to locate the (time of the) thematic event in a time span that is identical with PROX (R). As a consequence, *jetzt* and *gegenwärtig* are interchangeable in many contexts:

- (5) Hans ist jetzt (gegenwärtig) in Berlin.
 (John is now (at present) in Berlin.)

The only difference between (1) and (2) is the opposition between proper and improper temporal inclusion. *Jetzt* is neutral with respect to this distinction, whereas *gegenwärtig* is restricted to improper inclusion; that is, its denotation time not only spans a subregion of PROX (R), but must exhaust PROX (R) as a whole. This seemingly rather subtle difference has important consequences:

- (6) Hans ist jetzt (*gegenwärtig) in Berlin gewesen.
 (John has now (*at present) been to Berlin.)
 (7) Der Ober wird Ihnen jetzt (*gegenwärtig) die Karte bringen.
 (The waiter is now (*at present) going to bring you the menu.)
 (8) Bernstein und Karajan sind jetzt (*gegenwärtig) tot.
 (Bernstein and Karajan are now (*at present) dead.)

The fact that *jetzt* may denote an arbitrary subregion of PROX (R) explains why it allows for anterior (6) and posterior (7) readings: according to (1), Temp (x) may, but need not, include R. Since *gegenwärtig*, in contrast, is restricted to identity with PROX (R), it necessarily denotes a time span that includes R; it is therefore incompatible with anterior or posterior readings. The fact that *gegenwärtig* must be exhaustive with respect to PROX (R) means that its denotation time is closed

by PROX (R). Therefore, a thematic event located in time by *gegenwärtig* is by the same token characterized as temporally restricted to PROX (R) and thus finally closed. This explains why situations that have no final boundaries (like being dead) cannot be located in time by *gegenwärtig* (8). For the same reason, *gegenwärtig* characterizes a potentially open situation as being in fact temporally closed:

(9) Hans ist *gegenwärtig* verheiratet.

(John is at present married.)

(10) Hans ist *jetzt* verheiratet.

(John is now married.)

Example (9) suggests that John's marriage is only temporary, whereas (10) does not, even though SF (1) does not exclude final boundaries for *jetzt*. This asymmetry can be explained by treating *jetzt* and *gegenwärtig* as forming a semantic scale $\langle \textit{gegenwärtig}, \textit{jetzt} \rangle$. *Jetzt* is the weaker term in this scale because it is neutral with respect to proper/improper temporal inclusion, whereas *gegenwärtig* is not. In consequence, the use of *jetzt* in a context where *gegenwärtig* would also in principle be possible implicates on the basis of a Generalized Conversational Implicature that temporariness, which is the defining property of *gegenwärtig*, does not hold; in other words, a situation located by *jetzt* is to be conceptualized as finally unbound.

Topological prepositions

U. Bartels continued her dissertation research on the lexical semantics of spatial expressions. Her main goal is to derive lexical representations for topological prepositions in German and Dutch, based on a descriptive analysis of these items. Conceptual structures and interactions between linguistic and nonlinguistic knowledge are also taken into account. Earlier

studies (see Annual Report 1990) showed similarities in the use of topological prepositions in German and Dutch, but certain “translation equivalents” – German *auf* and Dutch *op*, German *an* and Dutch *aan*, all roughly equivalent to English *on* – are not interpreted in quite the same way in the two language.

In 1991 Bartels conducted two experiments to test whether the German topological prepositions *auf* (on (top)), *an* (on), *bei* (near), and *in* (in) can be adequately represented, and distinguished from each other, with the binary topological and dimensional features [+/-contained in], [+/-near], [+/-higher than], [+/-lateral], and [+/-contact]. On each trial subjects were presented with a sentence containing a preposition and asked to complete a drawing in accordance with the sentence. Both affirmative sentences (like *Der Ball ist auf dem Tisch* (The ball is on the table)) and negative sentences (like *Der Ball ist nicht auf dem Tisch* (The ball is not on the table)) were used. Sentences of the latter type were included to test the saliency of a preposition’s features according to the “principle of minimal negation” (cf. Schreuder & Levelt, 1978, *Forum der Letteren*, 19). For example, if subjects illustrated *Der Ball ist nicht auf dem Tisch* with a picture of a ball above a table, the feature [+contact] (and not, for example, [+higher than]) was taken to be the most salient feature of *auf*.

Results suggest that the five candidate features indeed provide an adequate representation of the meanings of *auf*, *an*, *bei*, and *in*. For prepositions presented in their positive form, subjects showed clear preferences for particular configurations, confirming the default settings of the features hypothesized for each preposition. For *auf*, the most important feature is [+contact]: subjects were most likely to modify this feature when *auf* was negated. [+higher than] is also fairly salient for *auf*. For *an*, [+contact] is salient as well, but subjects also

often changed the features [+near] and [–contained in] when *an* was negated. For *bei*, [+lateral] is most salient. [–contact] seems to be less salient for *bei* than had been expected. *In* has only one salient feature: [+contained in].

Crosslinguistic studies of the acquisition of spatial reference

M. Bowerman continued her crosslinguistic research on how children learn the system of spatial reference of their native language. This work focuses on the effects on acquisition of differences in how spatial relations are categorized and how spatial information is combined with or distinguished from other information in the grammar and lexicon of a language. Bowerman's goal is to clarify how children's nonlinguistic perceptual and conceptual understanding of space interacts with their linguistic experience to produce knowledge of a language-specific system for referring to space.

In previous research on children's spontaneous speech, Bowerman, together with S. Choi (San Diego State U.), found that language-specific differences in children's spatial reference may emerge extremely early: by the time children learning English and Korean begin to use spatial words productively – about 17-20 months – they already categorize spatial events in different and language-appropriate ways (see Choi & Bowerman, 1991, and Annual Reports 1988-1990). To explore how these differences arise, Bowerman and Choi have begun to look at the early comprehension of spatial words. Conventional approaches to testing comprehension, such as elicited picture-pointing or acting out with toys, are hard to use with children younger than about two-and-a-half years. A promising alternative is the "preferential looking paradigm", in which the child simply sits on a parent's lap in front of two TV mon-

itors. Previous research has shown that when two scenes (e.g., a ball and a boat) are shown concurrently, and when a verbal stimulus (e.g., "Look at the ball!") is presented simultaneously, children as young as 13 months tend to look longer at the matching screen if they comprehend the word (Golinkoff et al., 1987, *Journal of Child Language*, 14).

In 1991, supported in part by the (U.S.) National Science Foundation, Bowerman and Choi conducted extensive pilot studies to determine whether this technique can be used to test comprehension of spatial words in very young children. First a smoothly functioning lab was set up with advice and technical help from L. Naigles (Yale U.). Pilot testing with Dutch children between 18 and 27 months focused on contrasts between surface-contact and containment relations. Some studies tested comprehension of the distinction between *op* (on) and *in* (in), and others the distinction between *af* (off) and *uit* (out).

Each study used two videotapes, running in synchrony and displaying a pair of actions, one on the left TV monitor and one on the right. A warm-up pair of actions (clapping hands, bouncing a ball) was followed by four test pairs of spatial actions. For the *op-in* distinction, for example, one monitor showed an action of putting an object 'on' something (e.g., a peg doll on a toy staircase), and the other showed an action of putting an object 'in' something (e.g., a peg doll in a toy car). A test sequence for a pair began by introducing each action in isolation (Trials 1 and 2), then showing both together (Trial 3). During these trials an audio from a loudspeaker between the TV monitors named the objects and oriented the child to the actions (e.g., "What's happening?"), but did not use the target word (*op* or *in*, in this case). Two identical test trials (Trials 4 and 5) followed, again showing both actions simul-

taneously, but now with the audio urging the child to look for the action specified by a verb phrase containing the target word. Subjects were videotaped by a camera hidden between the two TV monitors, and independent observers later coded their looking behavior with a button-press box linked to a computer.

Analyses of trials during which subjects saw both members of the pair of scenes simultaneously but did not hear a target word (Trial 3) showed that children preferred the 'putting in' actions to the 'putting on' actions, and the 'taking off' actions to the 'taking out' actions. Following Naigles (1990, *Journal of Child Language*, 17), Bowerman and Choi controlled for these nonlinguistic preferences on a child-by-child basis by asking whether the child looked longer at the scene that matched the target word during the *test* trials for a pair (i.e., Trials 4 and 5, with target word) than during the *control* trial (i.e., Trial 3, no target word) for that pair. A significantly larger mean difference score for the test trials than for their corresponding control trials was taken to indicate understanding of the target words.

Aspects of the visual and auditory presentation were varied in different pilot studies to determine how to elicit an optimal performance from children. Overall, children did best in studies in which they saw an action three times rather than twice within each trial, and in which they heard longer rather than shorter texts containing the target word (e.g., "Where is she putting it IN?" rather than simply "Put it IN."). Children also performed better on the *af*(off)/*uit*(out) contrast than on the *in*(in)/*op*(on) contrast, which is consistent with Bowerman and Choi's finding that words for 'separation' emerge earlier than words for 'joining' in the spontaneous speech of children learning Dutch, English, and Korean. Children also did better

when the target words were *in* or *uit* than when they were *op* or *af*. This is consistent with the often-reported result (e.g., Clark, 1973, *Cognition*, 2) that children learn the meaning of *in* before *on*. The preferential looking paradigm thus seems to provide a sensitive tool for testing comprehension of spatial words in very young children. Bowerman and Choi hope to adapt the paradigm to cross-linguistic testing in future work, to clarify how children learning different languages manage to home in on just those features of spatial scenes that are picked out by the spatial words of their language.

Bowerman and Choi also continued their contrastive analyses of how spatial reference works in adult English and Korean, and of the relative difficulty for children learning these languages of various spatial contrasts and grouping principles. In their earlier work, Bowerman and Choi concentrated on English directional and topological particles such as *up*, *down*, *in*, *out*, *on*, and *off*, and the Korean verbs with which analogous meanings are expressed. More recently they have begun to look at concepts expressed in both languages by verbs, such as (in English) *fall*, *hang*, *open*, and *break*.

Fall is one of the earliest verbs acquired by learners of English, appearing before the age of two. The ease with which it is learned and extended to new events is often taken to indicate that it is mapped directly to a concept of 'falling' that is given by nonlinguistic cognition. But analyses of how Korean children talk about falling casts doubt on this assumption. Korean has two verbs that are both typically translated as *fall*. *Nemecita* means to fall down or over on the same base level (e.g., a child falling down on the floor, a tree falling over). *Ttelecita*, in contrast, roughly means to fall from one level to another (e.g., a child falling down stairs, a pencil falling off the table); it can also be used for change of base position

in directions other than downward, e.g., when a flower petal comes off in one's hand. Analyses of spontaneous speech data suggest that learners of Korean make the basic distinction between *nemecita* and *ttelecita* with little difficulty: for example, between about one-and-a-half and two years they use *nemecita* when they fall down or when a toy falls over on the floor, but *ttelecita* when a magnet falls off a door or a crayon off a table. English-speaking children in this age range use *fall* indiscriminately for events of both types. These findings, like Bowerman and Choi's earlier findings on children's use of directional and topological spatial words, indicate that – contrary to widespread assumptions – the way young children classify events for purposes of talking about them depends not only on their (presumably universal) nonlinguistic cognitive biases but also on the way events are classified in the speech around them.

P. Brown joined the staff of the Institute in August. She participates in the Reference Project, and also works closely with members of the new Research Group for Cognitive Anthropology to investigate spatial concepts and spatial language in the Mayan language Tzeltal, as spoken in the Mexican Indian community of Tenejapa. In two field trips in 1991, she added to a significant data base of videotapes and audio-recordings of spatial language generated both during semi-natural interactive games (see Section 5.2), and in natural verbal interactions about building houses, pruning trees, repairing roads, and the like. Her emphasis so far has been to understand the Tzeltal systems for spatial description – the grammar and semantics of locatives, motion verbs and the derived auxiliaries and directionals, the system of absolute coordinates ('uphill' and 'downhill'), and how these are used by Tzeltal speakers. In her second field trip, Brown, in consul-

tation with Bowerman, began data collection on how Tzeltal speakers talk about the kinds of topological spatial relations that are typically expressed in English with the prepositions *in* and *on*. These data will be compared with data that Bowerman has collected in her crosslinguistic work on the acquisition of spatial terms. Work is planned for the immediate future on the semantics of Tzeltal positional roots, Tzeltal learners' acquisition of the underlying semantic dimensions of spatial language, and the interaction between spatial concepts and spatial reasoning in Tzeltal.

3.1.2 Temporal reference

The present perfect puzzle

The expression of temporality is typically not confined to a single expressive device, such as tense morphology, but relies on the joint contribution of various utterance components such as tense, aspect, inherent lexical properties of the verb, and adverbials. A satisfactory analysis of temporality thus requires not only an account of these components individually but also of their interaction. In a study of temporality, W. Klein worked out a solution to a problem of interaction in English: the "present perfect puzzle".

The problem is this. In an utterance such as *John has left London*, the event in question, John's leaving London, clearly occurred in the past – for example, yesterday at ten. Why is it impossible, then, to make the time of the event more explicit with an adverbial, as in *Yesterday at ten, John has left London*? But English does not tolerate such a combination of present perfect and past time adverbials (there are certain exceptions). This puzzle is well known. A lesser-known but related problem is that the present perfect cannot be used

in *when*-questions, as in *When has John left London?* (again, with certain exceptions).

Any solution to these problems hinges crucially on the meaning assigned to the English perfect, and to the present perfect in particular. Familiar analyses of the present perfect in terms of notions like “current (ongoing) relevance”, “extended now”, or “indefinite past” cannot explain why the exact position of the event (or process, or state) on the time axis cannot be made explicit. Moreover, such analyses cannot explain certain other constraints on the use of the present perfect – for example, that it is possible to say *John was dead*, but not *John has been dead*. This pattern should follow from differences in the meanings hypothesized for the simple past and the present perfect.

Klein’s solution has two steps. First, he suggests a strictly compositional analysis of the English perfect based on a distinction between two time spans: the time for which a particular utterance makes a claim (Topic Time, abbreviated TT), and the time of the “situation” (i.e., event, process, or state) (TSit). Tense is an abstract relation between TT and the time of utterance, TU, and aspect is an abstract relation between TT and TSit. Thus, tense does not locate the situation (TSit) before, including, or after TU, but instead locates the time for which a claim is made (TT) before, including, or after TU; hence, it is only via TT that TSit is related to TU. In consequence, a past tense utterance does not necessarily rule out the possibility that TSit includes TU – in *John was dead*, for example, TSit obviously does include TU, since John is still dead. The English perfect combines a variable tense component (before, including, or after TU) with a constant aspect component (TSit after TT):

	Tense part	Aspect part
John had been in London	TT before TU	TSit after TT
John has been in London	TT includes TU	TSit after TT
John will have been in London	TT after TU	TSit after TT

The present perfect thus specifies that right now (at TU), John is in the posttime of some situation of being in London (whose duration is not specified). Since it is not possible to be in the posttime of being dead (resurrection aside), it does not make sense to say *John has been dead*, although it does make sense to say *John has been dead for seven days* (since by the eighth day John is in the posttime of being dead for seven days).

Although this analysis of the perfect tenses is strictly compositional, there is an important difference between the tense component of the present perfect and the tense component of the past (and future) perfect. The former marks that TT includes TU; hence, the position (although not the duration) of TT is fixed by the meaning of the morpheme *has*. In the case of *had*, there could be many different TTs as long as they all precede TU (whose duration, again, is open). A present tense morpheme like *has* is “position-definite (p-definite)”, whereas a past tense morpheme like *had* (or a future tense morpheme) is not p-definite; none of them is “duration-definite”. This contrast between present and past tense morphemes resembles the difference between the deictic terms *here* and *there*: in a given speech situation, there is only one ‘here’ – the place around the speaker, whose boundaries are open – but there can be many ‘theres’, i.e., places that do not include the speaker (each of them also with open boundaries). It is this difference between p-definite and not p-definite forms that accounts for the present perfect puzzle.

Imagine a situation in which the following utterances are true:

- (1) Yesterday, Mary came to John's office at seven.
But John had left at six.

The temporal adverbial *at six* specifies TSit, the time of John's leaving, and *at seven* specifies the time for which the claim is made – the time that corresponds to the morpheme *had*. It is strange that in the very same situation one cannot say:

- (2) At seven, John had left at six.

Clearly, (2) is true in this situation. But it gives the somewhat unfortunate impression that at some other time yesterday, John had not left at six. Now, if John indeed had left yesterday at six, then the utterance *John had left at six* is nonsensical for any possible topic time earlier than six (e.g., it makes no sense to say *At five, John had left at six*). But since the utterance is true for any possible topic time after six, it is odd to single out some specific time span for which it is claimed that then, John was in the posttime of leaving at six.

These considerations can be stated in the form of a general pragmatic principle, the "P-definiteness constraint", according to which the expressions of TT and TSit cannot be both p-definite in an utterance. This constraint excludes both utterances like (2) above and utterances like (3):

- (3) John has left at six.

In the case of (2), the position of TT is specified by the adverbial *at seven*. In the case of (3), there is no explicit adverbial. But according to the analysis of the present perfect suggested here, the form *has* is itself p-definite: it singles out a particular time span for which a claim is made.

In contrast, if the claim only extends over John's leaving, and nothing is said about its time – as, for example, in *John had left* – then the position of the posttime of the event is not

fixed. In this case it makes sense to single out a certain TT, in contrast to some other TT, for which this claim is made, as in *At seven, John had left*. It could be that at five, John had not left, so there is a reasonable contrast.

Finally, while a question such as *When has John left London?* does not directly violate the P-definiteness constraint – because *when* does not in itself specify any time span – any legitimate answer (e.g., *Yesterday at ten*) would violate it. Therefore, it is pragmatically odd to ask such a question.

The crosslinguistic study of temporality

M. Hickmann continued her crosslinguistic research on the development of tense and aspect, in collaboration with J. Liang (U. Leiden) and with the assistance of H. Hendriks, B. Kaiser, and F. Roland. This research examines the semantic and pragmatic determinants of the use of temporal-aspectual devices in narratives produced by four- to ten-year-old children and adult speakers of French, German, English, and Mandarin Chinese.

Previous analyses showed an overall association in the three Indo-European languages between past perfective inflections and predicates expressing bounded events (e.g., past tense forms appear earlier with verbs for bounded events like *break* and *spill* than with verbs for unbounded events and states like *cry* and *stay*). This association demonstrates the impact of verb semantics on the use of verbal inflections, but it must be qualified in two ways. First, the magnitude of the impact depends on the system being acquired. For example, in both French and German, the nonpast neutralizes aspect distinctions, and it is preferred by speakers of all ages. In English, in contrast, both past and nonpast mark aspect, and learners of English either use the two forms equally or – unlike adults – use the past more than the nonpast. Children learning English

also distinguish between bounded and unbounded predicates at an earlier age than children learning French or German: by four or five years, they not only associate the perfective past with bounded predicates but also the present with unbounded predicates.

Second, children's use of temporal-aspectual devices is affected by discourse factors in all three languages. For example, shifts to a past perfective form have specific functions such as marking the temporal overlap or juxtaposition of two events (e.g., "And the dog bites the cat's tail when the cat just about got up there"). Such uses of the past are often accompanied by adverbials and connectives providing further temporal-aspectual specification (e.g., *just*, *at the same time*, *almost*, *when*; *juste*, *en même temps*, *à ce moment-là*, *quand*; *gerade*, *fast*, *in der Zeit*, *als*). The use of a past form to mark overlap does not become common until about age 6-7; younger children tend to shift to the past when describing results regardless of the relationship between a resulting event and any other event. Analyses of the Chinese corpus are expected to show similar semantic and discourse influences on the use of aspect markers.

Temporality in the acquisition of German

H. Behrens continued her dissertation research on the acquisition of temporality in German. The project focuses on how children express temporal meanings with verb tense and lexical items, and on the morphosyntactic properties of their early verb inflections. The study addresses the interface between the semantic and syntactic properties of the verb phrase, since children have to master both temporal concepts and dependencies between verbal inflection and word order. The analysis is based on longitudinal diary and tape-recorded data from

seven children between the ages of one and four years. The data were coded according to the formal properties of the VP (tense, agreement, position), and the temporal reference of each utterance was determined by examining its verbal and nonverbal context. This two-pronged approach allows the development of temporal reference to be studied independently of how it is linguistically encoded.

Behrens finds that conclusions about children's temporal concepts cannot be based solely on their use of the temporal devices of the adult language. Before children use verbs or tenses productively, they refer to past and (anticipated) future events by mentioning the location of and/or participants in the event. Contrary to earlier claims, past markers (in this case past participles) initially refer not only to visible resultant post-states of prior events, but also to nonvisible post-states and to prior activities with no resulting state. Past markers therefore express genuine pastness, and not merely resultativity. Lexical items such as *gleich* (soon, immediately), *noch* (still), and *wieder* (again) specify temporal relations before tense marking is fully developed. They are crucial for determining the temporal content of an utterance even when tense marking is present, since German tenses are underspecified with respect to the temporal location of an event.

Although children do not necessarily express temporal concepts with adult linguistic devices, they adhere fairly systematically to the restrictions imposed on word order by finiteness. In main clauses in German, nonfinite forms like infinitives and participles occur sentence-finally, while finite forms occur in verb-second position. Children observe these restrictions even when the morphological distinction between finite and nonfinite forms is blurred in their production. For example, some children initially omit the prefix *ge-* from past partici-

ples, producing forms like *nitten* in place of *geschnitten* (cut). With weak verbs the omission of *ge-* yields a form identical to the third person singular form (cf. *er macht* (he makes) vs. *(ge-)macht* (made)). Yet children usually differentiate the homophones by placing forms with past-time reference in verb-final position, as is appropriate for nonfinite forms, and forms with non-past reference in verb-second position, as is appropriate for finite forms.

Despite these systematicities, children master the formal system only gradually. Even when they use formal temporal devices correctly in some utterances, they often omit them from contextually and formally very similar utterances where they are required. The gradualness of progress presents a challenge to strong innatist claims, and demands a developmental account.

3.1.3 The relationship between spatial and temporal reference: Inchoative verbs and phase quantification

Spatial and temporal reference interact in compositional semantics. As a diagnostic case of this interaction, M. Bierwisch explored the role of so-called phase quantification in connection with inchoative verbs.

The basic pattern of phase quantification, expressed in German by *noch* (still) and *schon* (already) and their negations *nicht mehr* (no longer) and *noch nicht* (not yet), can be indicated schematically in the following way (see Löbner, 1990, *Wahr neben Falsch*):

- (1)(a) Hans schläft. (b) Hans schläft nicht.
 //////////●////////// ———●————
 (H. sleeps.) (H. does not sleep.)
- (2)(a) Hans schläft noch. (b) Hans schläft nicht mehr.
 ///●///———— —————●——
 (H. still sleeps.) (H. doesn't sleep any longer.)
- (3)(a) Hans schläft schon. (b) Hans schläft noch nicht.
 ———///●/// ———●////////
 (H. sleeps already.) (H. doesn't sleep yet.)

//////// represents a phase instantiating the proposition 'SLEEP h', ——— represents a phase instantiating its negation; and ● marks the Topic Time, i.e., the time interval for which a claim is made. While in (1) the claim is simply that the proposition holds or does not hold, in (2) and (3) the claim is made relative to the phase structures introduced by the phase operators *noch* and *schon* (where *nicht mehr* is suppletive for *nicht noch*, and *noch nicht* is equivalent to *nicht schon*). In other words, *noch* introduces the presupposition that a positive phase is followed by a negative phase, while *schon* introduces the presupposition that a positive phase is preceded by a negative phase. The problem to be solved stems from the fact that the analysis indicated in (2) and (3) does not account for the effects of phase quantification with inchoative verbs. Consider the contrast shown in (4):

- (4)(a) Hans ist noch da.
 (Hans is still here.)
 (b) Hans kommt noch
 (Hans is still to come.)

In a fairly strict sense, *kommen* (to come) can be consid-

ered the inchoative verb corresponding to the stative predicate *da sein* (be here). This can be captured by the following somewhat simplified analysis, in which 'PROX u' represents the proximal environment of a deictically specified variable u, within which the theme h is located:

- (5)(a) Hans ist da. $\exists e$ [e INST [h LOC [PROX u]]]
 (b) Hans kommt. $\exists e$ [e INST [BECOME [h LOC [PROX u]]]]

In (5a), e denotes a state instantiating the proposition 'h LOC [PROX u]', while in (5b), e denotes an event instantiating the change to this state. The point at issue is this: whereas (5a) and (5b) denote a present state and an event, respectively, the addition of the phase quantifier *noch* to (4b) turns the event into a future event, while the addition of *noch* to (4a) simply imposes on the state a phase structure of the type shown in (2a).

Another fact to be captured is illustrated by the contrast in (6):

- (6)(a) Hans ist nicht mehr da.
 (Hans is not here anymore.)
 (b) Hans kommt nicht mehr.
 (Hans will not come anymore.)

Although (6a) and (6b) are the negations of (4a) and (4b), respectively, they draw quite different contrasts: (6a) presupposes or implies a preceding positive phase of the type (2b), but (6b) does not – no positive phase of coming is presupposed. These facts require a closer inspection of the difference between states and events, i.e., changes of state.

Canonical events like those expressed by *kommen* are characterized by a final or target state and a (presupposed) initial or source state, which is usually the negation of the final state. Schematically, events can be represented as in (7), where the interval between $\neg P$ and P is the transition, which is in prin-

tuple void of any specification and may in fact be empty.

$$(7) \quad \frac{\text{————}}{\neg P} \quad \frac{/////}{P}$$

The question, then, is how the phase structure in (7) compares with that in (2). Intuitively, the answer is this. For state predicates like *schlafen* or *da sein*, the phase structure introduced by *noch* and *nicht mehr* applies to the state expressed by the predicates. In contrast, for inchoative verbs like *kommen*, the phase structure applies to the change condition. The effect of this combination is that *noch* extends the initial state, so to speak, thereby creating the future interpretation observed in (4b), while *nicht mehr* negates the final state, thereby extending the presupposed initial state and giving the effect noted for (6b).

In order to show in a unified and systematic way how these different effects come about, the initial phase INIT *e* and the final phase FIN *e* of an event or state must be identified. With these concepts, the phase structure of inchoative verbs indicated in (7) can be defined as follows:

$$(8) \quad e \text{ INST } [\text{BECOME } P] =_{\text{def}} [\text{INIT } e] \text{ INST } [\neg P] : \\ [\text{FIN } e] \text{ INST } [P]$$

In other words, an event *e* that instantiates a change to the state *P* has an initial phase instantiating $\neg P$ and a final phase instantiating *P*.

With this proviso, a unified, compositional analysis of *noch* and its negation can be based on the following conditions:

- (9)(a) What is considered in cases of phase quantification with *noch* is a state or event instantiating a proposition *P*.
- (b) Some part *e'* of *e*, which includes the final phase FIN *e* of *e*, is picked out.

- (c) The proposition P is claimed to be instantiated by e'
– that is, the final part of e .

For a simple one-state predicate, (9) only introduces the condition that the state in question has a final phase, which means that it is followed by a phase instantiating its negation. For an event predicate, however, (9) requires the change from $\neg P$ to P to take place within the phase e' including the final part of e , thereby in a sense extending the initial phase of e .

A more formal account of (9) shows that the properties illustrated by the crucial cases in (4) and (6) follow in a strictly compositional way. Moreover, the phase structure introduced by *schon* and its negation *noch nicht* is obtained if FIN e in (9b) is replaced with INIT e , and “final part” in (9c) with “initial part”.

The main result of this study is the observation that phase quantification must have access to the internal phase structure of event predicates, such that *noch* and *schon* can pick out the final and the initial state of an event, respectively. With this assumption, the intriguing effects of phase quantification can be accounted for in a strictly formal and compositional way.

3.2 Acquisition of Syntax

3.2.1 Functional categories, verb placement, and question formation

J. Weissenborn continued his research on early syntactic development in French, German, and Hebrew, supported by grants from the German-Israeli Foundation for Scientific Research and Development (GIF) and the Deutsche Forschungsgemeinschaft (DFG). In collaboration with R. Berman (Tel Aviv U.) and with assistance from M. Verrips, D. Adone-Resch, and J.

Guichard, he studied further aspects of the development of functional categories and verb placement.

Analyses of adverb placement, negation, and topicalization of constituents other than subjects support the assumption (see Annual Report 1990) that in the acquisition of German, the finite verb moves to the COMP position (hence, appears in second position) as soon as the finite/nonfinite distinction is made; a COMP projection is thus available early to German learners.

Research by M. Haverkort (U. Brabant, Tilburg) and Weissenborn on the acquisition of pronominal clitic placement in Romance languages has suggested that although French learners systematically distinguish finite from nonfinite forms from an early age, they may initially lack a COMP position. Weissenborn and his co-researchers hypothesize that the difference in the availability of a COMP position in the acquisition of German and French may be related to differences in the consistency with which the two languages manifest the verb-second properties that reflect movement of a finite verb to COMP: German is a generalized (fully) verb-second language in which finite verbs always occupy the COMP position in main clauses, whereas French is a residual verb-second language in which finite verbs normally occupy INFL.

In declaratives with a pronominal object clitic, the clitic occupies INFL along with the verb, and is positioned just before the verb, as in *Je la mange la pomme* (I it eat the apple). Children follow this pattern correctly from the beginning (see Annual Report 1988). In positive imperatives with an object clitic, the verb occupies COMP, with the consequence that the object clitic comes just after the verb (e.g., *fais-le!* (do it!)). Children initially make systematic errors with this construction, placing the clitic before the verb (e.g., *la mange!* (it

eat!)) just as in declaratives. (At a second stage they place the clitic in either preverbal (incorrect) or postverbal (correct) position; at a third and final stage they consistently place it correctly.) In standard French, the verb occupies COMP in interrogatives as well as in positive imperatives, with a consequent inversion of subject and verb (e.g., *Jean est-il venu?* (John is he come?) and *Où est-il allé, Jean?* (Where has John gone?)). In the colloquial French children hear, however, the verb normally remains in INFL in interrogatives and there is no inversion (e.g., *Jean il est venu?* (John he is come?) and *Jean est allé où?* (John has gone where?)).

Haverkort and Weissenborn hypothesize that children's shift to correct placement of object clitics in positive imperatives results from their acquisition of verb-to-COMP movement. If so, correct clitic placement in positive imperatives should emerge together with other verb-second constructions in children's language. This prediction seems to be borne out: inversion in WH-questions and topicalizations without clitic copies (e.g., *Des pommes, j'aime* (apples I like)) come in at around the same time as postverbal clitics in positive imperatives. This finding supports the view that parametric variation across languages is located in differences in the system of functional categories like COMP and INFL, which means that the acquisition of these categories is critical for the development of syntax.

The development of a COMP projection is also central to research being carried out by Weissenborn, in collaboration with T. Roeper (U. Massachusetts, Amherst) and J. de Villiers (Smith College), on the development of question formation in various languages. One hypothesis currently being investigated is that in the early grammars of children learning German, SVO projects to IP as a default, and not – as in

adult grammars – to CP. That is, in early German the verb in a declarative SVO sentence would be in INFL rather than in COMP. This hypothesis is based on the finding (see Annual Report 1990) that children can (wrongly) extract from a quotation context like (1):

- (1) *Wie_i hat Hans gesagt: “Das Mädchen kann t_i trommeln?”
 (How_i did Hans say: “The girl can t_i drum?”)

That is, German children often answer this question by naming an instrument, e.g., *Mit den Füßen* (with the feet), instead of the required manner, e.g., *Er hat es laut/leise gesagt* (he said it loudly/softly). This extraction pattern can be explained if we hypothesize that the child analyzes the embedded quotation in (1) as an IP, as shown in (2). This would leave empty the Spec-C position, through which cyclic movement can operate:

- (2) Wie_i hat Hans gesagt [_{CP} SPEC t_i' [_{IP} Das Mädchen kann t_i trommeln]]?

This hypothesis is currently being investigated by presenting children age three and up with embedded quotations in which the preverbal position is filled either with a subject, as in (3a), or a non-subject, as in (3b):

- (3)(a) *Wie_i hat er gesagt: Er trinkt Wein t_i?
 (How did he say: He drinks wine?)
 (b) *Wie_i hat er gesagt: Wein trinkt er t_i?
 (How did he say: Wine drinks he?)

In adult German, neither (3a) nor (3b) allows a reading in which the WH-phrase *wie* (how) refers to the manner of drinking. These sentences are hypothesized to have the structure shown in (4), which does not allow movement of a WH-phrase

out of the embedded quotation because its Spec-position is occupied by the topicalized subject/object.

- (4) [SPEC-C Wein_i [_C trinkt_j [_{IP} er t_i t_j]]]

The prediction is that children, unlike adults, should allow the WH-phrase *wie* (how) to modify the verb of the embedded quotation in sentence (3a), because for them the sentence has the same structure (shown in (2)) as sentence (1). But for sentence (3b), children should not allow the WH-phrase to modify the verb of the embedded quotation, because the presence of the object in the preverbal position in the embedded quotation should clearly indicate to them that the structure of the sentence is as in (4).

This experiment will also test an alternative hypothesis put forward by several investigators that in the early grammars of learners of German, all (declarative) verb-second clauses have a structure as in (2) (i.e., they project to IP), regardless of whether they have a subject or a non-subject in preverbal position. If this hypothesis is correct, children should allow the WH-phrase *wie* (how) to modify the verb *trinkt* (drinks) in (3b) as well as in (3a).

3.2.2 Verb-argument structure

Crosslinguistic perspectives

In collaboration with J. Randall (Northeastern U.), Weissenborn started a project, supported by the DFG (German National Science Foundation), on the acquisition of verb-argument structure in French, German, and – in collaboration with R. Berman (Tel Aviv U.) – Hebrew. It is based on extended longitudinal corpora and experimentation. Much recent research in linguistic theory suggests that argument structure constitutes the interface between the semantic structure of

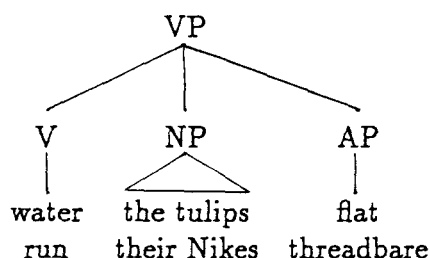
verbs and their syntactic behavior, that is, how the verb and its complements are syntactically realized. The project focuses on three issues: 1) How does the child determine how many arguments a verb has, and which arguments these are? 2) How does the child determine how to link particular arguments to syntactic positions? 3) How does the child solve the learnability problem resulting from verbal diathesis (i.e., determine which verbs are allowed to participate in which syntactic frame alternations; cf. *Mary knitted a sweater for Linda* and *Mary knitted Linda a sweater*; *Mary opened the door for Linda* but not **Mary opened Linda the door*). The project aims at evaluating alternative developmental proposals about the acquisition of verb-argument structure, e.g., semantic vs. syntactic bootstrapping theories. Testing the developmental predictions that follow from the current lexical and syntactic accounts of verbal diathesis in adult language should contribute to this aim.

Resultatives

During her stay at the Institute, Randall continued her theoretical work on argument structure. In collaboration with J. Carrier (Harvard U.), she completed a project on the argument structure and syntactic structure of resultative verbs in English (i.e., the verbs in transitive constructions like *The gardener watered the tulips flat*, intransitive constructions like *The joggers ran their Nikes threadbare*, and unaccusative constructions like *The water froze solid*). The result XP in a resultative (i.e., *flat*, *threadbare*, *solid* in these examples) is an argument of (i.e., is lexically governed by) the verb, as shown by selection restrictions, lexicalization, Adjectival Passive Formation, and long-distance WH-extraction. For transitive and unaccusative resultatives, the postverbal NP (its trace, in the

latter) is also an argument of the verb, as shown by Middle Formation, Adjectival Passive Formation, Nominal Formation, and selection restrictions. Of four candidate syntactic analyses for resultatives – the Ternary Analysis, the Binary Small Clause Analysis, the Hybrid Small Clause Analysis, and the Complex Verb Analysis – only the Ternary Analysis is compatible with this evidence while maintaining standard assumptions about theta-marking:

The Ternary Analysis



Resultatives shed light on necessary reformulations of the Theta-Criterion and the proper condition on predication. For *the tulips* to be theta-marked by both the verb and the result XP, a Relativized Theta Criterion must be introduced; this allows an NP to receive more than one theta-role provided that the roles come from independent heads. Predication cannot be subject to the standard C-command condition but rather must satisfy a mutual M-command condition (see Carrier & Randall, in press, *Linguistic Inquiry*). This explains the ungrammaticality of resultatives like **They laughed sick*, alongside the grammaticality of subject-oriented depictives like *The artist ate lunch drunk* and the impossibility of double depictives like **The artist_i sketched the model_j nude_i drunk_j*.

The conclusions reached about resultatives have implications for the argument structure of verbs in other classes, in-

cluding implicit argument verbs, middle verbs, reciprocal and reflexive verbs, and verbs generally treated as taking a Small Clause (e.g., *consider*). These implications are being pursued in a related project with Carrier on the relationship of argument structure to conceptual structure.

The locative alternation

Brinkmann continued her work on the locative alternation in German, which is exemplified by the following pair:

- (1) (a) Er lädt Heu auf den Wagen.
(He is loading hay onto the wagon.)
- (b) Er belädt den Wagen mit Heu.
(He is loading the wagon with hay.)

The prefix *be-* in (1b) can be regarded as a preposition incorporated into the verb (cf. Wunderlich, in press, in Jacobi (Ed.), *Handbuch der Syntax*) (analogous, for example, to the prefix *über* (over) in *überklettern* (to 'overclimb') – cf. *den Zaun überklettern* (to 'overclimb' the fence) vs. *über den Zaun klettern* (to climb over the fence)). The locative thematic role (*Wagen*), which is assigned case by the preposition in the (a) version, must in (b) be assigned case by the prefixed verb; the locative thus becomes the direct object of the verb.

Although the locative alternation is quite productive in German, not all candidate verbs allow it. Two major classes of verbs that do not are causativized verbs of motion (e.g., *rollen* (to roll)) and transitive verbs specifying motion in a certain direction, e.g., *heben* (to lift). Brinkmann is investigating why such verbs do not alternate in an effort to determine how children learning German could develop a rule for the alternation that is productive, but that does not generate ill-formed sentences like (2b) and (3b):

- (2) (a) Die Kinder rollen Murmeln an die Wand.
(The children are rolling marbles to the wall.)
(b) *Die Kinder berollen die Wand mit Murmeln.
(The children are berolling the wall with marbles.)
- (3) (a) Er hebt Heu auf den Wagen.
(He is lifting hay onto the wagon.)
(b) *Er behebt den Wagen mit Heu.
(He is belifting the wagon with hay.)

Sentences like (2b) appear to be impossible because of constraints on the thematic role of the subject of *be*-prefixed verbs: these verbs require or strongly prefer an agent subject (which can at the same time be a theme). Superficially, it might seem that the agent for (2b) could be *Kinder* (children), just as it is in (2a). But the verb in (2a) is the causativized form of the intransitive verb *rollen*. When *be-* is prefixed to *rollen*, the base verb is interpreted as the noncausativized, intransitive verb *rollen*, whose subject is purely a theme. The desired (2b) reading is thus not available. (Some causativized verbs do take *be-*; cf. *behängen* (to 'behang' – e.g., the walls with pictures)) and *bespritzen* (to 'bespray'), but these differ in certain critical ways from verbs like *rollen*.)

The ungrammaticality of **beheben* (to 'belift') in contexts like (3b) is explained in a different way. (The form *beheben* does exist, but it has a different, more abstract meaning.) As noted, when a verb is prefixed with *be-*, the locative argument formerly assigned case by the preposition is now assigned case by the verb. But transitive verbs denoting motion in a certain direction apparently already incorporate a locative argument; for example, *heben* (to lift), means roughly 'make something go to [UP]'. In consequence, the verb cannot assign case to another locative argument such as *Wagen* (wagon) in (3b), and the derivation is thereby blocked. Evidence from pilot studies

suggests that both adults and children find ungrammatical sentences like (3b) more difficult to process than those like (2b), which supports Brinkmann's hypothesis that they are ungrammatical for different reasons.

In further work on locative verbs, Brinkmann studied the relationship between unaccusativity and auxiliary selection in German. (Unaccusatives, e.g., *treiben* (drift), are intransitive verbs whose subjects have object-like properties; cf. Grimshaw 1987, *Proceedings of NELS*, for an overview.) Counter to current theorizing, Brinkmann found that the choice of *sein* (be) over *haben* (have) as auxiliary in the perfect tenses depends not on unaccusativity, but on whether a change of location is predicated of the sentence-subject. For example, unaccusatives like *treiben* (drift) take *sein* if a change of location is specified by a prepositional phrase, but otherwise *haben*. The effect of change of location on choice of auxiliary does not depend on completive aspect (another hypothesized determinant of auxiliary choice) – for example, even though the event is incomplete in *Paul ist das Ufer entlang geschwommen* (Paul swam along the shore), the auxiliary needed is *sein*.

3.2.3 Negation and modality in Dutch

P. Jordens, in collaboration with T. Hoekstra (U. Leiden), continued his research on early stages in the acquisition of negation and modality in Dutch. The research is based on an investigation of longitudinal diary data from one child between 1;3 (one year, three months) and six years of age. In the initial stages, two negative elements are used in word combinations: *nee* (no) and *niet* (not).

mag *niet* (may not)

poessie hoef *nie* meer (pussy want not more)

Mijnne kannie(t) (Mijnne cannot)
wil *niet* (want not)

poes *nee* teenie bijte (pussy no toe bite)
poessie die *nee* ete (pussy that no eat)
Peter, *nee* poes tafel klimme (P., no pussy table climb)
nee melk Cynthia hebbe (no milk Cynthia have)

The distribution is not random. *Niet* expresses alethic negation (to do with the truth of propositions): it negates a description pertaining to the here and now. *Nee* is a boulemaic modal (to do with desire) meaning "I do not want". In infinitival contexts, it is in complementary distribution with the epistemic (to do with knowledge and belief) modal *kan/mag* + *niet*. This analysis of the child's system of modality can be further supported by taking into account her non-negative utterances: the positive polarity of boulemaic modality is overtly expressed as well – by the element *minne/unne/hunne*, meaning something like "I want", e.g.:

minne hoene uit (I want my shoes off)
hunne Mijnne sijfe (I want Mijnne write)

Until 1;10 there is no syntactic difference between strings with *kan/mag* + *niet* and those with *nee*. In adult grammar, *nee* is an adverb while *kan/mag* is a finite verb, but in the child's grammar both *nee* and *kan/mag* + *niet* are adjoined to the projection of which the non-finite verb is the lexical head.

Around 1;11 three developmental changes take place: 1) the intonation pattern shifts from the doubly-stressed pattern typical of adjunction to an integrative pattern with a single stress on the infinitive; e.g., *kánnie zitten* (cannot sit) becomes *kannie zitten*. In adult language this pattern is characteristic of a head-complement structure, where stress is placed on the

lexical head of the complement. 2) The non-verbal modals *nee* and *minne* disappear. 3) Whereas earlier, *kan/mag + nie* could either precede or follow the non-finite construction, it now only precedes it. These changes suggest that instead of having an adjunctional structure, the child's grammar now has a head-complement structure with the requirement that the head be verbal. What triggers this restructuring? Consider sentences of the type *Mijnne kannie zitten* (Mijnne cannot sit). Under an epistemic interpretation, *Mijnne* is the topic of *kannie zitten*; under a deontic interpretation (to do with obligation and permission), *Mijnne* is the subject of *kannie*. Jordens hypothesizes that it is the acquisition of the deontic interpretation that triggers restructuring of *kannie zitten* as a verbal projection headed by *kannie*.

3.3 Acquisition of Morphology

3.3.1 German noun declension classes

P. Indefrey continued his research on the acquisition of German weak noun declension (nouns that require the 'weak' [-(ə)n] dative or accusative ending include *Junge* (boy) and *Elefant* (elephant)). The class of weakly declined nouns has properties that make it an ideal test case for evaluating alternative theoretical positions on how linguistic rules are represented in the speaker's mind and how this representation is acquired. First, it is small enough to raise the question of conservatism vs. productivity in a new way: is a productive rule-like behavior acquired even if simply learning by heart is a parsimonious alternative? The results of an elicitation experiment indicate that the answer is yes: there is productivity in adults and in children from age seven. Second, members of this noun class have properties that, according to cue compe-

tition and connectionist theories, might pull for generalization along different lines. They are all of masculine gender, a grammatical feature that is critical to correct generalization. But they also share semantic features like 'animate' and 'not female' that are not exclusive to the class of masculine nouns. Work on generalization in adults suggests that these semantic features do not influence generalization. Experiments with children are in progress. Indefrey also continued work, together with R. Goebel (T.U. Braunschweig), on an artificial network model for the acquisition of weak noun declension.

3.3.2 Regular and irregular past participles in German

U. Brinkmann and G. Marcus (MIT) conducted an experiment examining the influence of morphological derivation on adult German speakers' choice of past participles for novel prefixed verbs. Novel verbs were introduced in the infinitival form either as a metaphorical extension of an existing irregular verb (e.g., *verscheren*, from the verb *scheren* (to shear), meaning 'to shear in a wrong way'), or as derived from a noun (e.g., *verscheren*, from *Schere* (scissors), meaning 'to put scissors on'). Subjects were asked to choose between a regular past participle (i.e., *verschert*) and an irregular past participle derived from the base verb (i.e., *verschoren*). Subjects chose more regular forms for the novel denominal verbs, and more irregular forms for the novel deverbal verbs. These results support claims by Kim et al. (1991, *Cognition*, 40) that the choice between regular and irregular inflection depends on formal grammatical structures such as syntactic category and morphological structure.

3.4 Acquisition of phonology

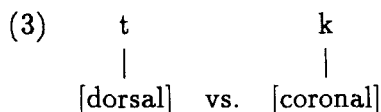
3.4.1 Phonological representations

A. Lahiri and L. Naigles (Yale U.) have begun to investigate language-specific phonological contrasts in children learning English and Dutch. Among other questions, this project asks whether two-year-olds have all the phonological contrasts available in the adult language, and what their quantitative and featural representations consist of. Recent phonological theory has been particularly interested in whether consonants and vowels share features, and this question is equally important for childrens' phonological representations.

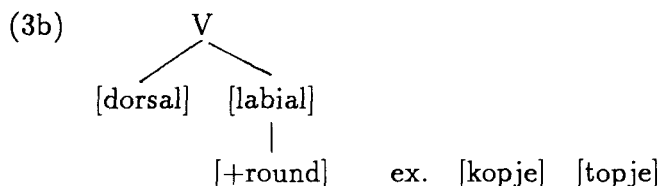
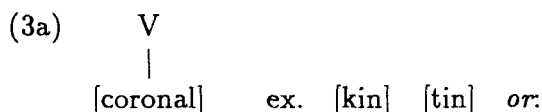
Exploiting the Principle of Contrast (see Section 3.5), Lahiri and Naigles asked two- and three-year-old Dutch children to match novel words (either nonwords or words unlikely to be known by children) with novel objects. Each novel word differed from a known word in either quantity (i.e., vowel length) or one phonological feature. The paired novel and known words were taped and digitized in sequences like *Here is X and this is Y*, (repeated), *Could you show me Y?* The sessions were video-taped and the pictures the child chose were noted.

The following contrasts were tested (see Lahiri & Evers, 1991, on the feature geometry):

Known word		Novel word	
(1)	$\begin{array}{c} X \quad X \\ \backslash \quad / \\ V \end{array}$	vs.	$\begin{array}{c} X \\ \\ V \end{array}$
		ex.	[fi:ts] [fits]
(2)	$\begin{array}{c} X \\ \\ V \end{array}$	vs.	$\begin{array}{c} X \quad X \\ \backslash \quad / \\ V \end{array}$
		ex.	[vis] [vi:s]



with vowels which are either



- (4) [labial] [b]/[p] vs. [coronal] [d]/[t] with above vowel contrasts (e.g., [bo:m] [do:m] vs. [bed] [det])

Results indicate that children have difficulty distinguishing length contrasts (1 and 2) regardless of whether the real word contains a long or a short vowel. Quantity does not seem to be represented at this age. The ability to distinguish [dorsal] from [coronal] consonants depends on the following vowel: children are poor at the distinction when the vowel is [coronal] (3a), but not when it is [dorsal] [labial] (3b). Since children can distinguish between words beginning with different [labial] consonants followed by a [coronal] vowel (4), the problem lies not with the [coronal] vowels themselves, but with the combination of [coronal] vowels and [coronal] or [dorsal] consonants. One hypothesis about why children have trouble with contrasts like (3b) is that [dorsal] consonants, which emerge relatively late in production, do not yet have a fully

specified representation. If features like [coronal] spread from the vowel to the consonant, the representations of [kin] and [tin] are indistinguishable. The results indicate that there is a close relationship between consonants and vowels, and that there may be a common system of features for both in children's phonological representations.

3.4.2 Infants' sensitivity to phonotactic constraints

A. Friederici, J. Wessels, and A. Deckers continued their research on the basis of speech segmentation in early infancy (see Annual Report 1990). A series of experiments was run to test infant's sensitivity to the phonotactic constraints of their native language. Such constraints might provide cues for parsing speech into words or syllables.

Earlier findings showed that 9-month-old Dutch infants prefer phonotactically legal to illegal strings (e.g., they attend longer to *BREF* than to *FEER*) when items are presented in isolation, but not when they are presented in a multisyllabic context (e.g., *lunt BREF par* vs. *lunt FEER par*). A new series of experiments tested whether the preference for legal strings might be evidenced in multisyllabic contexts after all if the complexity of the context was reduced or if the items were presented with an exaggerated stress pattern typical of speech directed to babies.

In a first experiment contexts were simplified by using the same syllable as both left and right context for the critical item (e.g., *mig BREF mig*). But 9-month-olds still showed no preference for the legal items. In a second experiment the critical items received exaggerated stress, but again there was no preference for legal structures.

In these experiments, a trial lasted 30-32 seconds. Perhaps this was too long: attention varied enormously across trials,

suggesting that infants' overall attention span dropped during the course of the test session. In a third experiment the length of the trials was reduced to 15-17 seconds – exposure times commonly used by other researchers in the field. Infants now attended longer to legal than illegal structures, but the difference still failed to reach significance. Perhaps the difference might have been stronger if reducing the length of the trials had not also entailed reducing the amount of speech input.

To test this possibility, new speech samples were created in which the pauses between speech fragments were reduced from 1250 ms to 800 ms, so that infants received more speech input than in the third experiment even though trial length was the same. These samples were first tested to see if the preference for legal items presented in isolation could be replicated. It was. Next the samples were embedded in multisyllabic contexts. Under these conditions, however, no preference for legal strings was found.

Thus, 9-month-old infants can detect illegal phonotactic sequences provided that they appear in isolated syllables. Whether they can also detect them in multisyllabic contexts is still unclear; this will be further explored in experiments using a simple noun phrase as the context (e.g., *een BREF* (a BREF)). At any rate, at present it seems unlikely that infants use phonotactic constraints as cues for segmenting the speech-stream.

3.5 Lexical development

During her sabbatical year at the Institute, E. Clark (Stanford U.) worked on a monograph on lexical development and word-formation in young children acquiring different languages. She

also analyzed data for two ongoing projects: 1) What do children know about verb forms that can be used for talking about resultant states following from some prior action? This work is being carried out in English and Hebrew (with R. Berman, Tel Aviv U.), with further data from Cantonese (with S. Lee Cheung, East Carolina U.) as part of a larger study of the notion of "goal" in young children. The data from all three languages support the view that children learn forms for "results" very early. 2) What meanings do children assign to unfamiliar verbs when they are asked to act them out? The data offer strong support for the view that children consistently assign meanings on the basis of the Principle of Contrast (the assumption that different forms have different meanings; E. Clark, 1983, in Flavell & Markman (Eds.), *Mussen handbook of child psychology*, Vol 3).

Clark also continued her work on the role of speaker-perspective in lexical development. In analyzing diary data, Clark and T. Svaib (Stanford U.) found that children as young as 1;8 were willing to accept or use two different labels for the same thing, clearly showing some ability to represent an entity from different perspectives (e.g., they would say either *horse* or *seat* for a toy horse on wheels). To explore this ability further, Clark and Svaib showed pictures of anthropomorphized animals from children's books to two-year-olds and asked, for example, about both *cat* and *animal* or about both *cat* and *sailor* in reference to the same picture. Two-year-olds were very competent in both accepting and using multiple labels. Children apparently begin to recognize very early that lexical choice serves to represent different perspectives. The diary and experimental data raise doubts about children's reported inability to use more than one label per referent in the early stages of lexical development.

3.6 The acquisition of referring expressions in Chinese

R.F. Min continued her dissertation research on early phases in the acquisition of referring expressions by children learning Mandarin Chinese. Based on longitudinal data from five children, the study focuses on the acquisition of contrasts between the third person pronoun and other noun phrases in a crucial discourse function: making and maintaining reference.

The often-cited contrast between 'first mention' and 'subsequent mention' is insufficient to explain speakers' choices among alternative forms. Choices also depend on whether the intended referents are specific for (can be singled out by) the addressee. Thus, three referential conditions are distinguished in Min's study: 1) The intended referent is nonspecific or new to the addressee; 2) The intended referent is specific because it is present in the nonlinguistic context; 3) The intended referent is specific because it is given by the shared knowledge of the speaker and addressee. Preliminary analyses of samples from the corpus of one child at 1;6, 2;0, 2;7, and 3;3 (age is given in years; months) show that before 3;3, the child seldom followed the common adult practice of introducing a referent with a noun preceded by a numeral and a classifier. For both first and subsequent mentions, she used pronouns, bare nouns, or nouns preceded by an adjective. Since, like most children at this age, she talked mainly about the here-and-now, her intended referents could usually be identified. Once the child began to use nouns preceded by a numeral determiner, she often used them for introducing new referents. Her forms for subsequent mentions of referents were more complicated. Pronouns were not very frequent before 3;3. Min is currently investigating determinants of the choice between

nouns, pronouns, and zero pronouns.

3.7 Form-function mappings

During her stay at the Institute, N. Budwig (Clark U.) completed a draft of a book outlining a developmental-functionalist approach to child language, and summarizing findings from a series of studies on early stages in the acquisition of the pronoun system of English. Together with A. Wiley (Clark U.), she also carried out new analyses of the role of caregiver input in the development of pronouns. This research suggests that semantic-pragmatic contrasts drawn by the choice among *I*, *my*, and *me* as sentence-subject in some children's speech, though seemingly creative, are more closely related to patterns in caregiver input than Budwig had originally proposed. In an attempt to better understand the relationship between caregiver input and the social-cognitive underpinnings of children's early links between form and function, Budwig also began to collect German data for crosslinguistic comparisons.

M. Bamberg (Clark U.) continued his crosslinguistic investigation of references to emotions in narratives. The data, consisting of story completions and descriptions of scenarios in which the subjects themselves experienced emotions, come from speakers of American English, Chinese, German, and Japanese. Of particular interest is whether six- to twelve-year-old children learning different languages follow different developmental routes in linking functions to forms.

3.8 Second language acquisition

3.8.1 Input in second language acquisition

The Input Project explores the role of input factors during the earliest phases of foreign-language acquisition, focusing on the segmentation of continuous speech, the acquisition of phonological and phonotactic knowledge, and the mapping between sound and meaning (see Annual Report 1989). Several studies were conducted in which native speakers of Dutch with no knowledge of Chinese were presented with Chinese input. The experiments made use of a 15-minute videotape in which a speaker of Chinese tells two stories that are illustrated in cartoon-like fashion. Some subjects were exposed to both the audio- and the video-track, others heard only the audio-track, and still others (controls) received no input at all. Subjects were subsequently tested on a number of on-line tasks. The results from experiments on segmentation and phonological factors have been presented in previous Annual Reports (1989, 1990). One study suggested that listeners rely heavily on what is distinctive in their native language when categorizing foreign speech sounds. In 1991 a number of control experiments was carried out to allow these data to be interpreted more confidently. It was shown that the effects indeed involve subjects' categorization of speech sounds, and are not due merely to strategies induced by the experimental situation.

In another experiment the mapping between sound and meaning was explored. After seeing the full input video, subjects were presented with correct and incorrect combinations of spoken words and pictures of objects from the film, and asked to decide whether the words went with the objects. Correct performance was strongly related to the two factors manipulated in the input: the frequency with which words were

used and whether or not an object to which a particular word referred was visually marked.

3.8.2 Utterance structure and temporal/spatial reference

Continuing his work on the second language acquisition of adult immigrants, C. Perdue compared the way such learners structure their utterances, as established in previous analyses, with the way they express temporal and spatial relations. The initial corpus consisted of retellings of a film, repeated three times at approximately ten-month intervals, by twenty adult learners of each of four target languages: Dutch, English, French, and German. In these learners' production, there was a regular transition from "nominal utterance organization" (NUO), to "infinite utterance organization" (IUO), to "finite utterance organization" (FUO) (see Annual Report 1990). This transition is gradual, and different types of organization often coexist. Not all learners attain the level of FUO.

These data were compared with personal narratives and instruction-giving from the same learners during the same period of observation. The retellings and personal narratives are similar to each other in the topic-focus organization of utterances (see Klein & v. Stutterheim, Annual Report 1986), but the two genres differ in other respects, e.g., a narrative, but not a retelling, privileges *first person* reference and must be anchored in *past time*. In the instructions, the learner tells a naive experimenter to move about and to manipulate sundry objects according to a pre-defined sequence (as a director would instruct an actor). In all three speech genres – retellings, narratives, and instructions – the learner has to relate a *theme* (=entity to be located) and a *relatum* (=entity

in relation to which the theme is located; see Klein, Annual Report 1987). In a personal narrative, the initial relatum is the past time span, which may be expressed deictally or by a nondeictic adverbial as in (1), which represents the first utterances of the first narrative of a Hispanic learner of French:

- (1) [Ze] mm + quand petit + la mer <gesture of fright>
 (I mm + when little + the sea <">
 mais moi la mer + les vague ... <gesture pulling out to sea>
 (but me the sea + the waves ... <">
 (+ indicates pauses)

In the stage directions, the addressee or the manipulated object is the theme, while the position the theme comes to occupy at a goal is the relatum. Expressions for change of location are acquired first, but they are produced only if the context alone is insufficient to convey the information. Beginners often leave the movement implicit, relying on the iconic order *theme* + *relatum* to indicate the instruction, as in (2), an example from a Turkish learner of German:

- (2) aschenbecher + tasche
 (ashtray + bag)
 < = put the ashtray into the bag>

Word order is the only means available at the outset to distinguish theme and relatum (Carroll, 1991, *Linguistics*, 28). The *relatum* + *theme* order is used later on to identify a non-salient theme, but this is only possible when word order can be supplanted by local oppositions between definite vs. indefinite article, as in (3), from an Italian learner of German:

- (3) in die tasche + eine zeitung
 (in the bag + a newspaper)
 < = there is a newspaper in the bag>

Before learners develop the definite/indefinite article opposi-

tion that permits the inverse order, the specification of a non-salient theme poses communicative problems. Local markings tend to be acquired *before* major constituents begin to be reordered, a phenomenon also noticed in analyses of the retellings (Annual Report 1989).

The overall course of development is clearly from NUO via IUO to FUO, which reinforces the initial findings from the retellings. Learners who achieve a FUO in the retellings also do so in the other two speech genres. Adverbial means are acquired earlier than tense to locate personal narratives in the past. In particular, *when* phrases (as in 1) appear early: almost all learners of the four target languages used them by the end of the first cycle of observation. The relatum of the temporal topic of utterances becomes relatively complex in the personal narratives earlier than in the retellings. Tense is a particularly late development overall.

One hypothesis of the original study (see Annual Report 1987) was that personal, spatial, and temporal relations would first be expressed by deictic means. This turned out not to be the case. For temporality, learners initially use both deictic and nondeictic relata. *When* phrases, as in example (1), provide learners with a unique device to refer to a previously-mentioned or about-to-be-mentioned event in the past or future. For space, the first-learned expressions to denote change of location are used independently of deictic correlates. The dominance of deixis is nevertheless manifest in personal reference: from the beginning, first person pronominal forms, such as *ze* and *moi* in example (1), are used systematically and contrastively. Anaphoric third person use develops significantly later. For adult learners, there is no appropriate alternative to a pronoun for self-reference.

3.8.3 Second language acquisition and Universal Grammar

P. Jordens tested claims about the relevance of Universal Grammar for second language learners. Felix (1988, in Flynn & O'Neil (Eds.) *Linguistic theory in second language acquisition*) and White (1989, *Universal grammar and second language acquisition*) argue that learners draw on principles of Universal Grammar to discriminate between grammatical and ungrammatical sentences in L2. They have tested this experimentally, using constructions for which L2 learners cannot draw on knowledge of L1 to make the distinction.

In Dutch, WH-extraction is possible both from subject position and object position, as shown in (1) and (2), respectively. In English, in contrast, WH-extraction is possible in constructions like (2) but not (1), due to the so-called *that*-trace effect.

- (1) Dutch: Wie zei Mary dat e het glas gebroken heeft?
(who said Mary that e the glass broke)
English: *Who did Mary say that e broke the glass?
- (2) Dutch: Wat denk je dat Mary zal doen e?
(what think you that Mary will do e)
English: What do you think that Mary will do e?

White has found that Dutch learners of English regard sentences like (1) as less correct than sentences like (2) in English. Since they cannot rely on Dutch for this information, White assumes that they have access to the principles of Universal Grammar responsible for blocking the extraction in English.

To test this claim, Jordens presented Dutch learners of English with Dutch sentences like (3), which are compatible with both subject extraction and object extraction, and asked them to indicate their preference for either *hij* (he), indicat-

ing an object-extraction reading, or *hem* (him), indicating a subject-extraction reading.

- 3) Wie hoop je dat hij/hem benoemt?
(Who do you hope that he/him appoints?)

Native speakers of Dutch clearly prefer the object-extraction reading to the subject-extraction reading even when both readings are in principle possible. This suggests that acceptability in L1 is not an all-or-none question. Some structures may be difficult to process, even though they are technically grammatical. In such cases L2 learners might judge the L2 equivalents as less correct than sentences conforming to their preferred reading. In sum, White's findings can be explained without appealing to L2 learners' knowledge of Universal Grammar.

3.9 Other work

3.9.1 Reference-tracking

During his two-month stay at the Institute, B. Comrie (U. Southern California, Los Angeles) worked on a book on the typology of reference-tracking systems. The book will cover the following phenomena, among others: reflexives (including long-distance reflexives and logophorics), gender-agreement systems as a means of reference-tracking, switch-reference (means of marking a dependent clause according to whether its subject is the same as or different from the subject of the clause on which it is dependent), and obviation (grammatical distinction among third person participants, depending roughly on which is most salient in the discourse; including also reference-tracking in sign languages).

3.9.2 Language learning in a robotic system

M. Böttner, in cooperation with P. Suppes and Lin Liang (both Stanford U.) continued to develop a natural-language learning interface for a robotic system that can be taught to execute, in an appropriate environment, commands like "Put the screw left of the nut into the hole between the washer and the black nut". In contrast to many other approaches to machine-learning, the present project is 'semantic' (rather than 'syntactic'), in that it is based on the assumption that the robot is in command of an internal language whose categories are related to the perceptual and manipulative abilities of humans. Natural languages are taken to be learned by associating entities of the natural language with entities of the internal language. The associations are based on probabilistic sampling. The system is an application to language learning of a set of learning axioms, in particular, certain principles of association and generalization. Context-free comprehension grammars have been generated for English, Chinese, German, and French on the basis of a set of roughly 500 commands with equivalent meanings across the four languages.

4. Language Disorders

1991 was the last year of the second five-year period of the NWO Priority Project "Aphasia in Adults". As described in previous reports, the project has focused on agrammatism in Broca's aphasia. Over the course of the project, the members arrived at an agreement with respect to two fundamental issues: 1) The deficit underlying agrammatism is a processing deficit, and not a loss of syntactic representational knowledge; 2) Patients try to cope with their deficit by developing adaptive strategies. Activities in 1992 were intended to round off certain areas of research, but in some cases new questions were raised instead. One completed project was the standardization and norming of the Dutch version of the Aachen Aphasia Test; the test will be on the market in 1992.

A. Friederici and K. Kilborn have hypothesized that the processing deficit in Broca's aphasics is a loss of automaticity of syntactic processes. In contrast, H. Kolk (U. Nijmegen) and H. Haarmann have proposed that syntactic information is activated too slowly. These hypotheses both predict that syntactic information will be accessed more slowly by Broca's patients than by normal speakers. The loss of automaticity hypothesis makes other predictions as well. One characteristic of automatic processes is that they cannot be consciously controlled. Friederici and H. Schriefers (F.U. Berlin) have tried to show that Broca's aphasics differ from normal speakers in that they *can* control syntactic processes, which indicates that these processes are not automatic any more. Friederici and Kilborn investigated whether loss of automaticity, including

loss of speed, affects the processing not only of closed-class elements, as shown in previous research, but also of open-class elements – verbs, in this case. Kolk and Haarmann have conducted further experiments to test their slow activation hypothesis.

The adaptation hypothesis has been tested during the project primarily by examining various features of the spontaneous speech of Broca's aphasics. Kolk and C. Heeschen have suggested that the telegraphic style typically found in these patients' speech is due to systematic simplification of syntactic structures. Thus, adaptation is located within the linguistic machinery. In contrast, Friederici has proposed that adaptation is located in the general processor, which has to compensate for the deficient output of the language processor. These views do not necessarily conflict, since Kolk and Heeschen have studied language production whereas Friederici has focused on comprehension. Further research is needed to clarify whether the two hypotheses are compatible.

An important feature of Kolk and Heeschen's adaptation approach is the assumption that Broca's and Wernicke's aphasics do not differ in their underlying deficit but only in adaptation: Broca's aphasics adapt to the deficit whereas Wernicke's aphasics do not. To determine why there is this difference, Heeschen has conducted comprehensive studies of the emotional status of patients in the two groups.

4.1 Loss of automaticity

A. Friederici and H. Schriefers (F.U. Berlin) investigated the effects of age and focal brain damage on processing semantic and syntactic information during sentence comprehension. In their experiments, subjects saw target words (printed in capi-

tals) preceded by a grammatical (see 1 below), ungrammatical (see 2, 3, and 4), or neutral (5) sentence context. Ungrammaticality was induced by a semantic violation (selectional restriction of the verb, see 2), syntactic violation (syntactic gender marked in the article, see 3), or both (see 4). The subject's task was to decide as rapidly as possible whether or not the target was a word by pressing one of two buttons.

- (1) Der Mann liest die ZEITUNG.
(The man reads the NEWSPAPER.)
- (2) *Der Mann trinkt die ZEITUNG.
(The man drinks the NEWSPAPER.)
- (3) *Der Mann liest den ZEITUNG.
(The man reads the (masc.) NEWSPAPER (fem.).)
- (4) *Der Mann trinkt den ZEITUNG.
(The man drinks the (masc.) NEWSPAPER (fem.).)
- (5) Das nächste Wort is ZEITUNG.
(The next word is NEWSPAPER.)

Target words were presented in both unmasked and masked conditions (e.g., ZEITUNG vs. Z*E*I*T*U*N*G). In experiments with normal young adults (see Annual Report 1990), lexical decision times for the targets were systematically affected by the grammaticality of the preceding context: reactions were slower after contexts containing semantic violations than after the other contexts, and this context effect was stronger for masked than for unmasked targets. The present experiment investigated whether the reduction of central resources that older adults supposedly experience would also affect the size of the context effects. If so, context effects in

the unmasked condition should be larger for older than for younger adults. Seventeen older adults between 45 and 74 years of age (mean age: 57 years) participated in the experiment.

As expected, more pronounced context effects were obtained for older than for younger adults. Appropriate grammatical contexts (condition 1) had a facilitatory effect compared to neutral contexts (condition 5), while ungrammatical contexts (conditions 2-4) had an inhibitory effect. Older adults apparently rely more heavily than younger adults on contextual information in recognizing target words, and they are at least as sensitive to morphosyntactic violations.

Stimulus degradation affected the performance of young adults differently than the supposed reduction of central processing resources affected older adults: the former reduced the strength of the semantic effect, while the latter increased it. Neither stimulus degradation nor reduction of central processing resources affected syntactic processing, which indicates that syntactic processes are highly automatic.

What happens, then, when the automaticity of syntactic processes is reduced? Agrammatic Broca's aphasics can help answer this question, since, according to Friederici and Schriefers' hypothesis, their deficit is a loss of automaticity of syntactic processing. Friederici and Schriefers repeated the experiment just described with six agrammatic Broca's patients, five fluent Wernicke's patients, and seventeen age-matched control subjects.

In the earlier study, as noted, normal young adults reacted more slowly in conditions (2) and (4), which involved violations of selectional restrictions, than in the neutral condition (5). There was no effect of gender mismatch alone (condition 3). In the present study, this pattern was replicated for

the aged-matched control subjects. The reactions of Broca's aphasics, in contrast, were much slower in condition (2) (selectional restriction violation but no gender mismatch) than in conditions (1), (3), and (4); reaction times in these latter conditions did not differ. The patients displayed large interindividual variance in the neutral condition (5). No specific context effects were found for Wernicke's patients.

These results suggest that normal subjects' access to nouns is affected by violations of selectional restrictions regardless of whether the sentence is otherwise grammatical or contains an ungrammatical gender violation. In contrast, Broca's patients are affected by semantic violations only when they appear in syntactically correct sentences. The occurrence of a gender mismatch seems to terminate integration processes before semantic violations can take effect. This implies that Broca's patients are able to detect syntactic gender violations. The presence of an advantage for syntactically correct over incorrect sentence contexts for Broca's patients, but not for normal subjects, suggests that parsing is not an automatic process for these patients, but can be controlled to some extent.

4.2 Timing in the access and integration of syntactic and semantic information

K. Kilborn, A. Friederici, and A. Kaiser (U. Nijmegen) completed their study of timing in the comprehension of verb-argument structures in German-speaking Broca's aphasics and normals (see Annual Report 1990). According to one widely accepted view, the processing of closed-class words is impaired in Broca's aphasics but the processing of open-class words is not. This hypothesis predicts that Broca's aphasics should be able to process the grammatical information about argument

structure contained in verbs, since verbs are open-class words. Test sentences for an auditorily-presented lexical decision task were constructed so that the main verb, which was the target for lexical decision, always occurred in the final position in past participle form. The verbs belonged to one of four argument-structure types of increasing complexity: one-place (intransitive), two-place, optional two- or three-place, and obligatory three-place (all transitive). Some sentences were grammatical and others were ungrammatical, either because they had case marking errors (e.g., dative article *dem* instead of correct accusative article *den*) or because an obligatory object was omitted.

Argument structure complexity alone did not affect the reaction times of either the normals or the Broca's aphasics, nor did case marking errors. When obligatory objects were omitted, however, the reaction times of both the normals and the aphasics increased with increasing argument-structure complexity. This indicates that Broca's aphasics indeed retain the ability to extract and use the structural information encoded in verbs.

A second experiment was run in which the nominals in the sentences used in the first experiment were replaced by pronouns, which have minimal lexical content but still carry case information. Unlike in the first experiment, the reaction times of normals and Broca's aphasics did not increase with increasing argument-structure complexity even when obligatory objects were omitted. However, the normal subjects were significantly slower than in the first experiment, whereas the aphasic subjects were significantly faster than in the first experiment and made fewer errors. These results are suggestive with respect to the hypothesis that Broca's aphasics suffer from a timing deficit, but follow-up work is needed before a

firm conclusion can be reached.

4.3 Slow activation

H. Haarmann and H. Kolk (U. Nijmegen) conducted several pilot experiments to further explore their hypothesis that Broca's aphasics suffer from a delay in syntactic activation that especially disturbs the processing of syntactically complex sentences. Students, elderly control subjects, and Broca's aphasics were tested in a series of auditory word monitoring experiments. The critical sentences were varied along three orthogonal dimensions: first, grammaticality: in some sentences (see 1, 3, 5, and 7 below) the subject (*the baker*) and a verb (*ask(s)*) agreed in number, whereas in other sentences (see 2, 4, 6, and 8 below) they did not agree; second, complexity: the sentence included either a coordination of two verb phrases (as in 1, 2, 5, 6) or a relative clause (as in 3, 4, 7, 8); and third, consistency: the direct object of the first verb (*customer(s)*) was either consistent in number with the subject (as in 1-4) or inconsistent (as in 5-8). The direct object of the second verb (BOY) was the target to be monitored for.

- (1) The baker greets the customer and asks the BOY not to make so much noise.
- (2) The baker greets the customer and ask the BOY ...
- (3) The baker that greets the customer asks the BOY ...
- (4) The baker that greets the customer ask the BOY ...
- (5) The baker greets the customers and asks the BOY ...
- (6) The baker greets the customers and ask the BOY ...
- (7) The baker that greets the customers asks the BOY ...
- (8) The baker that greets the customers ask the BOY ...

Students showed a significant grammaticality effect (i.e., faster monitoring times for grammatical than for ungrammat-

ical sentences) for both simple and complex sentences in the inconsistent condition (they were not tested in the consistent condition.) Elderly control subjects showed a significant grammaticality effect only for complex sentences, regardless of consistency. Finally, Broca's aphasics showed a grammaticality effect only in the consistent condition. The subject-verb agreement error in the ungrammatical condition can only be detected after a syntactic representation of the input sentence has been constructed. The absence of a grammaticality effect in the inconsistent condition in the Broca's aphasics suggests that they either did not construct a syntactic representation or that their syntactic processing was delayed so that the representation was not completed when they encountered the target noun. On this view, the grammaticality effect obtained in the consistent condition must have had a non-syntactic basis. Perhaps sentences in which singular or plural morphemes are repeated are easier to process than sentences in which these morphemes alternate. The possibility of a syntactic delay is currently being investigated in an experiment in which patients are given more time to complete syntactic processing before they encounter the target noun.

4.4 Adaptation, emotional status, and ability to make grammaticality judgments

C. Heeschen finished his studies of depression in aphasic patients. He hypothesized that adaptation is a symptom developed to protect against "catastrophic conditions" (Goldstein, 1971, *Language and language disturbances*), i.e., situations in which patients fail to produce complete and correct sentences no matter how hard they try. Goldstein's "catastrophic conditions" can be reinterpreted as situations involving "learned

helplessness" (cf. Seligman, 1975, *Helplessness: On depression, development, and death*). By adaptation – i.e., by adjusting their level of aspiration to their restricted syntactic abilities – patients can escape this depression-causing situation. Heeschén predicted that if this interpretation is correct, Broca's patients in the *chronic* phase should not be particularly depressed; in particular, they should not be more depressed than Wernicke's patients.

Forty-eight patients were tested for depression with the Hamilton Scales (external rating) and Beck's Inventory (self-rating). The two tests were usually administered within two weeks of each other. The patients were 15 Broca's aphasics, 13 Wernicke's aphasics, 8 anomics, 2 global aphasics, 4 conduction aphasics, 4 transcortical aphasics, one non-classifiable patient, and one patient with rest aphasia. Crucial for testing the hypothesis outlined above were the Wernicke's and Broca's aphasics; the others were important for checking the reliability and validity of the tests.

The mean score on the Hamilton Scales was 3.07 for the Broca's aphasics and 9.31 for the Wernicke's aphasics; on the Beck Inventory, the scores were 8.93 and 12.31, respectively. (For comparison: although a clinical psychologist or psychiatrist would not base a diagnosis on Hamilton or Beck scores alone, Hamilton scores of 8 or more and Beck scores of 15 or more can be taken to indicate at least mild depression.) On a bivariate test, the group difference was significant.

The low degree of depression in the Broca's patients was predicted, but the higher degree in the Wernicke's patients was surprising. Thus, checks on interrater-reliability and validity became essential, especially since the tests are both verbal scales, and were not designed with verbally handicapped subjects in mind.

First, interrater reliability of the Hamilton scores was established by having two experienced clinical psychologists code 12 of the audiotaped interviews. To establish validity, correlations of Hamilton and Beck scores were computed. For non-aphasic subjects in other studies, a fairly wide range for the correlation coefficient between Hamilton and Beck scores has been reported, but $r = .60$ is probably a good estimate. A subject's Hamilton score is usually lower than the Beck score by three to five points. In our sample, a correlation of .57 was obtained, and the mean Hamilton and Beck scores were 5.4 and 10.5, respectively. These results thus correspond well to those obtained for other samples.

As a further test of validity, 42 patients were also tested on Kuhl's Hakemp Test (Kuhl, 1983, *Motivation, Konflikt und Handlungskontrolle*), which assesses "state- vs. action-orientation". A low score on the Hakemp Test has been shown to be a good predictor for an inclination toward depression. If the Hamilton and Beck scores for the aphasics are valid, they should correlate negatively with the Hakemp scores, and they do: $r = -.31$ and $-.34$, respectively, with both coefficients significant.

Finally, the validity of the depression scores was tested experimentally. According to the learned helplessness theory of depression, depressed subjects should do worse on the second administration of a task than on the first if, between the two administrations, they are exposed to a learned helplessness situation, i.e., a situation in which they consistently fail. In an experiment with 34 patients, the critical task was a version of Benton's Line Orientation Test, a perceptual task considered fairly easy by most normals and aphasics. Between the first and second administrations of the test, the patients had to perform an objectively insolvable task: they were given

far too little time to find the way through a pictured maze. Patients with more than 15 points on Beck's Inventory were classified as at least mildly depressed and patients with less than 8 points as not depressed; with these criteria, 8 clearly depressed patients and 18 clearly non-depressed patients were identified (the classification also agreed with the judgment of the clinical psychologist who had administered the Hamilton Test). Of the 8 depressed subjects, 5 performed more poorly on the second than on the first administration of the Line Orientation Test; of the 18 non-depressed subjects, in contrast, only 2 performed more poorly (the difference is significant by Fisher's exact probability test). This result agrees with established findings for depressed vs. non-depressed normal subjects, which again indicates that there is no reason to question the validity of the aphasics' scores on the Hamilton and Beck Tests.

Recall that adaptation theory predicts low depression scores for Broca's patients, but not necessarily higher scores for Wernicke's patients. The unexpectedly high scores of the Wernicke's patients prompted Heeschen to carry out a grammaticality judgment experiment. In order to adapt to a deficit, patients must have a fairly good idea of what they cannot do. Broca's aphasics can usually give fairly accurate grammaticality judgments, which has been taken to imply that they can also evaluate their own linguistic ability adequately and so develop adaptive strategies. In contrast, Wernicke's patients are commonly assumed to be unaware of or unconcerned with their syntactic deficiencies; hence they do not adapt and are not expected to be depressed (sometimes they have even been considered euphoric). In one condition of Heeschen's experiment, patients had to indicate whether there was an error in each of a series of auditorily presented sentences. Half the

sentences indeed contained an error. In the second condition, the patients were truthfully informed beforehand that there would be an error in each sentence; their task was to indicate whether it was in the first or second part of the sentence. The Broca's patients performed considerably better than the Wernicke's patients in the error detection condition, but the two groups did not differ in the error localization condition. The Broca's patients performed slightly worse in the detection than in the localization condition, as would be expected for normals; in contrast, the Wernicke's patients were better at locating errors than at simply detecting them.

This surprising result requires follow-up investigations. Heeschen's preliminary interpretation is as follows. Contrary to common wisdom, Wernicke's patients are not insensitive to grammatical abnormalities, but they cannot judge whether an abnormality is really an error or only a tolerable deviance. In the error location task, they know that all sentences contain errors so they do not have to decide between these alternatives; in consequence, they perform as well as Broca's aphasics. If this interpretation can be extended to patients' evaluation of their own speech, then Wernicke's patients are in a worse situation than Broca's patients: they suspect that their speech is not normal, but – unlike Broca's patients – they are not certain, and so they cannot adapt efficiently. Being in this situation resembles being in a learned helplessness situation, and it might contribute to the higher degree of depression in Wernicke's patients.

4.5 The Aachen Aphasia Test

P. Graetz, together with R. De Bleser and K. Willmes (both RWTH, Aachen), completed the analyses of the Dutch version

of the Aachen Aphasia Test (AAT) data (see last year's Annual Report for the psychometric characteristics of the Dutch AAT). In 1982-1990, 820 tests were administered, including 735 first tests and 85 retests. An initial validation sample was compiled from 180 of these tests, including 30 tests each from Broca's aphasics, Wernicke's aphasics, global patients, anomics, right hemisphere lesion patients, and subjects without neurological impairment.

In 1991, 342 of the remaining tests were added to the validation sample, bringing the total to 522: 422 from aphasic patients and 100 from normal controls. Test norms were developed from this sample for establishing the presence and severity of aphasia and for detecting specific syndromes (global aphasia, Broca's aphasia, Wernicke's aphasia, anomia, conduction aphasia, and transcortical aphasia) and modality-specific deficits (e.g., alexia, agraphia). In addition, norms were established for comparing different subtests and retests. A menu-based PC-program is available to help in the evaluation of test results.

5. Cognitive Anthropology Research Group

5.1 Beginnings

The Research Group for Cognitive Anthropology has been founded to further research into the relationships between culture and cognition by conducting in-depth fieldwork on leading issues of common interest to anthropology, psychology, and linguistics. There are many important questions about the nature and extent of universal human intellectual endowments in various domains, for which there has hitherto been little reliable cross-cultural data. The Group's goal is to fill some of these gaps, and to contribute to the development of more sophisticated theories about the relationship between learned and native abilities, about the contribution of culture to cognition, and about the nature and transmission of culture itself and its relation to social structure and process. It also aims to develop new methods for studying cognitive and linguistic processes in field conditions.

While sharing administrative, technical, and library resources with the Institute, the Research Group is in principle intellectually autonomous from it. One of the main reasons for locating the Group in Nijmegen, however, is the many kinds of cross-cutting ties between projects in the Institute and in the Group, and the many kinds of psychological, linguistic, and technical expertise available within the Institute.

Installation and inception

The Research Group was founded on August 1, 1991, as the successor to a Max-Planck-Projektgruppe in Berlin. The Institute's administration oversaw the construction of a fine temporary building, and the Institute's Technical Group, augmented by two technicians for the Group, installed a Unix network linking Unix workstations, PCs, and Macs together with a complex video analysis and editing system. The Institute's library staff recatalogued books brought from the Berlin Projektgruppe, and continued to build a good collection of reference grammars and ethnographic works. With the help of the Institute's administration and Technical Group, and advance preparation by S. Levinson and G. Senft with the aid of E. Sjoerdsma, intellectual work could start almost at once.

In the remaining five months of the year, the rest of the Group assembled. By the end of the year, the Group had five staff members, two long-term visitors, two student assistants, three technicians (one half time), a library assistant, a software assistant, a student trainee, and a secretary. The staff members began at once both to plan future field work and utilize existing field materials to begin work on project themes. Two major projects on Tzeltal and Tzotzil spatial conception, which had begun the previous year in the Berlin Projektgruppe, produced substantial results, reported in a series of working papers available from the Group.

5.2 Spatial conception and description

The initial major goal of the Group's research is to investigate the nature of spatial description and conception in cross-cultural perspective. To pursue this, effort has been invested in developing methods to yield data of comparable depth and

kind from a variety of languages. A manual for field investigation of spatial conception and description, written by S. Levinson, has been distributed to a number of other institutions (e.g., in India and Mexico) with parallel interests, and is available through the Working Paper Series.

Initial findings already point to some intriguing cultural differences that are fundamental enough to bring into question the view, found widely in the psychological and linguistic literature, that spatial conception is essentially the same in all languages and cultures. But it is clear that there must be a universal foundation of spatial cognition on which such cultural differences are built. Trying to understand this interplay between cultural specificity and cultural invariance is a major research goal of the Group. One may hope to get further insight along a number of distinct lines: by collecting greater in-depth information on some of the spatial systems most contrastive with our own; by studying the acquisition of such systems, which might reveal, for example, relatively late developmental divergence; by constructing typologies of spatial systems that may disclose conditional universals (implicational relationships between specific features of spatial systems); by designing experiments to discriminate between different hypotheses about the cognitive basis for each system. The Group hopes to pursue each of these themes in due course, but meanwhile the following sub-projects are emerging.

5.2.1 Typology of spatial systems

Existing linguistic and psychological treatments of spatial description and conception tend to presume that the kind of conceptualization of space encoded in the familiar, Indo-European languages is the natural way to think about space. The re-

search work of the Group has already demonstrated that there are radically different, equally viable, ways to conceptualize and talk about space. Our own system is predominantly relative and egocentric in nature: we think about something (the 'Figure', theme, or referent) as in some kind of relation (e.g., above, below, in front of, behind) to a landmark object (the 'Ground' or relatum), which is often ego. To specify horizontal angles, we rely on planes drawn through the body dividing in front from behind and left from right. We then map some of these egocentric distinctions onto non-human landmark objects, allowing us to talk about things as in front of or behind the building or the cupboard. When the reference object has no obvious front or back, we may talk as if the object faces us, so that its front is the part toward us. In the case of left and right, we tend to project our own egocentric left/right into the visual field. With such a system we can describe the locations of objects relative to other objects, describe route directions, and so on.

But there are other kinds of systems. Most striking are systems that operate on absolute concepts of direction. In such systems, notions like 'in front', 'behind', and 'to the left of' can be partially or totally dispensed with. Instead, one may specify directions by reference to cardinal points, fixed landscape features (seawards, downhill, etc.), or astronomical or meteorological angles (the direction of the monsoon winds, etc.). These absolute angles can be used at all scales, from the macro ('He drove north') to the micro ('There's a fly on your north cheek'). Group members have now conducted primary fieldwork in three societies where absolute systems play an important or predominant role (Hopevale, Queensland; Tenejapa, Mexico; Zinacantán, Mexico). Although at first sight such absolute systems do not seem so radically different from

our own, they have far-reaching cognitive and linguistic consequences. Our own system requires us, for example, to project our own spatial coordinates (front/back, left/right) onto other objects, a process that children do not fully master until age 11 or so. The absolute systems, in contrast, require a sense of absolute direction and the mastery of a dead-reckoning system.

Absolute systems of spatial conception offer an alternative way to conceive of regions projected off a landmark object ('to the north', etc., instead of 'in front', etc.). But what about the so-called topological spatial relations, such as 'at', 'in', and 'on', when Figure and Ground are in contact – are there interesting variants here? It seems so. Work in the Institute (e.g., by M. Bowerman, in collaboration with S. Choi (San Diego State U.) on Korean, English, and Dutch) has already shown how language-specific these topological concepts are. Meanwhile, the Group has been investigating languages where these locative notions are largely encoded in verbs (rather than prepositions) which are highly specialized to the shape and position of the Figure. The Mayan language Tzeltal, for example, forces a choice between over 100 commonly-used predicates of location according to whether the subject (the Figure) is round, flat, leaning, a constricted container, etc. This language (under investigation by Levinson together with P. Brown of the Institute's staff) also offers a way of being precise about the location in such relations. The Ground object can be segmented into body-parts by analogy to a human or animal body. A bowl, for example, can be said to be located at the 'ear' (corner) of the table. This system is interesting because it is not purely conventional – any object can be analogically segmented in this way and assigned a 'nose', 'tail', etc., as appropriate to its shape, regardless of its orientation

(so the 'face' of a stone may be the flat undersurface).

While it is premature at this stage of the Group's investigations to offer any kind of general typology covering these various systems, Levinson has attempted to formulate an overview (see the previously-mentioned manual for field research). E. Pederson is beginning to catalogue the data gathered by the Group to characterize more precisely the similarities and differences among languages with regard to these spatial systems. He is using three preliminary typological parameters to sort languages: 1) The types of spatial systems they use (absolute direction, egocentric, geographic landmark orientation, etc.); 2) The geometrical dimensions each system is applied to (e.g., absolute with vertical orientation vs. egocentric with horizontal orientation); 3) The different topical and discourse domains that each system is used for. For example, an English speaker might use absolute cardinal directions when talking of the location of Belgium relative to Holland, but will use an egocentric system when talking of the location of his notebook on the table. In contrast, a speaker of Guugu Yimidhirr (an Australian language (Queensland) explored by J. Haviland (Reed College, Portland) and Levinson) uses absolute cardinal directions in both cases. Typological groupings of unrelated language communities which are found to share systems of spatial relations distinct from the more familiar Western uses can then be investigated for correlated features. This should help reveal any shared non-linguistic conceptualization which is systematically distinct from Western cognition on spatial relations.

One way the Group hopes to advance understanding of spatial reference is by collecting a great deal more cross-cultural information on spatial systems. To this end it is hosting a series of area-specialist workshops, two of which were held in

1991 (see Section 5.5.1 for participants). The first, organized by G. Senft on spatial description in Austronesian and Papuan languages, suggested the importance in the Austronesian languages of absolute systems of orientation based on east/west monsoons and the inland/seaward dimension. (These differ from orthogonal cardinal directions, since the directions picked out by the latter opposition rotate as one goes around an island while those picked out by the former remain fixed.) Absolute terms often get built into motion verbs and demonstratives. Another important feature of these languages is their tendency to use body-part terms, and sometimes house-part terms, as the basis for an incipient prepositional system. The Papuan languages (covering perhaps a third of the world's languages) are unlikely to yield any simple generalizations.

The second workshop, organized by L. de León, focused on Mesoamerica. Mesoamerica looks like a prime example of a linguistic area, with cross-family diffusion of spatial linguistic traits in particular. Preliminarily, it seems that 1) much more spatial information is packaged into the verb and much less into prepositional constructions than in more familiar languages; 2) there is an area-wide set of spatial metaphors based on the human or animal body (head, ears, mouth, butt, legs, arms, etc.); such metaphors are not in themselves unusual, but the metaphorical specializations of body part terms are quite precisely similar across the linguistic area – e.g., ‘mouth’ yields ‘edge’ designations, presumably by focusing on the surrounding tissue of the lips; ‘ear’ yields ‘corner’ and ‘protrusion’ designations (perhaps through focus on the relevant angular tissues); and 3) these body-part terms may either get semi-grammaticalized into nominal ‘prepositions’ or incorporated into verbs.

Further workshops on spatial systems are planned for 1992,

including one on Mayan languages and another on Australian Aboriginal languages. To provide an additional flow of information over which generalizations can be made, links to institutions in other culture areas (e.g., Mexico and India) are being established, as well as working relations with interested scholars around the world.

5.2.2 Acquisition of spatial and relational concepts

Are absolute systems in some sense 'unnatural' and learned late, being superimposed over a relative-system substrate? Or are all systems incipiently in play, being culturally emphasized one way or the other? Or are the two kinds of systems both learned alternatives, arguing for an empiricist rather than a strongly rationalist view of human spatial conception? Data on human conceptual development will be critical in answering such questions.

So far, de León has collected pilot material from a sample of 14 Tzotzil-speaking children, aged 3-7 years, who live in a Zinacantán township in Chiapas, Mexico. In Western languages projective space involves both deictic and non-deictic projections. (In the former, but not the latter, the meaning of a locative term depends on aspects of the situation in which an utterance is produced. For example, to identify the location of the ball in "It's in front of the tree", one must know where the speaker was standing, while for "It's at the side of the car" this is irrelevant.) But in Tzotzil, there is no deictic projection of the 'front/back' axis. Instead, projective space in static descriptions involves projection to geographically anchored points: landmarks and the absolute points upland and downland, which correlate with east and west. De León found that in describing the position of one toy to the left, right, front, or back of another, children often said things like (in

translation) "The man is downland (west) from the truck". Such constructions emerged soon after the age of three, although not always with the correct orientation. Studies of elicited mother-child interaction showed that instructions with absolute directions are also comprehended early. Children's early use of the upland (east)/downland (west) coordinates and other local landmarks suggests that spatial terms do not inevitably map onto concepts of space developed independently of language, as proposed by Johnston and Slobin (1979, *Journal of Child Language*, 6). Rather, they may map onto locations of a socially acquired map.

The literature on the acquisition of locative terms in Western languages has separated the acquisition of deictic verbs (e.g., *come*, *go*) and path particles (e.g., *up*, *down*, *away*) from the acquisition of static location (prepositions). Tzotzil has a set of path particles derived from motion verbs that specify locative trajectories of a projective kind; these can be used metaphorically for static locations, as in *tey ta xokon tal* ('it is at the side coming towards here'). Path particles are acquired perhaps as early as the topological notions of containment and support. Preliminary analyses of Tzotzil acquisition data reveal that the distinction drawn by psycholinguists between topological and projective space requires further clarification.

E. Danziger has collected developmental data on the acquisition of kinship concepts by Mopan children in Belize. Piaget suggested that the acquisition of relational concepts in different domains should proceed in parallel, and he investigated the relationship between the acquisition of kinship terms and spatial terms. He claimed that the acquisition of first- and second-order kinship terms (e.g., 'mummy' vs. 'John's mummy') is related to the acquisition of first- and second-order spatial terms (e.g., 'to my left' vs. 'to the left of the tree'). Danziger

left for the field at the end of the year to explore these and related issues.

5.2.3 Lexical semantics: Predicates of location and motion in some Mayan languages

In the Mayan languages Tzeltal and Tzotzil, rather different linguistic resources are used to describe motion vs. location. But in the case of both motion and location, virtually all the information is packed into the predicate, there being just one generalized preposition covering all possible spatial relations and much else besides. The set of pure motion verbs in both languages is small, and forms a tight syntactic and semantic class. In contrast, the set of location/disposition predicates is large and morphologically and semantically diverse.

Haviland has examined the Tzotzil motion verb roots in detail, exploring their special syntactic properties as auxiliary verbs and as directional particles. (A root is a lexical base form to which derivational and inflectional affixes may or must be added.) The Tzotzil motion verb roots express meanings similar to 'come', 'go', 'arrive here', 'arrive there', 'return', 'go and return', 'remain', 'enter', 'exit', 'ascend', and 'descend'. Generally they encode the notion of a schematized path, specifying its inception, through-point, and/or goal. These verbs may function as inflected main verbs agreeing with their absolutive subjects (Tzotzil has ergative/absolutive verbal inflection). But they may also occur as auxiliaries and directionals (or path particles) not explicitly inflected for person. Such forms are construed differently: the logical subject of the auxiliary is normally understood to be the subject (whether ergative or absolutive) of the main verb, while the subject of the directional is normally identified with the absolutive argument of the main verb.

The predicates used in location descriptions are more difficult to analyze. There are hundreds of such roots in both Tzeltal and Tzotzil, making fine discriminations in the 'disposition' of the subject (Figure): its shape, pattern, spatial distribution, orientation, etc. A puzzling fact is that although there are morphological subclasses of these roots, they do not map easily onto semantic classes. Many of them belong to a subclass that Mayanists call 'positionals': roots that must be derived with special affixes to make stems, which then generally encode dispositional information. But in both Tzeltal and Tzotzil, the positionals grade into other subclasses on both formal and notional grounds. Brown and Levinson have analyzed about a hundred of these roots in common use in Tzeltal location descriptions, and have found that the great majority specify elaborate selectional restrictions on the Figure and none on the Ground. These restrictions require that the Figure be an object of very specific shape or other disposition – for example, an upright container with an opening narrower than its widest circumference, a spherical object, or a stick or narrow cylinder leaning at more than 70 degrees. Contrary to claims in the literature about the nature of human spatial description, the Tzeltal distinctions do not reveal a naive geometry based solely on topology, but rather one in which metric specifications and precise angles and shapes and other Euclidean notions play a crucial role.

A problem with the analysis of such a large set of roots in potential opposition is that the normal methods of structural semantics are insufficient. The set cannot easily be broken into semantic fields, since each such field intersects with numerous others. Most roots seem to fall simultaneously into several natural notional categories, with the specific denotational content of any given token being the product of both

morphological form and lexical collocation. Nor can one get clear insight into the overall semantics of the repertoire of roots by grouping roots which contrast in a single syntactic environment (as, for example, in Berlin's classic study *Tzeltal numeral classifiers*, 1968, on classifiers which may be formed from many of the 'locative' roots considered here). Since the roots appear with a wide range of derivational affixes, it is also important to distinguish the specific semantic contribution of a given root from the more schematic semantics of the morphological package in which it appears.

Haviland has used several different approaches to untangle the semantics of Tzotzil verb roots and the semantic effects of productive derivational processes. Using an extensive Tzotzil dictionary and a large body of computerized Tzotzil text (from narrative and conversation), he has begun to analyze derivational possibilities for Tzotzil verb roots, patterns of frequency, and co-occurrence in usage. In a preliminary study, he considered a set of roots which share certain derivational possibilities and which denote a particular configuration or disposition of a complex whole (as opposed to the shape or position of a simplex object or part of an object). The resulting set of about fifty Tzotzil roots seems to derive its semantic inspiration from the human body and its various postures both at rest and in action, thus giving some hints about the origins and nature of semantic hypertrophy in this part of the Tzotzil lexicon. In addition, Haviland has used intensive elicitation to try to push the derivational possibilities and extensional ranges of roots to their limits. This work has led to the discovery and investigation of somewhat unexpected morpho-syntactic contexts for roots whose primary meanings seem to involve location, position, and shape: 1) the use of some locational or positional roots as numeral classifiers to individuate enumerated

objects, and 2) the use of many such roots to form compound color terms in which a color root denotes a hue and the compounded verb stem limits the range of possible referents to objects with appropriate shapes or positions as well as colors.

To examine the use of the same roots in communicative settings where positional and shape discriminations were at a premium, de León devised spatial tasks in which one informant had to describe a photograph so that another could select an identical photograph from a contrasting set. She and Haviland also explored how adults and children used the roots in narrating illustrated children's books (after an experimental design by Slobin and his co-researchers). Even very young children could use verbal roots to make elaborate discriminations of position, shape, and location.

It is an interesting question why Tzeltal, Tzotzil, and other Mayan languages are so rich in roots describing highly specialized shapes and dispositions. One possibility (raised by Lucy, in press, *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis*) is that these languages make minimal linguistic commitment to an ontology of individual objects; instead, nominals perhaps generally denote 'stuff', like English mass nouns. If so, the languages would require a system of individuation, and this would be provided by a set of sortal predicates that presuppose particular shapes of 'stuff' or arrangements of 'particles'. Lucy has conducted sorting experiments in Yucatec Mayan that suggest that informants sort on the basis of 'stuff' rather than shape. Attempts by Brown to replicate such sorting experiments in Tzeltal have so far been equivocal, but the question should be further explored.

5.2.4 Classification

Pederson has begun exploring the semantic parameters of classifier systems. In any given grammatical system, each construction has a prototypical use and extends to further uses on the basis of 1) the nature of the prototype or its intermediate extensions; and 2) the competition of other constructions in the system. Classifier systems can be modeled as an 'ecology' of grammatical items in structural and semantic opposition. Competition from the preferred extensions of neighboring classifiers in the same semantic space will affect how each classifier develops diachronically and, importantly, how the entire set will be conceptually organized. Constructing ecological models of divergent classifier systems will help clarify how the speakers of classifier languages organize spatial and shape relations.

Kilivila, the Austronesian language of the Trobriand Islanders, has a sophisticated system of (so-called) numeral classifiers. In 1991 Senft finished his monograph, *The System of classificatory particles in the Kilivila language*, in which he describes the Kilivila inventory of classifiers, their functions in actual speech production, and their acquisition, diachronic change, and semantics. He found that the 88 particles studied in detail can be seen as operating dynamically within 20 semantic domains (for example, human beings, animals, shape, time). In discourse, particles can often be substituted for each other within and between domains. Senft developed variable rules to account for the choice of individual particles in a given domain. When the substitution possibilities are plotted in two dimensions, the result is a network that can be viewed in three different ways: 1) as a linear order in which all semantic domains are granted the same status and quality within the network; 2) as a linear hierarchical order in which the seman-

tic domains are differentiated with respect to importance or status (e.g., one of the more important domains is 'animacy', one of the less important ones is 'textual reference'); and 3) as a multidimensional hierarchical order in which certain semantic domains can be located on different levels within the comprehensive hierarchically structured network according to the speaker's intentions. This last model is probably the most accurate and comprehensive, and Senft continues to develop this.

De León's research on classifiers started with a comparative study of the grammaticalization of gender and noun classifiers in several Mixtec dialects (Mexico). She found that the semantic category of shape – encoded in the basic distinction between longish and round – plays a crucial role in how Mixtec nouns become grammaticalized and turn into classifiers. Since classifiers had not been considered a feature of Mixtec and other Otomanguean languages, she decided to contrast these findings with those from a language where classifiers had been attested: Tzotzil. Tzotzil classifiers fall into two major sets: mensural and sortal. Mensural classifiers are used to individuate referents with no inherent shape, just as terms like *handful* are used to measure the referents of mass nouns in English. Sortal classifiers refer to natural units of countable objects with an inherent shape. Despite typological differences between Mixtec and Tzotzil, de León found that Tzotzil sortal classifiers distinguish semantic categories on the basis of distinctions similar to those picked out by Mixtec noun classifiers, including especially shape (e.g., long/one-dimensional objects, rectangular objects, flat/two-dimensional objects, and round/three-dimensional objects). These similarities may be related to the fact that Mixtec noun classifiers and Tzotzil sortal classifiers share certain grammatical functions,

including identifying new referents and referring pronominally to old referents.

Tzotzil numeral classifiers deal not only with shape but also with other spatial features such as position, anatomy, canonical orientation, number, and distribution. The structuring of the semantic domains of classifiers in the related language Tzeltal was explored by Berlin in his 1968 book *Tzeltal numeral classifiers*. However, very little has been known about how Mayan speakers actually use classifiers and other associated spatial resources. To learn more about this, de León explored the use of classifiers in everyday work such as weaving and in experimental interactive spatial tasks. Here the role of the classifiers and of positional adjectives revealed that positional roots – from which classifiers and adjectives are derived – provide rich semantic packets of spatial information that pervade Tzotzil grammar.

J. Wassmann (U. Basel) has been exploring systems of food classification among the Yupno (Papua New Guinea). Like most peoples, the Yupno have folk taxonomic systems – an ‘ethnobotany’ and an ‘ethnozoology’. In addition, they classify all foods by their ‘interior essence’ (not actual temperature) into the categories ‘hot’, ‘cold’, and ‘cool’, with esoteric consequences for proper diet on different occasions. Participant observation, elicitation, and sorting tasks showed that the folk taxonomic systems play no active role in either practical matters of food preparation or sorting by likeness. The ‘hot’/‘cold’/‘cool’ system is used instead for practical purposes like food preparation. It is also used by sorcerers (who command the relevant esoteric knowledge), but not by others, as the basis for sorting in experimental tasks. These findings suggest that taxonomic classifications are not the only way to classifying natural kinds, and are not necessarily even the

most important way.

5.2.5 Grammaticalization

De León has been studying the grammaticalization process that several core body part terms are undergoing on their way to becoming locatives in Tzotzil. Data from narratives, conversational material, and communicative tasks suggest that Tzotzil distinguishes between objects that have an inherent orientation and those that do not, and that terms for body parts are becoming locatives restricted to objects with inherent orientation. That is, Tzotzil body part locatives – in contrast to the English terms *front* and *back* – apparently cannot be used projectively to specify fronts, backs, and other parts on the basis of the speaker's perspective, but are assigned only on the basis of the intrinsic anatomy of objects.

Haviland exploited an unusual resource for the study of the grammaticalization of Tzotzil motion verbs as auxiliaries. Although Tzotzil is essentially an unwritten language, the existence of a remarkably thorough four-hundred-year-old colonial dictionary makes it possible to compare two states of the language. This comparison reveals a complex series of changes. The present use of motion verbs as uninflected auxiliaries marks either aspect or purpose. In the colonial language there were two distinct constructions, one with two inflected verbs for purpose and one with a nominalized main verb for aspect. The main changes have been an increase in the set of auxiliaries and a loss of auxiliary inflection reflecting a tighter semantic and grammatical link between auxiliary and main verb. This whole process provides an interesting example of how devices for marking spatial concepts may be extended and grammaticalized to mark nonspatial meanings. The comparative study, now in progress, of auxiliary and directional

constructions in other Mayan languages is needed to understand more fully the grammaticalization processes involved.

5.2.6 Language and the nonlinguistic representation of space

Space is apprehended and mentally represented in a number of different modalities (e.g., linguistic, visual, haptic). Some projects of the Group may help uncover properties of each mode of representation and the relationships between them.

An intriguing aspect of absolute systems of spatial description (see Section 5.2.1) is the way they determine a whole set of cognitive processes on different levels. For example, in Guugu Yimidhirr, angles on the horizontal dimension are coded linguistically only in terms of cardinal points (or quadrants, to be more exact). Thus, instead of describing Bill as in front of the house, speakers must choose a locution glossable as 'Bill is standing to the north (south, etc.) of the house'. If speakers later want to refer to Bill's location in front of the house, they must have coded in memory the absolute orientation of the scene. Further, when speakers describe their own position vis-à-vis some landmark, they must constantly dead-reckon location. Naturally, this system requires speakers to be absolutely oriented at all times.

A first hint of the wider implications of this linguistic system comes from Haviland's research on Guugu Yimidhirr ethnohistorical narratives. When analyzing a film of a storyteller recounting events from the 1930s, Haviland noticed that the man's gestures, as well as his descriptions of events from half a century before, were properly oriented in space. His descriptions of relative positions and of motions across land and sea were correctly phrased in terms of the Guugu Yimidhirr north/south/east/west quadrants. Moreover, his gestures

were correctly anchored in a variety of interesting ways. For example, when the narrator described looking north, he pointed north; when he described a motion that was, as it turns out, west to east, he traced a west-to-east vector with a sweep of his hand.

Gesture may play a special role in absolute systems of spatial reckoning, since linguistic description is likely to under-specify exact angles or distances. Haviland and Levinson have examined several Guugu Yimidhirr narratives to determine whether gestures often supplement or replace linguistic specifications of direction. Haviland has also studied gestures in both narratives and route descriptions in Tzotzil, a language with a similar but much less pervasive system of linguistic coding for direction. For both languages, it appears that the precise orientation of many gestures conveys directional information which is not routinely encoded verbally. To be able to exploit this information, listeners must distinguish gestures for which orientation is critical from those for which it is irrelevant. Using recently acquired video analysis machinery, Haviland and Levinson have begun to investigate the differences between the two kinds of gestures. One hypothesis is that oriented gestures are performed with different hand shapes and are differently synchronized with the verbal channel than ordinary gestures.

Haviland has gone on to examine how oriented gestures are interpreted under conditions of 'transposition' – when point of view is relativized to different perspectives or frames. For example, a gesture in a Guugu Yimidhirr story meaning 'coming from the north' may be ambiguous: is the goal of the movement the current location of the speaker, or of the story's protagonist, or of somebody else? Further, the Guugu Yimidhirr system allows discourse referents to be set up in gestural space, a little like anaphoric reference in American Sign Language.

Sometimes, however, a gesture will hop out of the story frame to identify a protagonist by implicit reference to – for example – the deictic location of his home-base. The complex set of visualized spaces that are thus invoked, and the momentary transitions between them, are essential to story comprehension, since they contribute crucial information (e.g., referent identification) not encoded in the linguistic channel. Haviland is investigating the nature of the constraints on transposition and how transitions are cued by, for example, gesture-shape and timing.

Gesture discrimination is intimately tied up with shape recognition. Shape discrimination is relevant to a number of projects of the Group, including the lexical semantics of Mayan positional roots and the shape-based classifiers of Tzeltal, Kilivila, and Mixtec. Levinson and Brown are beginning to investigate the relation of linguistic shape discrimination in the body-part locative system of Tzeltal to the kinds of object-analysis predicted by current theories of vision. They are also exploring how spatial meanings are expressed in languages that do not use the opposition between left and right in the visual field. Although Tenejapan Tzeltal has words for the left and right hands, these are body-part terms with only the limited spatial uses that other body-part terms have in the language (one can talk of things in contiguity with one's head, stomach, hands, etc.). Contrary to anthropological expectation, there is almost no systematic symbolism associated with left and right. There is also no systematic projective use allowing one to talk of something as 'to the left (right)' of something else. In place of terms like left and right, crucial use is made of an absolute system of 'uphill' and 'downhill' terms, which are correlated (roughly) with south and north (due to the overall fall of the terrain). In a series of eight tasks, informants con-

sistently used absolute designations where English speakers would use left/right to designate angular rotation or location in the visual field. They also failed to verbally distinguish between spatial configurations reflected around the vertical axis (i.e., left/right mirror images), which may be related to coding spatial arrays in non-observer-centric ways. Further work on the perception and nonverbal sorting and recall of mirror images is in progress.

Wassmann, in collaboration with P. Dasen (U. Geneva), has worked with the Yupno in a remote part of Papua New Guinea to determine how individuals mentally represent known spaces. Although the Yupno have had minimal contact with the Western tradition of maps and plans and have no indigenous tradition of any kind of graphic representation, informants could, upon request, produce drawings on the ground of their enclosed mountain valley, its central river, and the dozen or so villages. The drawings varied systematically in accordance with the drawer's degree of exposure to the outside world. People with little or no experience of a world beyond the enclosing mountains consistently drew the valley as a closed ovoid with a schematic central river separating a row of villages along either side. Those who had traveled or had some schooling produced drawings without a boundary and with map-like attention to angles and details. Experience of an unbounded world seems to have led to a radical shift in the 'mental map' of the same bounded valley.

5.3 Other projects

Group members are carrying out many other projects that diverge somewhat from the focal projects on spatial cognition. For example, J. Wassmann (U. Basel), a cultural anthropolo-

gist, and P. Dasen (U. Geneva), a neo-Piagetian psychologist, have been collaborating in a series of experimental studies on various aspects of everyday knowledge among the Yupno of Papua New Guinea. In addition to the work on mental maps outlined above, these include studies of classification, ethnomathematics, and the indigenous system of dream interpretation. Wassmann is also researching the Yupno system of 'password' melodies associated with each individual, which are supposed to be used when people pass through each other's territory.

J. Haviland (Reed College, Portland) has been working on two monographs, one covering a range of interconnections between language and social life in Zinacantán, Mexico, the other on the social history of the Guugu Yimidhirr speakers of Hopevale Mission, Queensland, Australia. He has also been working on conversational and narrative material related to the ethnography of space in Zinacantán. As Tzotzil-speaking Indians have begun to participate in the large-scale migrations of rural workers to urban centers in Mexico and even the United States, their expanded understanding of the world has penetrated discourse in their villages. In a case study, Haviland has been analyzing the events, and their representations in narrative and legal proceedings, surrounding the unexplained death of one of the first Zinacantecs to leave his home and travel illegally to the United States in search of work.

L. de León has worked on Mixtec migration patterns in the United States, and on a court case arising from an accusation of murder against a migrant. She has played a leading role in the development of methods of data collection now used by the Group, which involve using focused tasks to elicit relatively natural verbal interactions. In collaboration with other

members of the Group, she is working on compiling a kit of methods, stimuli, and tasks that might be widely used for exploring spatial cognition in different cultures.

E. Danziger recently completed a Ph.D. on the kinship system of the Mopan in Belize, in which she used acquisition data to decide on the relative semantic complexity of kin terms. She is currently applying the same strategy to a number of other semantic domains, including space.

S. Levinson, in collaboration with John Gumperz (U. California, Berkeley) organized a Wenner-Gren conference reexamining the concept of linguistic relativity, from which an edited volume will appear (see the report published in *Current Anthropology*, 1991, 32). He has also continued to work on a monograph on conversational implicature, and has been thinking about the role of pragmatics in understanding spatial descriptions.

E. Pederson recently completed a Ph.D. on the semantic typology of reflexives and causatives, with a focus on general principles underlying the extension of meanings. He is continuing to work on verb valency.

G. Senft completed his Habilitationsschrift on Kilivila classifiers and has been working on a general review of what is known about spatial description cross-linguistically, from deixis to prepositions. He has also worked on a number of other descriptive problems posed by Kilivila, including special registers, incorporated English loans, and serial verb constructions.

5.4 Technical notes

The research of the Group has required new methods and materials to bring what has been a well-domesticated branch of

cognitive psychology out into the more demanding circumstances of anthropological fieldwork (see also Section 6.1.1). Group members have experimented with a variety of hardware and software configurations for using portable computers in field research. They have also created a number of specialized tools for the projects described above. For example, J. Haviland (Reed College, Portland) wrote a series of programs for manipulating and glossing conversational transcripts. These have been integrated with existing lexical database programs as well as with various filters and other tools, some borrowed from Unix and adapted to the MSDOS environment of the Group's portable computers. Group members continue to increase the number of texts from exotic languages available for analysis in machine-readable form, with the hope of eventually applying lexico-statistical methods to them.

Group members have also developed techniques to use lightweight and highly portable Hi-8 Video technology in their research. This has involved everything from using video stimuli with informants in the field, to enlisting native speakers in the analysis and transcription of locally recorded materials, to detailed analysis of gestural formation and movement/sound synchrony using the Group's video editing system. In addition, Group members have experimented with video capture technology and graphics software, both for analysis of field videorecordings and to integrate video images with text and transcript. Haviland wrote software – now being revised by R. Dirksmeyer – to allow real-time video subtitling. It uses computer word-processing software to create and edit subtitles which can then be automatically superimposed over a video sequence.

5.5 Other Activities

5.5.1 Conferences, symposia, and workshops

A workshop entitled "Concepts of space and spatial reference in Austronesian and Papuan languages" took place on September 30-October 1. Speakers included B. Kaswanti Purwo (U. Indonesia Atma Jaya, Jakarta), S. Adelaar (Australian National U., Canberra), B. Nothofer (J.W. Goethe U., Frankfurt am Main), V. Heeschen (Forschungsstelle für Humanethologie in der Max-Planck-Gesellschaft, Andechs), R. van den Berg (Summer Institute of Linguistics, Ujung Pandang), H. Steinhauer (Proyek Pengembangan Ilmu Bahasa Indonesia II, Jakarta), P. Brown from the Institute, and J. Haviland, L. de León, S. Levinson, G. Senft, and J. Wassmann from the Research Group.

A second workshop, entitled "Space in Amerindian languages", was held on December 3-4. Speakers included W. Adelaar (Leiden U.), A. Veerman-Leichsering (Leiden U.), P. Levy (National U., Mexico City); C. Lehmann (Bielefeld), C. Goldap (Bielefeld); S. Wichmann (U. Copenhagen); T. Stolz (Ruhr-U., Bochum); P. Brown from the Institute, and E. Danziger, L. de León, S. Levinson, and J. Haviland from the Research Group.

5.5.2 Colloquia

Colloquia organized by the Research Group were given by J. Bowden (U. Auckland), N. Evans (U. Northern Territory, Darwin), A. Kendon (U. Philadelphia), D. Spitulnik (U. Chicago), B. Bickel (U. Zürich), V. Manfredi (U. Boston), and members of the Group.

6. Other Activities 1991

6.1 Activities of the Technical Group

6.1.1 Creating facilities for the Research Group for Cognitive Anthropology

A major challenge for the Technical Group has been to design and implement appropriate technical facilities for the new Research Group for Cognitive Anthropology. As this had to be accomplished in addition to the normal maintenance and development work, two new members joined the group.

Creating the technical facilities for the new group involved several tasks. First, researchers and secretarial staff had to be provided with facilities suitable for text processing, computing, accessing data bases, and mailing. This meant that the existing network of workstations, terminal servers, and personal computers had to be considerably extended. Second, the research of the group has required the development of new methods and materials such as portable PC-versions of standard experimental setups to take into the field. (Such setups are, of course, also useful for out-of-house experiments by members of other research groups.) In addition, a number of specialized tools were developed in collaboration with group members (see Section 5.4).

6.1.2 Development of experimental facilities and laboratories

The Technical Group supported a large number of computer-controlled experiments. To realize the researchers' changing ideas and requirements, increase the ease and elegance of experimentation, and facilitate maintenance, existing hardware and software were extensively modified and new tools were developed. In addition, new experimental setups were built so that more experiments can be run simultaneously. For instance, a "preferential looking paradigm" setup was added to the baby lab to allow testing of infants' language comprehension (see Section 3.1).

One particularly important innovation was the development of hardware and software for timer servers and speech servers for experimental personal computers. These allow speech stored on the hard disc of a computer to be played back to subjects at precisely defined moments. In 1992, PCs with speech servers will replace PDP-setups in both single and multi-subject experiments.

In addition, some speech servers have been attached to SCSI-bus-based VAX/VMS workstations, and the speech editing software has been adapted to the windows-environment of the workstations, so that researchers can do speech-editing right at their desks. This software will also be ported to UNIX workstations.

6.1.3 Computer facilities and other applications

The Institute has opted for a distributed computing system with relatively low-cost servers of different types (file servers, computer servers, network/mail servers) and attached workstations and PCs. A number of VMS and UNIX worksta-

tions allowing access to the latest window-based technology has been acquired. Training courses were offered to optimize use of these tools. Many PCs have been connected via Ethernet to servers, allowing direct access to the central mailing system and printers. Because of the increased number of workstations and PCs, substantial modifications were made in the assignment of functions to computers and in the configuration of the computers. The Institute continued its move to UNIX by integrating many UNIX workstations and servers.

6.2 CELEX: The Center for Lexical Information

CELEX, the Center for Lexical Information, is an expertise center located in the same building as the Max Planck Institute and the Interfaculty Research Unit for Language and Speech of the University of Nijmegen. CELEX supports linguistic research and language-and-speech-oriented technological projects by providing lexical databases on Dutch, English, and German, the hardware and software to access these data, and the expertise to apply the data and facilities. CELEX is a resource open to all Dutch academic institutions. The databases can be accessed through the Dutch academic research network SURFnet.

Much effort was devoted in 1991 to improving the documentation of the databases in the CELEX User Guide, which gives a detailed description of the linguistic criteria underlying the database representations and the way these can be manipulated in the FLEX user interface.

The pilot version of the German data base, released in 1990, was extended in 1991 with approximately 350,000 inflected forms generated from the core set of 51,000 German

lemmata. These new forms were supplied with the same kinds of orthographic, phonological, morphological, and syntactic information as their corresponding lemmata. The approach to syntactic classification was revised with the addition of subclasses for nouns, adjectives, numerals, pronouns, and verbs. For verbs, detailed information is provided about subcategorization frames (e.g. 'takes an obligatory accusative complement and an optional genitive complement'). Frequencies were also calculated for both lemmata and word forms on the basis of a 6-million-token corpus supplied by the Institut für Deutsche Sprache in Mannheim.

A new version of the English data base, released in 1991, includes frequency counts based on the 17.9-million-token Birmingham corpus. Homographs are not yet disambiguated in these frequency counts, but a disambiguated version is scheduled to appear in 1992. This upcoming version will contain almost twice as many lemmata (55,000) and word forms (110,000) as before, all provided with orthographic, phonological, inflectional, morphological, syntactic, and frequency information.

The Dutch lexical database was enriched with detailed syntactic and semantic information and Dutch-English translation equivalents. English translation equivalents have now been supplied for all verbs, including separable verbs (e.g., *opnemen* (take up)). Syntactic frames were given for all verbs, and semantic features, prepositional complements, and post-modifying clausal complements (e.g., *de vraag OF* (the question WHETHER)) for all nouns. Properties listed for adjectives include attributive, predicative, and adverbial uses, complementation patterns, and semantic features such as absolute/relative, gradable, classifying/qualitative and static/dynamic.

Many researchers and system developers in the field of natural language applications have found CELEX databases unique and powerful resources essential to advanced systems in the field of language and speech technology. In addition to the Max Planck Institute, the University of Nijmegen, the Institute for Perception Research (Eindhoven), and the Institute for Dutch Lexicology (Leiden), all of which participate in the Center's activities, universities and companies using CELEX in 1991 include the Universities of Amsterdam and Leiden, the Dutch Spelling Commission, Instituut voor Toegepaste Informatica (TNO), MIT (USA), the University of Neuchâtel (Switzerland), the University of Antwerp (Belgium), Digital Equipment Corporation, Philips, Hewlett-Packard, WANG, and Océ Nederland. Most of these institutions will continue their cooperation with CELEX in the future.

6.3 Conferences, symposia, and workshops

6.3.1 Workshop "Lexical statistics"

A workshop on lexical statistics organized by the Nachwuchsgruppe was held on November 20. The workshop covered a range of topics such as the estimation of frequencies from dispersions, the analysis of sentence length alternation, the analysis of large number of rare event distributions, and an information-theoretic modification of the uniqueness point concept.

6.3.2 Workshop "Computational modeling and experimentation"

A two-day workshop on computational modeling organized by the Nachwuchsgruppe was held on May 9-10. The goal of

the workshop was to compare different computational models (stochastic models, spreading and interactive activation models, and PDP models). Applications of these approaches to modeling reaction time data in diverse areas (e.g., language comprehension and language production) were discussed.

6.3.3 Workshop “Formal properties of language acquisition”

A workshop entitled “Formal properties of language acquisition” was organized jointly with the Netherlands Institute of Advanced Studies (NIAS). It was held on June 22-23 at the end of a year-long NIAS workgroup on the same topic organized by H. van der Hulst and T. Hoekstra. Issues discussed included acquisition of segmental and metrical structure, functional categories, question formation, and verb-argument structure. Participants included D. Archangeli (U. Arizona, Tucson), K. Demuth (Brown U. and U. Stuttgart), E. Dresher (U. Toronto), J. Frijn (U. Groningen), H. Goodluck (U. Ottawa), M. Haverkort (U. Brabant, Tilburg), A. Hulk (U. Amsterdam), R. Ingham (U. Reading), C. Jakubovicz (Lab. de Psychologie Expérimental, Paris), R. Manzini (U. College, London), A. Mills (U. Amsterdam), B. Schwartz (Boston U.), K. Wexler (MIT); (from the NIAS workgroup:) T. Borowski, T. Hoekstra (U. Leiden), H. v.d. Hulst (U. Leiden), A. James (U. Amsterdam), P. Jordens (F.U. Amsterdam), C. Koster (U. Utrecht, U. Groningen), T. Roeper (U. Massachusetts, Amherst), H. Wekker (U. Groningen); (from the Institute:) D. Adone-Resch, H. Behrens, M. Bowerman, U. Brinkmann, E. Clark (Stanford U. and MPI), P. Indefrey, B. Kaiser, W. Klein, A. Lahiri, W. Levelt, R.F. Min, M. Verrips, and J. Weissenborn.

Workshops organized by the Cognitive Anthropology Research Group are described in Section 5.5.1.

6.3.4 The Nijmegen Lectures 1991

The 1991 Nijmegen Lectures were given by James McClelland (Carnegie-Mellon U., Pittsburgh). The theme of the lectures was "The mechanisms of language and cognition: A parallel distributed processing approach". In three public lectures, McClelland presented the principles of processing, learning, and representation of the PDP approach and the implications of these principles for basic questions in the psychology of language and cognition. In three seminars and two tutorials, McClelland addressed several controversial psycholinguistic issues including the nature of context effects and interactive processing, the acquisition and processing of inflectional morphology, and the neurolinguistic implications of the PDP approach. McClelland's presentations attracted a large number of participants from all over Europe.

The lectures were organized in cooperation with the Interfaculty Research Unit for Language and Speech (IWTS) of Nijmegen University. Members of the organizing committee were H. Baayen, U. Frauenfelder, D. Povel, and T. Rietveld.

6.4 Internal lectures and colloquia

Colloquia organized by the Institute's Colloquium Committee (V. Ehrich and K. Kilborn) included lectures by K. de Bot (U. Nijmegen), J. Hawkins (U. Southern California, Los Angeles), G. Kasper (U. Hawaii, Manoa), C. McKee (U. Arizona, Tucson), J. Morais (F.U. Bruxelles), and F. Wilkening (U. Frankfurt). Many informal lectures were also given by long-term and occasional visitors to the Institute.

Colloquia organized by the Cognitive Anthropology Research Group included presentations by B. Bickel (U. Zürich), J. Bowden (U. Auckland), N. Evans (U. Northern Territory, Darwin), A. Kendon (U. Philadelphia), V. Manfredi (U. Boston), and D. Spitulnik (U. Chicago).

6.5 Teaching

The staff of the Institute and the Cognitive Anthropology Research Group taught courses at the following summer schools and universities (* marks members of the Cognitive Anthropology Research Group): Baayen (U. Groningen); Bierwisch (Third European Summer School in Languages, Logic, and Information, Saarbrücken); Bowerman (Research Summer School on Language Acquisition, Mallsjö, Sweden); P. Brown (F.U. Berlin); E. Clark (U. Brabant, Tilburg); Ehrich (U. Cologne); Feldweg (U. Leiden); Frauenfelder (LSA Summer Institute, Santa Cruz); Graetz (Erasmus U., Rotterdam; U. Groningen); Heesch (IWAL Amsterdam; U. Nijmegen); Hickmann (U. René Descartes, Paris); Jordens (U. Leiden; U. Salzburg); Klein (U. Beijing; U. Heidelberg); Levelt (U. Tenerife); A. Meyer (U. Brabant, Tilburg; U. Nijmegen); *Pederson (U. California, Berkeley); Perdue (U. Leiden); *Senft (T.U. Berlin); Vonk (U. Nijmegen); *Wassmann (U. Zürich); Wittenburg (DECUS Deutschland Symposium, Hannover; Fachhochschule Steinfurt/Münster; U. Beijing); Zwitterlood (U. Brabant, Tilburg; U. Nijmegen).

6.6 Colloquia presented

The following members of the Institute, the Cognitive Anthropology Research Group (marked by an *), and visitors

(during their time at the Institute) presented colloquia at various institutions: Bamberg (U. La Sapienza, Rome); Bierwisch (Johns Hopkins U., Baltimore; U. Konstanz; U. Pennsylvania); Böttner (Stanford U.); Bolwiender (U. Nijmegen); Bowerman (F.U. Amsterdam; New York State U., Buffalo; U. Birmingham; U. Kansas, Lawrence); C. Brown (Dartmouth College, Hanover; Tufts U., Boston; U. Arizona, Tucson; U. Illinois, Urbana-Champaign); P. Brown (F.U. Berlin); Budwig (Academy of Sciences, Berlin; Society for Research in Child Development, Seattle); Chwilla (U. Amsterdam; U. Nijmegen); E. Clark (Bergische U. und Gesamthochschule Wuppertal; Friedrich-Wilhelms-U., Bonn; U. Amsterdam; U. Braunschweig; U. Edinburgh; U. Gothenburg; U. Linköping; U. Stockholm); H. Clark (U. Amsterdam; U. Basel; U. Braunschweig); Ehrich (U. Bonn); Flores d'Arcais (U. Bergamo; Tokyo U.; Chinese U., Hong Kong); Friederici (F.U. Berlin; Max-Bürger-Krankenhaus, Berlin; Ruhr-U. Bochum; T.U. Berlin; U. Freiburg; U. Gießen; U. Hamburg); Hagoort (Dartmouth College, Hanover; Tufts U., Boston; U. Arizona, Tucson; U. Düsseldorf; U. Illinois, Urbana-Champaign; U. Nijmegen; U. Brabant, Tilburg); *Haviland (National U. of Mexico, Mexico City); Heeschen (U. Freiburg); Kilborn (Carnegie-Mellon U., Pittsburgh; Southeastern Louisiana U., Hammond); Lahiri (U. Brabant, Tilburg; U. Calcutta; U. Edinburgh); *de León (F.U. Berlin; National U. of Mexico, Mexico City); Levelt (Brandeis U., Waltham, M.A.; Club Parisien de Neuropsychologie, Paris; DESY, Hamburg; Sciences de Cognition, Paris; U. Amsterdam); *Levinson (F.U. Berlin); A. Meyer (U. Nijmegen; U. Saarbrücken; U. Utrecht); R. Meyer (IBM Deutschland, Stuttgart); Monsell (F.U. Brussel; U. Leiden); Randall (U. Hamburg; U. Brabant, Tilburg); Swaab (U. Nijmegen); Vonk (U. Groningen); Weissenborn (U. Stuttgart);

Wittenburg (F.U. Berlin); Zwitserlood (F.U. Berlin; U. Massachusetts, Amherst; U. Nijmegen).

6.7 Presentations at conferences, congresses, and workshops

(Members of the Cognitive Anthropology Research Group are marked with an *.)

Baayen, R. H. "A stochastic process for word frequency distributions". 29th Annual Meeting of the Association for Computational Linguistics. Berkeley, June.

Baayen, R. H. "De productiviteit van prefigering in het Nederlands". Morfologiedagen. Gent, September.

Bamberg, M. "'Informed consent' in der Wirklichkeit und im Rollenspiel. Diskurs-analytische Überlegungen". 13. Jahrestagung der Deutschen Gesellschaft für Sprachwissenschaft. Aachen, February.

Bamberg, M. "'You're not the only one!' An examination of children's understanding of mixed emotions in narrative contexts". Child Language Seminar. Manchester, March.

Bamberg, M. "Actions, events, scenes, and plots. Language and the constitution of part-whole relationships". Fourth Biennial Symposium of the Department of Linguistics and Semiotics on Language and its Cognitive Interpretation. Rice University, Houston, April.

Bamberg, M. "Towards a theory of development in language acquisition research". Symposium Deutschdidaktik. Pädagogische Hochschule Erfurt, June.

Bartels, U., and Brinkmann, U. "Prepositions in experiment". Kolloquium des Sonderforschungsbereich 282 'Theorie des

- Lexikons'. Bergische U. und Gesamthochschule Wuppertal, June.
- Bierwisch, M. "Semantic form as interface between linguistic and conceptual structure". Workshop on Semantic Theory. San Marino, December.
- Bölte, J., Drews, E., and Zwitserlood, P. "Hat der Erkennungspunkt (Recognition Point) eine psychologische Bedeutung bei der auditiven Worterkennung?" 33. Tagung experimentell arbeitender Psychologen. Gießen, March.
- Böttner, M., Suppes, P., and Liang, L. "Comprehension grammars generated from machine learning of natural language". 8th Amsterdam Colloquium. Amsterdam, December.
- Bowerman, M. "Discussion of 'Théories de l'acquisition du langage' by A. Karmiloff-Smith". Sciences de la Cognition (Series 'Grands Colloques de Prospective', Ministère de la Recherche et de la Technologie). Paris, January.
- Bowerman, M. "The origins of children's spatial semantic categories: Cognitive vs. linguistic determinants." Wenner-Gren Foundation for Anthropological Research Symposium 'Rethinking Linguistic Relativity'. Ocho Rios, Jamaica, May.
- Bowerman, M. "Where do children's spatial semantic categories come from?" Northern European Language Acquisition Seminar. Mullsjö, Sweden, August.
- Bowerman, M. Discussant in Symposium "Language and cognition in normal and handicapped children: A tribute to Richard Cromer". British Psychological Society Developmental Psychology Section Annual Conference. Cambridge, September.
- Bowerman, M. "Studying semantic development cross-linguistically". Conference on Crossing Boundaries: Formal and

- Functional Determinants of Language Acquisition. Tübingen, October.
- Brinkmann, U. "Zur Inadäquatheit von 'Konzepten' im Erwerb lokaler Präpositionen". Workshop 'Begriffsbildung in natürlichen und künstlichen Systemen'. Bonn, April.
- Brinkmann, U. "Wie wichtig sind vorsprachliche Konzepte für den Erwerb von Präpositionen?". 10. Tagung für Entwicklungspsychologie. Cologne, September.
- Brown, C. M., and Hagoort, P. "In search of the neural architecture for language processing". Workshop on Biomagnetic Investigations of the Nervous System. Porto Carras, Halkidiki, Greece, June.
- Budwig, N. "An analysis of physicians' presentations of medical treatment options and related risks". 13. Jahrestagung der Deutschen Gesellschaft für Sprachwissenschaft. Aachen, February.
- Budwig, N., and Wiley, A. "The contribution of caregivers' input to children's talk about agency and pragmatic control". Child Language Seminar. Manchester, March.
- Burgers, H. H. A., and Vonk, W. "De invloed van context op de syntactische interpretatie van ambigue woorden". 14e Minisymposium over Lezen. Nijmegen, April.
- Chwilla, D., Brown, C. M., and Hagoort, P. "The N400 and attentional processing in a word priming paradigm". 31st Annual Meeting of the Society for Psychophysiological Research. Chicago, October.
- Clark, E. "Constraints on lexical acquisition". Symposium on Models of Language Acquisition, Netwerk Eerste Taalverwerving. Groningen, February.
- Clark, E. "Word-formation in the acquisition of English and Hebrew". AILA Child Language Commission Workshop on Comparative Studies of Acquisition: Problems and

- Prospects. Manchester, March.
- Clark, E. "Speaker perspective and lexical acquisition". *Werk-gemeenschap Taal en Geheugen*. Amsterdam, May.
- Clark, E., and Svaib, T. "Speaker perspective and lexical acquisition". *Child Language Seminar*. Manchester, March.
- Clark, H. H. "Meaning in action". *The Gustaf Stern Memorial Lectures in Semantics*. Gothenburg, March.
- Clark, H. H. "Actions in discourse". *Dandi Workshop on Discourse Coherence*. Edinburgh, April.
- Clark, H. H. "Communities and communication". *Wenner-Gren Foundation for Anthropological Research Symposium 'Rethinking Linguistic Relativity'*. Ocho Rios, Jamaica, May.
- Comrie, B. "Typology and reconstruction". *10th International Conference on Historical Linguistics*. Amsterdam, August.
- Comrie, B. "Serial verbs, verbal periphrases, and imperfective aspect in Haruai". *Workshop on Verbal Periphrases: Origin and Development*. *10th International Conference on Historical Linguistics*. Amsterdam, August.
- Drews, E. "Lexical representation of morphologically complex words". *32nd Annual Meeting of the Psychonomic Society*. San Francisco, November.
- Drews, E., and Zwitserlood, P. "Lexikalische Repräsentation von Partikelverben im Deutschen und Niederländischen". *DFG Schwerpunkt Kolloquium 'Kognitive Linguistik'*. Bochum, October.
- Drews, E., Zwitserlood, P., and Bolwiender, A. "Visuelle Worterkennung: Morphologische und/oder orthographische Priming-Effekte?" *33. Tagung experimentell arbeitender Psychologen*. Gießen, March.
- Emmorey, K., Bellugi, U., Friederici, A. D., and Horn, P. "Effects of age of acquisition on grammatical sensitivity: Evi-

- dence from on-line and off-line tasks". Annual Meeting of the Linguistic Society of America. Chicago, January.
- Feldweg, H. "Computer-aided exploitation of language acquisition databases". Conference on Crossing Boundaries: Formal and Functional Determinants of Language Acquisition. Tübingen, October.
- Flores d'Arcais, G. B. "The process of comprehending a word in a non-alphabetic system". Sylvia Beach Language Comprehension Conference. Newport, August.
- Flores d'Arcais, G. B. "Sviluppo della consapevolezza metalinguistica e abilità nella lettura". 10th Congress of the Pure Research Division of the Italian Psychological Association. Ravello, October.
- Flores d'Arcais, G. B. "The processes of reading in logographic orthographies". 3e Congres Nederlandse Vereniging voor Psychonomie. Noordwijkerhout, December.
- Frauenfelder, U. "Morphological processing in Turkish". SISSA Workshop on the Psycholinguistic Consequences of Contrasting Language Phonologies. Trieste, June.
- Frauenfelder, U. "The interface between acoustic-phonetic and lexical processing". OTS Conference on Speech Perception. Utrecht, July.
- Frauenfelder, U. "Psycholinguistic aspects of morphological parsing in Turkish native speakers". Morfologiedagen. Gent, September.
- Frauenfelder, U. "Morphological parsing in Turkish: An on-line experimental study". 32nd Annual Meeting of the Psychonomic Society. San Francisco, November.
- Friederici, A. D. "Speech perception in infancy: Sensitivity to language-specific phonotactic constraints". SISSA Workshop on the Psycholinguistic Consequences of Contrasting Language Phonologies. Trieste, June.

- Friederici, A. D. "Natürliche Sprachverarbeitung: Funktionen und Dysfunktionen". GWAI-91. Fachtagung für künstliche Intelligenz. Bonn, September.
- Friederici, A. D., Schriefers, H., and Lindenberger, U. "Processing of semantic and syntactic information in young and old adults". Gerontological Society of America. San Francisco, November.
- Friederici, A. D., and Wessels, J. M. I. "Spracherkennung bei Kleinkindern: Sensibilität gegenüber phonotaktischen Merkmalen". DFG-Kolloquium 'Kognition und Gehirn'. Bonn, April.
- Graetz, P., De Bleser, R., and Willmes, K. "The Dutch adaptation of the Aachen Aphasia Test". 9th European Workshop on Cognitive Neuropsychology. Bressanone, January.
- Graetz, P., and De Bleser, R. "Adaptation and standardization of the Dutch version of the Aachen Aphasia Test". Plenary Conference of the Concerted Action 'The Evaluation of the Efficacy of Technology in the Assessment and Rehabilitation of Brain-Damaged Patients'. Bad Neuenahr, September/October.
- Haarmann, H. J., and Kolk, H. H. J. "The production of grammatical morphology in Broca's and Wernicke's aphasics: Same underlying impairment?" 29th Annual Meeting of the Academy of Aphasia. Rome, October.
- Hagoort, P., Brown, C. M., and Swaab, T. Y. "Using event-related brain potentials (ERPs) to investigate comprehension deficits in aphasia: A priming study". 29th Annual Meeting of the Academy of Aphasia. Rome, October.
- Hahne, A., Friederici, A. D., and Rösler, F. "Syntaktische und semantische Restriktionen bei einer lexikalischen Entscheidungsaufgabe". 33. Tagung experimentell arbeitender Psychologen. Gießen, March.

- Haverkort, M., and Weissenborn, J. "Clitics and affix interactions in Early Romance". 16th Boston University Conference on Language Development. Boston, October.
- *Haviland, J. B. "La tipología del lenguaje espacial, con referencia al Tzotzil de Zinacantán." Seminario de Lenguas Indígenas. National University of Mexico. Mexico City, February.
- *Haviland, J. B. "Projections, transpositions, and relativity". Wenner-Gren Foundation for Anthropological Research Symposium 'Rethinking Linguistic Relativity'. Ocho Rios, Jamaica, May.
- Hickmann, M., Hendriks, H., and Liang, J. "Some discourse determinants of word order in acquisition: A crosslinguistic study". Conference on Crossing Boundaries: Formal and Functional Determinants of Language Acquisition. Tübingen, October.
- Hickmann, M., Kaiser, B., and Roland, F. "Semantics and pragmatics in the development of tense and aspect: A crosslinguistic study". 2nd European Congress of Psychology. Budapest, August.
- Hoeks, B. "Quantitative input estimation of the pupillary system in cognitive tasks". 1st European Psychophysiology Conference. Tilburg, June.
- Jordens, P. "The acquisition of negation in Dutch". Northern European Language Acquisition Seminar. Mallsjö, Sweden, August.
- Jordens, P. "The acquisition of word order in L2 Dutch and German". Inaugural Conference of the European Second Language Association. Salzburg, September.
- Jordens, P. "The acquisition of negation in Dutch". Crossing Boundaries: Formal and Functional Determinants of Language Acquisition. Tübingen, October.

- Jordens, P., and Hoekstra, T. "From adjunct to head". GLOW Conference. Leiden, March.
- Kilborn, K. "Grammatical processing in real time in Wernicke's and Broca's aphasia". Theoretical and Experimental Neuropsychology. TENNET. Montreal, May.
- Kilborn, K. "Crosslinguistic approaches to sentence comprehension". 2nd European Congress of Psychology. Budapest, August.
- Kilborn, K., Friederici, A. D., and Kaiser, A. "Aphasics' interpretation of predicate-argument structures when the verb at the end of the sentence is: Evidence from German". 29th Annual Meeting of the Academy of Aphasia. Rome, October.
- Kiparksy, P. "Catalexis". EUROTYP Workshop. Salzburg, October.
- Klein, W. "Wie ist der Stand der Germanistischen Sprachwissenschaft, und was können wir tun, um ihn zu verbessern?" Colloquium 'Germanistik 2000'. Wassenberg, Germany, May.
- Lahiri, A. "Metrical structure and vowel lengthening in MNL". European Science Foundation 1st Plenary Conference on Language Typology. Lucca, Italy, May.
- Lahiri, A. "Phonological representations and processing". SISSA Workshop on the Psycholinguistic Consequences of Contrasting Language Phonologies. Trieste, June.
- Lahiri, A. "Consequences of non-linear representations in comprehension". 13th International Congress of Phonetic Sciences. Aix-en-Provence, August.
- Lahiri, A. "Prosodic shifts in Germanic". European Science Foundation, 4th Word Prosody Systems Conference. Salzburg, November.
- * de León, L. "Sí means Yes: Authority and metalanguage in

- an American court". Law and Society Association. Amsterdam, July.
- Levelt, W. J. M. "Speaking: From intention to articulation". 13. Jahrestagung der Deutschen Gesellschaft für Sprachwissenschaft. Aachen, February.
- Levelt, W. J. M. "Speaking: The time course of lexical access". 33. Tagung experimentell arbeitender Psychologen. Gießen, March.
- Levelt, W. J. M. "Sprachliche Musterbildung und Mustererkennung". Jahresversammlung Leopoldina. Halle, April.
- Levelt, W. J. M. "Tutorial on phonological encoding". SISSA Workshop on the Psycholinguistic Consequences of Contrasting Language Phonologies. Trieste, June.
- Levelt, W. J. M. "On the skill of speaking". Conference on Conceptions of the Human Mind. Princeton, October.
- * Levinson, S.C. "Relativity in spatial conception and description". Wenner-Gren Foundation for Anthropological Research Symposium 'Rethinking Linguistic Relativity'. Ocho Rios, Jamaica, May.
- Meyer, A. S. "Phonetische Enkodierung: Planung von Pausenlängen". 33. Tagung experimentell arbeitender Psychologen. Gießen, March.
- Meyer, A. S. "Metrische Kodierung in der Sprachproduktion". 3. Linguistisches Kolloquium. Bergische U. und Gesamthochschule Wuppertal, November.
- Noordman, L. G. M., Vonk, W., and Simons, W. H. G. "Reader's expertise and inference processes in text understanding". EPS Symposium on Discourse Processing. Brighton, July.
- * Pederson, E. "Categories of reflexive voice: Homonymy vs. polysemy in two-form languages". Annual Meeting of the Linguistics Society of America. Chicago, January.

- * Pederson, E., and Koenig, J.-P. "The *se faire* construction in Modern French". 5th Annual Cognitive Linguistics Workshop. San Diego, May.
- Perdue, C. "L'absence de grammaticalisation: variation individuelle dans l'acquisition d'une deuxième langue". 8th Colloque International 'Acquisition des Langues: Perspectives et Recherches'. Grenoble, May.
- Perdue, C. "Les études de cas et le généralisable". 1er Colloque International sur les Interactions. Aix-en-Provence, September.
- Perdue, C. "Understanding the acquisition of French in a social setting". Annual Conference of the British Association of French Language Studies. Edinburgh, September.
- Piepenbrock, R. "A longer term view on the interaction between lexicons and text corpora in language investigation". ICAME conference. Leeds, May.
- Roelofs, A. "A theory of lemma retrieval in speaking". 32nd Annual Meeting of the Psychonomic Society. San Francisco, November.
- Roeper, T., Weissenborn, J., and de Villiers, J. "The acquisition of complementizers and quotation". 16th Boston University Conference on Language Development. Boston, October.
- * Senft, G. "Network models to describe the Kilivila classifier system". Sixth International Conference on Austronesian Linguistics. Hawaii, May.
- * Senft, G. "These 'Procrustean Feelings'...- some of my problems in describing Kilivila". Seminar on Descriptive Austronesian and Papuan Linguistics. ILDEP/DSALCUL. Leiden, September.
- Swaab, T. Y., Brown, C. M., and Hagoort, P. "Sensitivity of the N400 to auditory associative and semantic priming".

- First European Psychophysiology Conference. Tilburg, June.
- Swaab, T. Y., Brown, C. M., and Hagoort, P. "Die Anwendung von Event-Related Potentials (ERPs) zur Erforschung von Sprachverständnisstörungen in Broca Aphasie: Eine Priming Studie". 18. Jahrestagung für Aphasieforschung und -behandlung. Amsterdam, November.
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- Vonk, W. "Specificity of referring and the comprehension of text structure". Dandi Workshop on Discourse Coherence. Edinburgh, April.
- Vonk, W. "The use of referential expressions in structuring discourse". EPS Symposium on Discourse Processing. Brighton, July.
- Van der Voort, M. E. C., and Vonk, W. "Compositionaliteit en syntactische flexibiliteit bij de verwerking van idiomatiche uitdrukkingen". 3e Congres Nederlandse Vereniging voor Psychonomie. Noordwijkerhout, December.
- Vorberg, D. "Aufmerksamkeitswechsel bei Mehr-Ebenen-Symbolen: Hierarchie-Ebenen oder größenspezifische Kanäle?" 33. Tagung experimentell arbeitender Psychologen. Gießen, March.
- Vorberg, D. "Ist der Rückschaufehler ein Artefakt? Hinsight bias und Regressionseffekt". 33. Tagung experimentell arbeitender Psychologen. Gießen, March.
- Vorberg, D. "Über die Dynamik der visuellen Aufmerksamkeit". Antrittsvorlesung. Braunschweig, May.
- Vorberg, D. "On the dynamics of visual attention: Switching between the forest and the trees". 10th Congress of the

- Pure Research Division of the Italian Psychological Association. Ravello, October.
- Vorberg, D. "On the dynamics of visual attention: Switching between the forest and the trees". 3e Congres Nederlandse Vereniging voor Psychonomie. Nooordwijkerhout, December.
- Vorberg, D. "Models for timing and synchronization". NATO-Workshop 'Time, Action and Cognition'. St. Malo, France, November.
- * Wassmann, J. "When actions speak louder than words: The classification of food among the Yupno of Papua New Guinea". The Cultural Environment in Psychology. Symposium in honour of Ernst E. Boesch. Merlingen, Switzerland, November.
- Weissenborn, J. "L'enfant a horreur du vide: Aspects of the development of WH-questions in French and German". GGS-Tagung. Bern, June.
- Weissenborn, J., and Haverkort, M. "Cliticization in early child language". Conference on Crossing Boundaries: Formal and Functional Determinants of Language Acquisition. Tübingen, October.
- Wittenburg, P., and Couwenberg, R. "Recurrent neural networks as phoneme spotters". International Conference on Artificial Neural Networks. Helsinki, June.
- Wittenburg, P., and Couwenberg, R. "Recurrent neural networks as building blocks for word recognition models". EUROSPEECH Conference. Geneva, September.
- Zandhuis, J., Couwenberg, R., and Wittenburg, P. "Phoneme and word recognition at the MPI for Psycholinguistics". 2nd Symposium on Neural Networks. Nijmegen, April.
- Zwitsersloot, P. "Syllables and morphology in Dutch". SISSA Workshop on the Psycholinguistic Consequences of Con-

- trasting Language Phonologies. Trieste, June.
- Zwitserslood, P. "Monitoring for syllables in morphologically complex words". 32nd Annual Meeting of the Psychonomic Society. San Francisco, November.
- Zwitserslood, P. "Orthografische en morfologische informatie bij de visuele woordherkenning". 3e Congres Nederlandse Vereniging voor Psychonomie. Noordwijkerhout, December.
- Zwitserslood, P., Drews, E., and Bolwiender, A. "Zur lexikalischen Struktur morphologisch komplexer Verben". 33. Tagung experimentell arbeitender Psychologen. Gießen, March.

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(Members of the Cognitive Anthropology Research Group are marked with an *.)

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- Baayen, R. H. (1991). De CELEX lexicale databank. *Forum der Letteren*, 32, 221-231.
- Baayen, R. H. (1991). A stochastic process for word frequency distributions. *Proceedings of the 29th Annual Meeting of the Association for Computational Linguistics* (pp. 271-278). Berkeley, California.
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Working papers of the Cognitive Anthropology Research Group

- (1) Levinson, S. C. "Relativity in spatial conception and description".
- (2) Haviland, J. B. "The grammaticalization of motion (and time) in Tzotzil".
- (3) Haviland, J. B. "Projections, transpositions, and relativity".
- (4) de León, L. "Space games in Tzotzil: Creating a context for spatial reference".
- (5) Levinson, S. C. "Primer for the field investigation of spatial description and conception".
- (6) Brown, P. "Spatial conceptualization in Tzeltal".
- (7) Levinson, S. C., and Brown, P. "'Uphill' and 'downhill' in Tzeltal".