

Max-Planck-Institut für Psycholinguistik

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1996

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Preface

Over the last five years, the Institute has cherished its outpost at the Humboldt University in Berlin, Manfred Bierwisch's Research Group on Structural Grammar. But the Group's five-year term ran out by the end of 1996. The present Annual Report contains a review of the Group's final scientific endeavors. There is all reason to look back with great satisfaction and to thank Manfred Bierwisch, his staff and students for their dedication and outstanding performance.

Last year's most conspicuous event was the beginning of our building's reconstruction and the full transfer of all staff and equipment to a huge, temporary container building on the Institute's lot. The expected chaos turned out to be surprisingly moderate, thanks to the perfect control of our administrative and technical staff. As a result, research could continue at almost normal pace. That the present Report is nevertheless 25% leaner than last year's, has a different reason. We decided to concentrate even more on essential findings, leaving out all details that wouldn't interest your significant other.

Willem Levelt

Organization of the Institute and the Cognitive Anthropology Research Group in 1996

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Project Descriptions

1. Phonological Structure in Comprehension

This project investigates the ways in which the processing of spoken and written language input is constrained by the phonological structure of the input language. Research on this project in 1996 included the investigation and modeling of infants' acquisition of native phonology, studies of the role of phonological structure in the processing of segmental structure, studies of the segmentation of continuous speech into words, of phonological factors in written and spoken word recognition, and cross-linguistic studies of prosodic structure and its role in processing.

1.1 Development of phonological structure perception

1.1.1 Infants' word recognition in fluent speech

In a series of head-turning experiments, infants' word recognition in fluent speech was investigated by C. Kuijpers, R. Coolen and A. Cutler (in collaboration with P. Jusczyk and D. Houston, Johns Hopkins U.). Jusczyk and colleagues have shown that American-English 7.5 month-old infants can recognize words with strong/weak (SW) stress pattern (e.g. *doctor*) when these are presented in connected speech. Since the metrical structure of Dutch is similar to that of English, Dutch infants were expected to use the SW segmentation strategy as well. However, 7.5 month-old Dutch infants did not recognize SW words in connected speech. This was true whether they heard Dutch input (e.g. *bokser*) or the original English materials. However, 9-month-olds presented with the Dutch materials did show a tendency towards recognition. The discrepancy between the English and the Dutch results might be explained by acoustic and distributional differences in metrical structure between the two languages.

During 1997 this latter hypothesis will be explored in a new project by Kuijpers, Cutler, and P. van Wijck (U. Nijmegen), which will examine

segmentation strategies in young children during the second year of life. Studies of early speech production in this period support the hypothesis that words and phrases are mapped onto a trochaic (SW) template, and this trochaic bias in production probably implies a trochaic bias in perception. In an experimental task (adjusted to young children) the nature of speech segmentation in the second year of life will be investigated, addressing in particular the role of stress and vowel quality.

1.1.2 Speech input to a prelinguistic infant

The dissertation project of J. van de Weijer analyzes the language input to a prelinguistic child between six and nine months: specifically, a corpus of tape recordings containing virtually all the language that a child heard in this period. Based on a sample of 18 days, taken from the first week, the middle week, and the last week, it is estimated that the input constituted about three hours of speaking time per day, of which about 12 percent was language addressed directly to the infant.

Language from adults to the infant has been transcribed and was coded for type of utterance (declaratives, imperatives, questions, other). These are orthographic transcripts in the standardized CHAT format established by the CHILDES database. Part of the adult-to-adult data has also been transcribed but is not yet coded. Comparisons of infant-directed speech with adult-directed speech indicate clear differences between the two speech styles, acoustically as well as grammatically. Infant-directed speech has higher average pitch and more pitch variation, a larger percentage of expanded intonation contours, lower speech rate (syllables per second), shorter utterances (seconds, number of syllables), lower type-token ratio, larger percentage of imperatives, a very high percentage of "other" utterance types (such as: social expressions, baby talk, vocatives, fillers).

Since this project aims to understand how infants can compile an initial vocabulary from continuous speech input, a parallel line of research within the project concerns modeling of this process. In collaboration with M. Brent (Johns Hopkins U.) an experiment was conducted with adult listeners learning an artificial miniature language. The goal of the experiment was to find out whether the listeners used distributional properties of the input in locating word boundaries, as proposed in a com-

putational model developed by Brent. The results of the experiment were in the predicted direction; listeners appeared to hypothesize word candidates on the basis of the boundaries of already-known words. However, the differences were too small to be statistically reliable, and the experiment is currently being replicated in Baltimore in an adapted version.

1.1.3 Modeling of the acquisition of a phonetic repertoire

K. Behnke's dissertation project investigates the development of the system of phonetic categorization in infants. According to the theoretical model, infants' capabilities in discriminating non-native phonetic contrasts decrease as phonetic categories, which are memory representations of the distributional properties of the language, develop. The main question of this project is whether the developmental process can be described by a self-organizing neural network approach (see Annual Report 1995).

The neural network has been tested with isolated spoken CVCV-words in which the consonant and vowel remain constant in a word. As consonants we used /b/, /d/, /l/, /m/, and /p/ and as vowels we used the seven long vowels of the Dutch vowel system. The sampled speech data was transformed into an Acoustical Band Spectrum (ABS) representation and filtered by different energy filters.

Simulation results show that the neural network was able to learn a representation for each vowel category. However, a representation was in general ambiguous, i.e. it showed a high activity for more than one vowel category. Further investigations of the input data and the simulation results showed that if more than one vowel category is mapped onto a representation then these vowel categories have a strong overlap in input space (e.g. /e:/ and /i/, or /o:/ and /u/).

An implication of the simulation results is that the development of phonetic categories cannot be the result of an exclusively self-organizing process based on infant's perception and representation of linguistic input. At a very early stage during development, discriminative processes must give an infant additional cues to form separate categories for each of the phonetic categories.

1.2 The role of phonological structure in segmental processing

The study of the perception by Japanese and Dutch listeners of nasals assimilated to the place of articulation of a following stop consonant (see Annual Report 1995) was followed up in two studies of the perception of assimilation; further work investigated the role of the phoneme repertoire in segmental processing.

1.2.1 Voice assimilation in Dutch

C. Kuijpers and W. van Donselaar investigated regressive voice assimilation in Dutch. Voice assimilation frequently occurs in obstruent clusters with a second voiced stop, thereby violating the obligatory final devoicing rule. For instance, the word *kaas* before *boer* may be realized as *kaazboer* instead of *kaasboer*. In a phoneme-monitoring task it was shown that voice assimilation did not facilitate recognition of the subsequent consonant: listeners detected /b/ equally fast in *kaazboer* as in *kaasboer*. However, detection of /p/ was considerably slower in *kaazplank*, than in *kaasplank*, because of the unconditioned voicing of /s/ before /p/. Phoneme recognition is only affected if obligatory phonological rules are violated. Follow-up experiments are currently in progress, comparing the role of voice assimilation across morpheme boundaries and word boundaries.

1.2.2 Assimilation of place in Japanese and Dutch

A word-blending task was used to compare the perception of assimilated forms by speakers of these two languages. In this study, carried out by T. Otake (Dokkyo U.) and A. Cutler, subjects were asked to construct a blend of two pseudo-names, using the (larger) first part of the first name and the (smaller) last part of the last name. For instance, Japanese subjects were asked to blend *ranga* with *serupa*, or *kumba* with *soroki*. Japanese were predicted to perceive the nasals as unmarked for place of articulation and to produce assimilated nasals in the blends (e.g. *rampa*, *kungkî*); if the nasal were represented in its surface form, on the other hand, this would

be preserved in the blends (*rangpa, kumld*). Japanese subjects indeed produced forms consistent with unmarked underlying-form representation. When analogous Dutch materials (*mengkerkltrabeek, stambest/sliekoop*) were presented to Dutch subjects, however, they produced forms consistent with surface representations (*mengbeek, stamkoop*) rather than with underlying representations (*membeek; stangoop*). In subsequent experiments the Japanese subjects were presented with the Dutch materials, and vice versa. The cross-linguistic task proved inordinately difficult for both subject populations, but those responses which could be analyzed showed that the Japanese listeners still used an underlying representation and the Dutch listeners a surface representation.

1.2.3 The size of the phonemic inventory

Languages differ in number of phonemes and in type of phonemes (e.g. the ratio of vowels to consonants). A collaborative project between the MPI (Cutler, M. Koster) and the University of Barcelona (N. Sebastian, A. Costa) addressed the issue of whether such differences affect listeners' processing of segments. The first study exploited known effects of phonetic uncertainty in phoneme detection: the reaction time to /b/ is slower in *si.fo, ta, bu* than in *su.fu, tu, bu*. Parallel phoneme-detection experiments in Dutch (which has vowel and consonant inventories nearly equivalent in size) and Spanish (which has four times as many consonants as vowels) examined detection of vowels in varied vs. fixed consonant contexts, and detection of consonants in varied vs. fixed vowel contexts. The number of varying phonemes in the experimental context was held constant across the two languages. In Dutch, strong effects of contextual uncertainty were exercised for detection of both types of target; in Spanish, consonant uncertainty had a stronger effect on vowel detection than vowel uncertainty had on consonant detection. This suggests that the size of the potential repertoire of contextual variation exercises an effect upon listeners' recognition of phonetic segments.

1.3 Phonological structure and the segmentation of continuous speech

This part of the project has been conducted in close collaboration with the Spoken Word Recognition project. Studies in English and Japanese on the language-specificity of the possible-word constraint in speech segmentation are described in the Spoken Word Recognition section of this report (section 2.1 below). Section 1.3.1 also describes collaborative work with that project.

1.3.1 Finnish vowel harmony and speech segmentation

Previous word-spotting experiments by K. Suomi (U. Oulu) with J. McQueen and Cutler indicated that Finnish listeners can use vowel harmony restrictions as a powerful speech segmentation cue to locate word onsets (see Annual Report 1995). The next step in this project aims to test whether Finnish listeners also exhibit a harmony effect when they are listening to foreign-language input. First, two experiments were conducted to see whether a similar harmony effect could be obtained using a syllable-monitoring task; however, these experiments revealed no harmony effect, suggesting that the facilitatory effect of vowel harmony on segmentation is restricted to word-level segmentation. The experiments thus ruled out the use of syllable-monitoring as an approach to cross-linguistic comparisons.

Consequently, a new line of research has begun in which Finnish listeners are presented with English input. The earlier word-spotting experiments on vowel harmony (see Annual Report 1995) used Finnish CVCV words embedded in CVCVCV items; that is, all context syllables were open (CV). Phonotactic restrictions on those English vowels that most closely correspond to vowels belonging to opposite harmonic classes in Finnish require that the context syllables of embedded words have a coda; the short vowel /æ/, for instance, as in British English *hat*, closely resembles the same front-harmonic vowel in Finnish, but in English can only occur in a closed syllable. A necessary first step in this new project was therefore to establish that the vowel harmony effects would also appear with input in which the context syllables were closed. A further word-spotting expe-

riment in Finnish with CVC context syllables produced the same results as the earlier studies: contexts containing disharmonious vowels strongly facilitated word detection.

1.3.2 Segmentation of foreign-language input

Studies of the perception of Arabic by Dutch and French listeners (see Annual Report 1995) were followed up in 1996 by van Donselaar and Cutler in collaboration with G. Altmann (U. York), using a probe recognition task to investigate the perception of continuous speech in Dutch by English listeners. Evidence from English indicates that English listeners use the strong/weak syllable opposition in speech segmentation. Since strong syllables are generally stressed and weak syllables unstressed, the strong/weak opposition largely coincides with the stressed/unstressed opposition. In Dutch, though weak syllables are usually unstressed (e.g. *BAKsel, geBAK*), strong syllables can either be stressed or unstressed (e.g. *ORka, orKAAN*). If English listeners have to segment Dutch, to what extent will they rely on strong/weak patterns and to what extent on stress patterns? A pilot experiment in Dutch with French listeners (in collaboration with D. Dahan) only showed an effect of position: subjects were more accurate and faster for probe words that occurred later in the sentence than for probes that occurred early in the sentence. Since the correct recognition of early probes was at chance level, the sentence materials in this experiment may simply have been too long; sentences were therefore shortened for the experiment in English. The experiment is currently in progress.

1.4 Phonological structure in word recognition

1.4.1 Dutch words realized with epenthetic schwa

In Dutch, words such as *tulp*, /*tvlp*/ ('tulip') are frequently pronounced with epenthetic schwa (i.e. as /*tvləp*/). The production and perception of words with epenthetic schwa has been investigated by van Donselaar, Kuijpers and Cutler. First, the relation between schwa epenthesis and rhythmic structure in speech production was addressed in a series of pic-

ture-naming tasks. Subjects pronounced target words in isolation and in sentence contexts. The target words in context occurred in the middle or at the end of sentences with different rhythmic structures. The results show that schwa epenthesis is triggered by a strong/weak speech rhythm. This suggests that in speech planning the rhythmic effect at the sentence level interacts with the segmental spell-out of the lexical form. The syllabic representation of words with epenthetic schwa was likewise explored by means of a reversal paradigm. Subjects were asked to reverse monosyllabic words phoneme-by-phoneme (*gips=spig*) and bisyllabic words syllable-by-syllable (*masker=kermas*). Real words and pseudowords with and without epenthesis were embedded in lists of monosyllabic and bisyllabic items. Subjects reversed words with epenthetic schwa (e.g. /Map/) predominantly as monosyllables (e.g. /pM). These results are consistent with the earlier finding in syllable monitoring experiments that words with epenthetic schwa are not processed as bisyllables.

In order to investigate whether epenthesis helps or hinders word processing, new lexical decision and word-spotting experiments were carried out. A replication of an earlier lexical decision experiment showed again that words with epenthetic schwa are processed faster than 'standard' realizations without schwa. This experiment gives us evidence that isolated words with epenthesis are processed faster, but are these words also processed faster in context? This question was answered by means of a word-spotting paradigm. The materials of an earlier word spotting experiment were considerably extended. Standard realizations and phonological variants were again embedded in nonword contexts (e.g., *berg*, /beRx/ in *berglaap*, /beRxla:p/). The word boundary following the target was either ambiguous because it contained a legal onset cluster (e.g., the cluster *lxV* in /bsRxla:p/ - /bsRaxla:p/) or unambiguous because it contained an illegal onset cluster (e.g. /xt/ in *bergtaap*, /beRXta:p/ or /beR9xta:p/). Listeners were instructed to detect words in these nonwords. Words with epenthetic schwa were detected faster and more accurately than their "standard" counterparts. Overall, unambiguous word boundaries facilitated the detection of target words. The results suggest that schwa epenthesis facilitates segmentation.

1.4.2 Lexical stress

Research by Koster, van Donselaar and Cutler investigated whether lexical stress is used during pre-lexical activation. A cross-modal priming and lexical decision paradigm was used in one experiment. Subjects listened to utterances like *Het was haast niet te lezen maar er stond dyNA*. ('It was hardly legible, but it said dyna.')

After such an utterance they saw a target word on a screen (e.g. FIETS 'bike'). They had to decide whether this was a real word or not. The idea was that if lexical stress is used in lexical activation, *dyNA* should only activate *dyNAmo* ('dynamo'), but not *dynaMIET* ('dynamite'). Reactions on targets related to the primes (e.g. FIETS after *dyNA*) should therefore be faster than to targets related to stress counterparts (e.g. BOM after *dyNA*). Apart from related targets like FIETS and BOM, the design also contained matched unrelated targets like FEEST and BEK. Separate baseline control conditions with fully unrelated primes (e.g. *douche*) were used as well. The results showed that *dyNA* primed FIETS but not BOM, as predicted. However, this priming effect was only small and not significant. Currently, this experiment is being replicated in a slightly changed form.

In another experiment the word-spotting paradigm was used. McQueen, D. Norris and Cutler found in 1994 that a word like *mess* in English is harder to detect in *demess* (a possible word onset: *domestic*) than in *nemess* (no word onset). It was expected that in Dutch it would likewise be harder to detect a word like *strak* in *abSTRAK* (the onset of the word *abSTRAKtie*) than in a non-word onset like *ibSTRAK*. The results confirmed this prediction and thus the English results were replicated for Dutch. If, however, lexical stress information plays a role in activation, incorrectly stressed *ABstrak* should not activate *abSTRAKtie* and no difference is expected between the detection of *strak* in *ABstrak* and *IBstrak*. As the reaction times showed no significant difference, it was concluded that lexical stress is indeed used pre-lexically in Dutch.

1.4.3 The open and the closed classes of words

The dissertation research of A. Haveman investigates whether open-class words (i.e., nouns, verbs, adjectives, and adverbs) are processed and stored differently from closed-class words (grammatical words). An auditory

priming experiment described in the 1995 Annual report showed that when semantic associates of homophones like *haar* (having both an open- and a closed- class meaning, i.e. *hair/her*) were preceded by short phrases that syntactically biased either meaning (i.e., *knal groen haar/vraag het haar* 'bright green hair'/'ask her'), only the decision on the associate of the intended meaning was facilitated. In two follow-up cross-modal priming experiments, the semantic associates were not only presented with an interstimulus interval of 400 ms., but also with an interval of 0 ms. The results suggest that the frequency discrepancy between the two meanings of the homophone plays an important role: for both intervals, significant priming was found for closed-class associates, but only when the high-frequency closed-class meaning was also biased by the syntactic context.

The influence of embedded low-frequency open-class words versus high-frequency closed-class words on spoken word recognition was tested by using a cross-modal priming paradigm. Subjects listened to sentences ending with an open-class word having another monosyllabic word embedded. These embedded words were either stressed open-class/closed-class homophones (*Kunstschilders verven HENDels* 'Artists paint handles'), nonhomophonous stressed open- and closed-class words (*De vreemde artiest spaarde BANjo'sIDUSters* 'The weird artist collected banjo's/ dressing-gowns'), or non-homophonous unstressed open- and closed-class words (*Defirma importeerde karTONnenImeLOEnen* 'The concern imported cardboard boxes/melons'). Lexical decisions were made on semantic associates of the embedded words (*hen, ban, dus, kar, me* respectively). The results showed a tendency towards priming in all conditions, indicating that all embedded words were activated, irrespective of stress, frequency, and vocabulary class.

1.4.4 Phonological structure in visual word recognition

G. Flores d'Arcais has continued a project on the choice of kanji characters in writing Japanese new words. A number of experiments have been carried out at Dokkyo University in Tokyo together with G. Hatano and S. Tokimoto. The main purpose of the study was to investigate the type of orthographic solutions people would choose for writing terms such as geographical regions, railroad stations, or personal names, for which traditional semantic relations are weak or non-existent. A train station such

as AKABANE could be written with the two kanji AKA and BANE, or A KA BA NE, etc. How do people make these choices? We have given our subjects a number of non-existing terms (non-existing railroad stations) with the request to write the name. The solutions proposed gave several interesting indications about the principles people are using in this type of task. The main principles were analogy with existing solutions for similar words, frequency of existing orthographic solutions, and a number of clear phonological principles (e.g. KATA YAMA is preferred over KA TAYA MA), which are being specifically investigated in new experiments.

Again with the cooperation of Hatano and Tokimoto, Flores d'Arcais continued working on a project concerning the interference between *on* and *kun* pronunciation of kanji characters, that is, the original Chinese and the Japanese pronunciation which characterizes *the* use of most kanji. In one experiment the subjects were asked to decide whether two characters have the same or different pronunciation, and it was found that when two characters are heterophones in the selected pronunciation but homophones in the rejected one, subjects tend to make more errors and are slower. The effect was stronger when the rejected pronunciation was *on* than when it was *kun*. This study tries to investigate the strength of the interference effects and the reason for the difference between *on* and *kun* interference effects.

1.5 Prosodic structure in comprehension

1.5.1 Intonational phonology

E. Grabe continued her dissertation work on intonational phonology. A comprehension experiment investigating relationships between intonational phrases in German showed that listeners can use the distribution of accents in successive phrases to resolve instances of ambiguous anaphoric reference. In the following dialogue:

- A. Anna's going to tell her brother about her problem.
- B. But will she tell Peter the truth?

listeners judged *Peter* and *brother* to be the same person when *Peter* was deaccented. When *Peter* was accented, however, subjects did not automatically judge that *Peter* and *brother* were different persons. The results show that deaccenting signals the absence of new information (i.e. Peter = brother) whereas accenting is compatible with both new and old information.

Further, a cross-linguistic investigation addressed the scaling of accents in lists. In both German and English, lists show a "staircase" effect; successive accents are systematically lowered, and for American English, researchers have shown that the scaling of each accent can be derived from that of the immediately preceding one. A production experiment showed that this algorithm also accounts for downstep patterns in British English, but requires modification for German where the last accent may optionally be stepped down to the bottom of the register, increasing the step size between the last pair of accents.

Finally, in collaborative work with researchers from Nijmegen University, the speaker attitudes as signalled by intonation phrase onsets in Dutch were investigated. Experimental data showed that contrary to the view held in the literature, the attitude signalled by onsets depends on the structure of the complete intonational phrase. Phrases with falling accents were judged positively when produced with low onsets and negatively when produced with high onsets. Conversely, phrases with rising accents were judged positively when they began high and negatively when they began low.

1.5.2 Processing of pitch accent in Japanese

Pitch accent in Japanese is like stress in that it is realized in a multisyllabic domain; monosyllables in isolation by convention have H pitch accent, hence contrasts do not arise. However it is also like tone in that contrasts are realized via pitch variation. Cutler and Otake carried out an experiment to examine whether listeners can extract from naturally spoken Japanese words reliable pitch accent information which could narrow the set of possible word candidates. 32 words were recorded, all with the segmental structure CVCV and containing the syllable *ka*. Half of the words had HL accent pattern, half LH. For each pattern, in half of the words the syllable

ka was word-initial, in half it was word-final. The *ka* syllables were extracted from each production and presented to listeners who chose for each token between two words from which it might have come. The results showed a very high proportion of correct responses. Identification was more accurate for H than for L syllables and for initial than for final syllables. This suggests that pitch accent information is realized most clearly in just the position where it would be of most use for listeners in on-line spoken-word recognition. Acoustic analyses of the stimuli showed that H and L syllables differed principally in fundamental frequency (higher in H syllables; more varying in L syllables), and correlations confirmed that listeners' judgements were based on these acoustic effects.

1.5.3 Prosodic cues to sentence segmentation

D. Dahan continued her research on the role of prosodic structure in segmentation and lexical access (see Annual Report 1995). First, the syllable-detection experiments with French materials reported in 1995, in which French listeners showed an apparent facilitatory effect of rhythmic-group boundaries in segmentation, were replicated with Dutch listeners. Detection latency patterns were very similar to those found for French listeners, suggesting that the facilitation may reflect exploitation of low-level cues available in the signal rather than being a necessary reflection of exploitation of language-specific prosodic structure.

Next, phoneme-detection experiments in French and Dutch tested the hypothesis that prosodic phrasing into constituents such as phonological phrases may facilitate segmentation of a continuous utterance into words, since the edges of those constituents are prosodically marked and always correspond to word boundaries. Sentences were constructed in two versions differing in prosodic phrasing. In the French material, the two versions differed on whether one or two adjectives modified a noun; one adjective would be prosodically grouped in the same phrase as the noun it modified (*/ les deux cartons pesants I*), whereas two adjectives would constitute a prosodic phrase by themselves (*/ les deux cartons I pesants et fragiles I*), resulting in a prosodic boundary between the noun and the first adjective. Similar materials were constructed for Dutch, using a verb-phrase grouping (*Zij hoorden I de pedaal tikken I* vs. */ de pedaal I tikken en rammelen I*). Target phonemes occurred either on the noun or on the

adjective. Despite the fact that the speakers produced the predicted prosodic phrasing in a clear and consistent way in both languages, no conclusive effect of the prosodic boundary on phoneme-detection latencies was found for either language. Instead, the pattern of the results suggested that phoneme detections were made at a pre-lexical level.

2. Spoken Word Recognition

This project has continued to explore how listeners recognize words in spoken language. The research strategy of the project is to combine experimental work with computational modeling, and with the analysis of speech corpora. Work is divided into three topics: the segmentation of continuous speech; the information-processing architecture of the wordrecognition system; and the processing and representation of morphology. Much of the work on morphology reported this year has focused on visual word recognition; comparisons with the auditory modality have been and are continuing to be made. The links between this project and the Phonological Structure in Comprehension Project remain strong, particularly in the cross-linguistic work done on segmentation (see section 1.3).

2.1 Segmentation of continuous speech

We have argued that the segmentation and recognition of words in continuous speech is based on competition between candidate words, as instantiated in the Shortlist model (see Annual Reports 1994, 1995). A. Cutler and J. McQueen, with D. Noms (MRC Applied Psychology Unit), have worked on developing Shortlist's account of continuous speech recognition. As described in last year's report, Shortlist has been enriched with a universal segmentation constraint, which acts on cues to word boundaries in the speech stream in order to bias the competition process. Words which are misaligned with clear boundaries in the input are penalized, making them more difficult to recognize. A word is considered to be misaligned with a boundary when the stretch of speech material between the edge of that word and the boundary fails the Possible Word Constraint (PWC), that is, when it is not a possible word (*apple*, for example, *va. fapple*, spoken in isolation, would be penalized because the [f] between the edge of *apple* and the preceding silence is not a possible word of English). Simulations using Shortlist have shown that the PWC can account for many experimental results on speech segmentation.

2.1.1 What constitutes a possible word?

Thus far, the PWC has been a simple vowel constraint: if the stretch of speech between a word and a boundary cue contains a vowel, the constraint is met, and no penalty is applied to the word. But is this an adequate definition for the PWC? Japanese listeners appear to segment speech into morae, but not all morae are possible words of Japanese. In particular, moraic nasals, such as the [N] in *honda*, are not possible words. As the PWC currently stands, a word with a moraic nasal between its edge and a boundary cue, such as *bikini* ('bikini') in *bikiniN*, should be penalized. But should the PWC tolerate moraic nasals because they serve as segmentation units? Cutler and McQueen, in collaboration with T. Otake (Dokkyo U.), have examined this question in a Japanese wordspotting experiment. Subjects were required to spot words like *bikini* followed by three types of contexts: a vowel (a mora and a possible word, e.g., *bikinia*); a moraic nasal (a mora but not a possible word, e.g., *bikiniN*); and a consonant (neither a mora nor a possible word, e.g., *bikiniP*). Targets were also preceded by contexts of these three types (e.g., for *agura* 'to sit cross-legged' (*oagura*, *Nagura*, and *tagura*)). Results suggested that, as in English, a single consonant fails the PWC (e.g., *agura* was easier to spot in *oagura* than in *tagura*). Results for the moraic nasals were less clear, but suggested that a context consisting of a moraic consonant does meet the PWC (e.g., *bikini* was no more difficult to spot in *bikiniN* than in *bikinia*). Preliminary results from a follow-up experiment, where shorter target words with later uniqueness points were used (thus maximizing any possible effects of context), appear to confirm these findings: words with preceding contexts were harder to spot when the contexts were consonants than when they were vowels; and words with following moraic nasal and vocalic contexts were equally easy to spot.

2.1.2 Transitional probability in segmentation

A. van der Lugt has begun a new dissertation project, modeling the pre-lexical stage of spoken language processing. One line of research has been on segmentation. As described in last year's report, the phonotactic permissibility of sound sequences provides a segmentation cue which listeners appear to exploit; the PWC in Shortlist can use such cues. But do listeners also exploit less extreme sequential probabilities for segmen-

tation? Van der Lugt has examined the effect on segmentation of the transitional probabilities of consonant clusters, using a word-spotting task. Does the relative frequency of a consonant cluster appearing as a syllable coda versus as a syllable onset influence the recognition of a word preceding or following that consonant cluster? Hearing a combination of sounds that often occurs before a syllable boundary may facilitate recognition of a following word but interfere with recognition of a preceding word; hearing a combination of sounds that often occurs after a syllable boundary may facilitate recognition of a preceding word but interfere with recognition of a following word. Six consonant clusters, [sk], [sp], [st], [ks], [ps] and [ts], which all occur both as onsets and as codas in Dutch, were selected. These six clusters were optimal with respect to two important properties: they were minimally different with respect to acoustic features; and they covered the entire range of onset/coda ratios found in an analysis of the CELEX phonological lexicon. The clusters were placed in nonsense syllables where the target word appeared either immediately before the cluster (e.g., *bloem* 'flower', before [ks] in *bloemksuum*) or immediately after the cluster (e.g., *vriend* 'friend', after [ks] in *duuksvriend*). The results showed no reliable effects of the relative probability of complex clusters on listeners' ability to spot the target words. A second experiment is currently under construction. In this experiment, the possible use of the relative probabilities of CV and VC sequences as boundary cues will be studied, again using the word-spotting task.

2.2 The architecture of the word-recognition system

2.2.1 Autonomous or interactive processing?

A central question concerning the information-processing architecture of the recognition system is whether, as in Shortlist, the system consists of autonomous prelexical and lexical levels, or whether these levels interact with each other through top-down flow of information. McQueen and M. Pitt (Ohio State U.), continuing their investigations of transitional probability effects on phonetic judgements, have attempted to distinguish between autonomous and interactive accounts of lexical involvement in

compensation for coarticulation. After a word like *foolish*, listeners label a subsequent ambiguous stop, midway between [t] and [k], more often as [t], and after a word like *christmas*, more often as [k]. The same effect occurs when the final fricative of the context word is replaced with an ambiguous sound, midway between [s] and [f], as is predicted by interactive models (the fricative information being provided top-down, by the lexicon). But the transitional probabilities in these words are biased: an [f] is more likely after an [i] and an [s] is more likely after a [a]. These results are thus also consistent with an autonomous model like Shortlist in which the prelexical level of processing is sensitive to transitional probabilities.

McQueen and Pitt presented listeners with words beginning with ambiguous stops, preceded by nonword contexts in which the final ambiguous fricatives had strong transitional probability biases. They found a probability bias in the labeling of the fricative and a compensation effect on the labeling of the stops, consistent with the bias (e.g., more [s] and [k] responses after a nonword with an [s]-bias). Listeners also heard the same stop-initial words, but preceded by word contexts where the transitional probabilities of the final ambiguous fricatives were balanced. Although there was a lexical bias in the labeling of the fricative, there was no compensation effect (e.g., more [s] responses after *jui?*, as if the listener had heard *juice*, but no tendency to label the stops in this context more often as [k]). These results suggest that compensation following ambiguous fricatives is determined by transitional probabilities, but not by lexical knowledge (even when the lexicon is influencing fricative decisions). They support autonomous models like Shortlist, and challenge the interactive view of spoken word recognition.

2.2.2 Is segmental information available prelexically?

In the Shortlist architecture, segmental decisions can be made in one of two ways: either on the basis of acoustic-phonetic information made available prelexically, or via phonological information stored in the lexicon. This claim is supported by a large body of evidence which suggests that lexical involvement in phonetic decision-making can be made to come and go, to the extent that phonetic decisions can sometimes be made in the absence of any lexical influences. Cutler, McQueen and Norris have examined whether lexical influences in phonetic decisions to

nonwords can also be made to come and go. Listeners were required to categorize phonemes appearing at the ends of nonwords (e.g., to decide whether the final segment of *troet*, a Dutch nonword, was a [t] or a [p]). The nonwords were made by splicing two tokens of the nonword, or cross-splicing the nonword with either a word or a nonword (*troet*, for example, was created by splicing the final [t], from a token of *troet* onto three different [tru] forms, one from another token of *troet*, one from the word *troep* 'crowd', and one from the nonword *troek*). The cross-spliced tokens contained acoustic-phonetic mismatch information, since the formant transitions in their vowels specified the wrong place of articulation of the final stop.

Phonetic decisions were indeed slower on the cross-spliced items than on the identity-spliced items. If the lexicon were involved, decisions would be even harder for nonwords cross-spliced with words than for those cross-spliced with nonwords. No such lexical effect was observed. This lexical effect was also not present when the experiment was re-run as a phoneme monitoring task. The lexical effect did emerge, however, both when the materials were presented for lexical decision and when a more difficult version of the phonetic decision task was run. The fact that tiis lexical effect, like many others, can be made to come and go, supports the claim instantiated in Shortlist that segmental information is available prelexically. These and other results on lexical effects in phonetic decision-making are currently being modeled in Shortlist.

2.2.3 Phonological priming

A further architectural question concerns the nature of processes operating at different levels of the recognition system. Phonological priming effects provide a means of studying processes at both lexical and prelexical levels. The recognition of *mound* appears to be inhibited if the listener has just heard *mount*, as would be predicted by Shortlist: the inhibition is likely to be due to lexical competition between *mount* and *mound*. But recognition of *mound* appears to be facilitated if the listener has just heard *bound*. It is unclear what aspect of normal processing is responsible for this facilitation, although it appears to be prelexical. A collaboration between McQueen and L. Slowiaczek (U. Albany) is comparing the inhibitory and facilitatory components of phonological priming, and seeking to establish

what causes facilitative rhyme priming. The first experiment in the series compared naming times on word and nonword targets, preceded by word and nonword primes. If facilitative rhyme priming is prelexical, the lexical status of primes and targets should not influence the priming effect. Reliable and equivalent facilitation was indeed observed for all prime-target combinations: word-word (*bound-mound*); nonword-word (*kound-bound*); and nonword-nonword (*founce-mounce*). In contrast, if inhibition is lexical, the effect should vary depending on lexical status. But no reliable inhibition was observed in any condition, perhaps because, given the experiment's length and the fact that 50% of targets were nonwords, subjects may have tended not to use lexical knowledge. The experiment is currently being re-run using the lexical decision task, where lexical influences on priming should be stronger.

2.2.4 Stressed and unstressed vowels

Another topic on the process of word recognition concerned whether lexical stress information could be of use in lexical access. D. van Kuijk (U. Nijmegen) analyzed differences between vowels with and without lexical stress in the Dutch Polyphone corpus. He found that, for most vowels, stressed variants were significantly longer and of higher intensity than unstressed variants. He also investigated whether these differences could be exploited in an automatic speech recognizer by training separate Hidden Markov Models (HMMs) for the stressed and unstressed variants of each vowel. Recognition performance did not improve significantly. But the recognizer had learnt distinctions between the vowel types. The trained vowel HMMs were tested by redefining the lexicon such that all stressed vowels were marked as unstressed, and vice versa. The recognition scores deteriorated substantially, suggesting that the HMMs for the two variants of each vowel were different. An analysis of the material used as input to the recognizer revealed an interaction between phonetic context and stress. Stressed variants of vowels could appear either much more frequently or much less frequently than unstressed variants in certain contexts. The differences between the two HMMs for each vowel cannot, therefore, be attributed only to differences in the vowels, but also to differences in phonetic contexts. The interaction between context and stress is currently being studied further.

2.2.5 Speech recognition by mind and machine

During his visit to the Institute, R. Moore (Defence Research Agency) worked with Cutler on a book they are writing together entitled *Speech Recognition by Mind and Machine*. The book, which is targeted at engineers and computer scientists as well as phoneticians and linguists, has chapters covering prelexical processing, the lexicon, model-making, levels of processing, prosody and laboratory methodology, alongside chapters covering the practical advantages of talking to a machine, algorithms and architectures for computer speech processing, a historical survey of automatic speech recognition, and non-mathematical descriptions of the components of contemporary automatic speech recognition systems. A final section draws together the implications of models of speech perception for automatic speech recognition and vice versa. It is expected that the book will be published in 1997.

2.3 The processing and representation of morphology

2.3.1 Morphological family size

Together with R. Schreuder (U. Nijmegen), H. Baayen continued his investigation of the effects of cumulative frequency effects in visual word recognition. He investigated the effects on the lexical processing of monomorphemic nouns of four disjunct frequency measures: the frequency of the singular form (e.g., *worm*, 133 tokens in 18 million words); the frequency of the plural form (e.g., *worms*, 177 tokens); the type count of all compounds and derived words containing the noun as a constituent, its "family size" (21 for *worm*, which appears in 21 complex words such as *wormy*, *woodworm*, *ringworm*, etc.); and its "family frequency", the summed token frequencies of the words in the morphological family (463 for *worm*, the frequency of *wormy* and *woodworm* and *ringworm* and so on).

In a series of experiments, Baayen and Schreuder investigated the effects of these four word frequency counts in visual lexical decision, progressive demasking, and subjective frequency ratings. The experiments, all carried

out on monomorphemic nouns, manipulated one of the frequency measures while matching for all other frequency counts. These experiments revealed that the frequency of the (unseen) plural form affected the experimental measures. Noun singulars with high-frequency plurals were responded to more quickly in visual lexical decision, and they received higher subjective frequency ratings. However, the summed frequencies of the (unseen) formations in the morphological family of a given noun, its family frequency, did not affect the experimental measures. Surprisingly, the family size, the number of different words in the family, emerged as a substantial factor. A monomorphemic noun with a large family size elicits higher subjective frequency ratings and shorter response latencies in visual lexical decision than a monomorphemic noun with a small family size. The effect of family size disappears in progressive demasking, a task which taps into the earlier stages of form identification. At the same time, the effect of the frequency of the singular is robust across all three tasks. This dissociation suggests that the effect of singular frequency arises during the early stages of visual identification, and that the effect of family size arises at more central, post-identification stages of lexical processing.

R. Lieber (U. New Hampshire) has collaborated with Baayen and Schreuder in a series of subjective frequency rating experiments on English, replicating for English the basic findings obtained for Dutch simple nouns with respect to the role of family frequency and family size. As in Dutch, differences in the family frequency of English simple nouns were not reflected in subjective frequency ratings, in contrast to differences in family size, which did produce reliable effects.

2.3.2 Modeling morphological processing

Baayen, Schreuder, and R. Sproat (Bell Laboratories, Murray Hill) further developed their mathematical model of morphological processing. Focusing on the early stage of visual identification, they implemented an algorithm that makes use of a probability measure to model lexical competition instead of a mechanism exploiting inhibitory connections between lexical representations. By imposing the restriction that the total activation in the system sums up to unity, access representations are in competition for activation probability, but at the same time remain fully independent units that each monitor the input for matching information. Over time,

identification probabilities increase for access representations that match the signal: neighbors, embedded words, and affixes. After an access representation has reached threshold activation level, its activation level enters decay. Different competitors may reach identification threshold over time, in contrast to traditional models, which culminate in the activation of one unique competitor only. Those competitors that have reached threshold are held in reserve in a short-term memory buffer. The representations in this buffer are the input to a process that, at each successive time step, checks whether a representation or a sequence of representations is present that exhaustively spans the visual input. Maximal spannings are passed on for further morphological processing: the checking of subcategorization compatibility, accessing the meanings of the constituents, and computation of the meaning of the complex form. Qualitatively, the model captures a series of experimental results using a realistic lexicon of some 40,000 entries.

2.3.3 Segment shifting

During her stay at the Institute, L. Feldman (U. Albany) collaborated with Baayen and Schreuder on the role of morphological structure in lexical processing. A key issue in Feldman's research is the possible relevance of several variables that might make morphological structure more or less available. Recently, she has focused on two variables inherent to individual words. First, does the presence of a real constituent in a morphologically complex word influence performance in the segment shifting task? In this task, subjects construct a new word by combining one word and an affix from another word (e.g., making *brighter* from *bright* and *blonder*). Shifting latencies were fastest when the affix came from a morphologically complex form, whether or not a morphologically simple control contained a word. That is, shifting latencies are faster from *blonder* than from either *wander* or *launder*. Second, are shifting latencies sensitive to the frequency of the word from which the affix was shifted? Experiments suggest that this is not the case: *musty* and *dusty* produced equivalent shifting latencies relative to a simple control. Together with Baayen and Schreuder, Feldman is investigating whether similar results can be obtained for Dutch, by examining the Dutch analogs of *blonder*, *wander*, and *launder*. In addition, conditions that are possible in Dutch but not in English will be tested. For instance, morphological stems with and without a phono-

logical change brought about by the suffix can be compared, for example, *helper* (from *help* 'help' without a phonological mismatch between base and derived word) and *vinder* (from /vint/ 'find', with a mismatch due to final devoicing). A second series of experiments, also planned in Dutch and English, will investigate the role of family size in morphological processing for complex words. Critical materials consist of word pairs matched on surface frequency and morphological structure but differing in family size.

3. Lexical Access in Speech Production

The members of the lexical access group continued their work on the representations and processes involved in the production of single words and longer utterances. Much of the research was devoted to the further theoretical development and empirical testing of a particular model of lexical access, namely the model first outlined by W. Levelt (1989, *Speaking*; see also Levelt (1992) and Levelt & Wheeldon (1992)). This theory differs from competing ones in its modular architecture and its primary explanatory domain, which is to account for *the normal* process of speaking rather than for speech errors.

Large parts of the theory have been implemented in a computational model, which is A. Roelofs's WEAVER++ (see Annual Report 1994). The three word form encoding stages in the model - morphological, phonological, and phonetic encoding - are lexically driven. The mental lexicon is conceived of as a network accessed by spreading activation. Network activation triggers procedures that select and connect nodes, thereby generating a phonetic plan. Encoding proceeds in a rightward incremental fashion, which is made possible by a suspend-resume mechanism. When given partial input, the three encoding stages start and proceed as far as possible and then stop and wait for more information.

This year's theoretical work has led to the unsurprising discovery that, though the theory seems to be largely adequate, a number of important issues are still unsettled and some of the model's assumptions may be in need of revision. These issues are discussed below, along with the empirical research carried out to address them. A large part of the experimental program tested specific predictions derived from Roelofs's computational model. This is true in particular for the research on semantic transparency, domains of syllabification, and metrical planning.

3.1 Semantic transparency

Roelofs and Baayen tested the modularity claim of WEAVER by examining the role of semantic transparency in form encoding. According to the model, morphological complexity can play a role in form planning without having a synchronic semantic motivation: Morphology operates by itself. In testing this claim, the implicit-priming paradigm (A. Meyer, Annual Report 1988) was used. On each trial, participants had to produce one disyllabic noun out of a set of three as quickly as possible. In homogeneous sets, the responses shared the first syllable, whereas in heterogeneous sets there was no form overlap. In this paradigm, sharing a word-initial syllable reduces production latencies. This is called the preparation effect. Overlap is partial input for WEAVER'S encoding stages, which allows computing part of the word form already before the beginning of a trial.

The experiment compared the preparation effect for three types of word: morphologically simple nouns, semantically transparent nominal compounds, and opaque nominal compounds. For example, it compared the preparation effect for sharing the syllable *bij* in sets of morphologically simple words such as *bijbel* (<bij><bel> 'bible'), sets of transparent compounds such as *bijrol* (<bij><rol> 'supporting role'), and sets of opaque compounds such as *bijval* (<bij><val> 'applause'). For the simple word *bijbel* only the syllable *bij* can be prepared. However, for compounds like *bijrol* and *bijval*, the morpheme <bij> can also be prepared. Thus, the preparation effect should be larger for *bijrol* and *bijval* than for *bijbel*. This prediction was confirmed. The preparation effect was larger for the compounds than for the simple words. Importantly, the size of the morphemic effect was the same for transparent and opaque compounds. This shows that morphological structure is represented in the lexical entries of both transparent and opaque compounds.

3.2 Domains of syllabification

The representation of morphological structure supported by the experiments described in 3.1. is, in fact, required by WEAVER'S encoding algo-

rhythm because morphological structure sometimes affects the phonological encoding of words. For example, the non-initial morpheme of a compound like *bijrol* can be omitted under identity with the non-initial morpheme of an adjacent compound in conjunction, such as *bij- en hoofdrol* ('supporting and leading role'). In addition, morphemes define domains of syllabification. For example, the segment *hi* of the prefix <ver> of the Dutch verb *vereren* ('honor') is not syllabified with the base *eren*, as maximalization of onset would predict, but is syllabified as the coda of <ver>. To test the idea that morpheme structure is only stored when it is required for syllabification, Roelofs and Baayen compared the preparation effect for prefixed verbs that need morphemic information for correct syllabification (e.g., *vereren*) to the preparation effect for prefixed verbs that do not need such information for correct syllabification (e.g., *verkopen* 'sell'), where /rk/ is an illegal onset cluster in Dutch). In homogeneous sets, the responses shared the prefix syllable (e.g., *ver-*), whereas in heterogeneous sets there was no overlap. As predicted, the preparation effect was much larger for verbs of the *ver-eren* type than of the *ver-kopen* type, suggesting that only for the former type of verb, morphological structure is stored, and therefore, morphological preparation is possible.

3.3 Production of inflected verbs

A new dissertation project was started by D. Janssen. The aim of this project is to examine inflectional processes in speech production and in particular the role of diacritics. These are abstract markers at the lemma level specifying properties of the word like number, case, and tense. During morphological encoding, these properties are needed to select the right inflectional affix(es) for the word (e.g., Dutch plural *-en*, German dative *-em*, English past tense *-ed*). In a series of experiments, Janssen compared the production of verbal forms, nominal compounds and morphologically simple nouns. The task was a novel version of the implicit priming paradigm, the so-called "odd-man-out" variant. A past tense form was inserted into a set of target words that would normally induce a morphological and phonological preparation effect. When a verb like *werkte* 'worked' was inserted in a set of nominal compounds like *werkdruk* 'workload', the morphological preparation effect that usually occurs among compounds sharing the first morpheme disappeared. A similar result was obtained

when a verbal form (e.g., *doodde* 'killed') was inserted into a set of simplex nouns like *dosis* 'dose'. The phonological preparation effect that had been found in many earlier experiments for sets sharing the initial syllable was strongly reduced by the introduction of this inflected verbal form.

Janssen proposes that there may be a categorical difference between the production of verbs and nouns. Perhaps there is a subcomponent of the morphological encoding process that is specifically devoted to the generation of verbal inflections. There is no such subcomponent for nouns, because the nominal paradigm is smaller and the frequency of nominal forms without affixes is much higher.

3.4 Metrical encoding

Most models of speech production assume that the process of phonological encoding includes the retrieval of stored metrical representations of words. Roelofs and Meyer tested this assumption in two implicit priming experiments. These experiments included two types of homogeneous sets. In both, the target words shared the first two segments, but in one type, they also had the metrical structure in common, whereas in the other type the metrical structure was variable (i.e., the targets varied in number of syllables or stress pattern). In addition, there were heterogeneous sets with constant and with variable metrical structure. A preparation effect was only obtained for the sets with constant, but not for those with variable, metrical structure. Thus, participants could only exploit the knowledge that all words of a set began, for instance, with /ma/, if they also knew how many syllables followed and which of them was stressed. This may be surprising, but it is exactly what WEAVER predicts. According to the model, the preparation effect arises when participants create a partial phonological representation of the targets before prompt onset. In such a representation, the recurrent segments are associated to positions in the metrical representation, which, therefore, must be available.

The conclusion that speakers retrieve stored metrical representations is perfectly compatible with the received psycholinguistic view of phonological encoding, but it is slightly odd from a linguistic point of view because properties of the metrical representation can often be derived from

segmental information. In *WEAVER*, the metrical representation captures the number of syllables and the stress pattern. But the number of syllables is the same as the number of vowels, and the stress pattern follows certain rules. In Dutch (as in English and German) most words are stressed on the first syllable with a full vowel. Using the *CELEX* data basis, N. Schiller computed that this simple rule assigns the correct stress pattern to more than 90% of the word tokens.

Considering the redundancy of the metrical and segmental representations for a large part of the vocabulary, Meyer and Roelofs have proposed that metrical information structure is only part of the lexical entries of those words that deviate from the main stress rule, i.e., are not stressed on the first full vowel. For all other words, the metrical structure is derived from segmental information. In implicit priming experiments testing exception words, a preparation effect should only be obtained if the metrical structure is constant. This result was obtained in the experiments described above, which, in fact, tested exception words exclusively. For metrically regular words, on the other hand, there is no metrical structure to be retrieved, hence preparation should be possible regardless of whether the targets have the same or variable metrical structures.

This prediction was tested, and born out, in two experiments with metrically regular words. The target words in homogeneous sets either had the same metrical structure, or they differed in number of syllables. Now a preparation effect was obtained for sets with constant and with variable metrical structure. Thus, in contrast to the received view, we now assume that speakers do not retrieve a stored metrical representation for each word they utter, but only for the exception words, which constitute about 10% of their vocabulary.

3.5 Metrical planning of suffixed forms and cliticizations

How do speakers produce suffixed forms, such as *sigaren* 'cigars', and cliticized forms, such as *geef de sigaar's* 'give the cigar now'? According to Levelt (*Cognition*, 1992), such forms are created by first combining the metrical frames of the individual lexical items and then associating the

segments to the resulting frame for the complete phonological word. This implies that segments are directly associated to the positions they occupy in the connected speech forms - there is no process of resyllabification moving segments from one syllable position to another. In her dissertation work, M. Baumann had tested this direct syllabification hypothesis by examining how the cliticized forms of Dutch nouns ending in underlyingly voiced plosives are pronounced (see Annual Report 1995). Dutch has syllable-final devoicing. For example, the word *hond* ('dog') is pronounced as /hont/. The voicing reappears in the plural form *honden*, where /d/ is no longer syllable-final. In pronouncing the phrase *de hond en de kat* ('the dog and the cat'), a speaker can cliticize *en* to *hond*. If there is only one level of syllabification, exactly the same syllabification should arise in the cliticization as in the plural form. Baumann found, however, that in cliticizations speakers usually produce *hon-ten*. Hence, she concluded that there are two levels of syllabification, the second resyllabifying the output of the first.

However, during his stay at the Institute, G. Booij (VU Amsterdam) together with Baayen and Levelt developed a different solution, saving the idea of one level of syllabification. It is to list several allomorphs of the same morpheme in the mental lexicon, with their context of application. For example, there would be two lexical items, <hont> and <hond>, where the latter is marked for productive inflection and derivation. The first allomorph is the default, unmarked case. In generating plural *honden*, the speaker must access the marked allomorph <hond>. It contains the segment /d/, which will appear as voiced in syllable-initial position. But in case of cliticization, where no inflection or derivation is required, the speaker accesses the unmarked form <hont>, which contains the unvoiced segment /t/.

Levelt's hypothesis of direct syllabification contrasts with the view implemented in WEAVER. In WEAVER, cliticized and suffixed forms are generated by first syllabifying the stem and later adjoining the clitic or suffix. Roelofs and Meyer used the implicit-priming paradigm to discriminate between these views. They compared the effect of segmental overlap for response sets combining disyllabic nouns (e.g., *dozijn* 'dozen') with disyllabic verb stems (e.g., *doneer* 'donate') to the effect for sets combining the disyllabic nouns with trisyllabic cliticized forms of the verbs (*doneer's*) or with trisyllabic infinitival forms of the verbs (*doneren*).

Thus, the stems of the target words were disyllabic in all cases, but in two of the three set types the complete phonological words were either di- or trisyllabic. If metrical frames are combined before segment-to-frame association, then these sets would be metrically variable, and preparation should not be possible. According to WEAVER, however, all three types of set are metrically constant because the clitic and the plural suffix are metrically independent elements that are adjoined after syllabification of the verb stem. The outcomes of the experiment supported this hypothesis. Preparation effects of the same magnitude were obtained for all three types of set.

3.6 Dutch syllable structure and syllabification

N. Schiller, in co-operation with Meyer, Baayen, and Levelt, continued his lexical-statistic analyses of the Dutch and English syllable inventories. Both languages have more than 10.000 different syllable types. These syllable types differ greatly in frequency. An important result of Schiller's analyses was that the 500 most frequent syllable types cover 85% of the syllable tokens in Dutch, and 80% of the syllable tokens in English. This is a strong argument in favor of a mental syllabary, i.e. a store of pre-compiled articulatory programs for entire syllables, at least for the high-frequent ones.

Are these high-frequent syllables the ones that are early acquired by the child? In a joint project with Schiller and W. Levelt, C. Levelt made her CLPF corpus (see section 12.2.3) in CHILDES available to address this question. The corpus consists of 20.000 utterances from 12 children acquiring Dutch as their first language. These utterances were analyzed into their component syllables by a program developed by Schiller. For every child the syllable types and syllable tokens found in each recording were listed. For their first recording, the 12 children, who were in different stages of phonological acquisition, could be arranged on a Guttman scale for their mastery of syllable types. This gave a first indication of a common course of development of syllable production. Ignoring the distinction between V and VV, the Guttman order was this: {CV, CVC}, V, VC, CCV, CCVC, CVCC, VCC. There were small alterations if later stages were taken into account as well. With one exception, this ordering

is in almost perfect correspondence with the syllable frequency distribution for Dutch text, reported in Schiller et al. (1996). The one exception is the single-vowel syllable (V or VV), which is the third syllable type in the children's Guttman ranking, but only the seventh in the adult frequency ranking. An obvious reason is that this syllable type has only very few members. Most of them are indeed highly frequent in Dutch.

There are some unsettled questions as to Dutch syllable structure in general. Schiller, Meyer, and Levelt carried out a series of experiments using a syllable-reversal task (Treiman & Danis, *JML*, 1988) to investigate the claim that Dutch does not permit short vowels in open syllables (Booij, 1995, *The Phonology of Dutch*). The results revealed that Dutch native speakers indeed generally, but by no means always, produced closed short-vowel syllables. Several follow-up experiments showed that the proportion of open short vowel syllables participants produced depended on several different factors such as word stress, spelling, vowel quality, identity of the intervocalic consonant, and the composition of the item set in the experiment. These results can be accounted for in terms of a set of output constraints on syllable structure which interact with each other in a probabilistic way, thereby producing a variable output pattern.

3.7 A MEG study of picture learning

As reported previously (see Annual Report 1995), Levelt, Meyer, Praamstra (U. Nijmegen), R. Salmelin and P. Kiesila (both Technical U. Helsinki) carried out a MEG study of picture naming using the 122-channel neuro-magnetometer in Helsinki. The aim of this experiment was to describe the neuro-magnetic correlates and cerebral localization of the stage of word form access. We had hoped to selectively affect this stage by asking participants to name pictures with high vs. low frequency names, as the word frequency effect is known to arise at the level of word form access (naming pictures with high frequency names is faster than naming pictures with low frequency names). However, no word frequency effect on naming latencies was found in the MEG study, and correspondingly there were no systematic differences in the magnetic fields evoked by pictures with high- vs. low-frequency names either. (Curiously, the same participants did show a word frequency effect on naming

latencies when later retested on the same materials in Nijmegen.) The study yielded a description of the neuro-magnetic field patterns in picture naming, refining an earlier MEG study by Salmelin et al. (*Nature*, 1994). In particular, our data revealed that in the time window between 275-400 ms after picture onset, which corresponds to the stage of word form access, the neuro-magnetic activity over the left hemisphere mostly stems from sources in the vicinity of Wernicke's area (i.e., the posterior part of the superior temporal gyrus). In addition, our study confirmed the strong right-hemisphere involvement in picture naming, especially in the 400-500 ms time window over right fronto-temporal areas.

3.8 Lexical access in larger utterance contexts

3.8.1 Units of production

A. Meyer continued her research on planning units in phrase production. Earlier experiments (Meyer, *JML*, 1996) had shown that in utterances such as "the dog and the basket" speakers often select both lemmas before utterance onset. This can be inferred from the finding that, in picture-word interference experiments, speech onset latencies are slower after distractors that are semantically related to the first noun (e.g. "cat") and after distractors that are semantically related to the second noun ("bag") than after unrelated distractors ("house").

In an extensive series of experiments using new materials this finding was, however, not replicated. In most conditions of these experiments, a semantic interference effect was only obtained for the first noun, suggesting that only that, but not the second lemma was selected before utterance onset. At present, it is unclear why the results of the two series of experiments were so different.

In related experiments by Meyer, C. Janssen, and F. van der Meulen (both U. Nijmegen) participants named picture pairs which were either presented simultaneously or in succession. The delay between the onset of the first and second picture varied between 40 and 480 ms. Speech onset latencies were approximately 70 ms shorter when participants only named the left picture (as in "the cat") than when they named them both ("the cat

and the bottle"), perhaps because the syntactic structure that had to be created was more complex for two- than for one-picture descriptions. Interestingly, the latencies were utterly unaffected by the timing of picture presentation, suggesting that participants initially focused entirely on the left picture, and only after considerable processing turned to the right picture.

3.8.2 Pronoun generation

Does a speaker activate the word form of a noun when it is pronominally referred to? B. Schmitt investigated the production of pronouns in utterances such as *The flower is red...It turns blue*. Because the pronoun refers back to a noun, one may expect semantic (re)-activation of the noun. But because the noun is not articulated, the word form should not be reactivated. This latter hypothesis was tested in experiments in German, where participants performed a lexical decision task during picture descriptions. On each trial, they described a sequence of two pictures. To describe the first picture, they named an object using a noun, as in *The flower is red*. Sometimes, the same object reappeared on the same picture in a different color. The participants then used a pronoun, as in *It turns blue*. On 50% of those trials a lexical decision probe was auditorily presented, time-locked to the second picture onset, and the participants first classified it as word or pseudo-word and then completed the naming. The probes were phonologically related to the noun or unrelated. Lexical decisions were slower for related than for unrelated probes, which shows that during pronoun generation the word form of the noun antecedent was active.

To find out whether this activation was due to residual activation of the first picture description, a follow-up experiment was carried out. Again, participants had to describe a sequence of two pictures, such as *The flower is red...The sun is blue*, and the probe-presentation was time-locked to the onset of the second picture. But now the probe was phonologically related or unrelated to the noun of the first picture. No phonological effect was found.

These results suggest that during pronoun generation the word form of the noun antecedent becomes reactivated. From that it can be indirectly concluded that the lemma, too, becomes reactivated.

3.8.3 Noun-pronoun agreement

K. Bock (U. Illinois) and Meyer continued their research on Dutch noun-pronoun agreement. Earlier experiments (see Annual Report 1995) had investigated the implementation of gender agreement between noun antecedents and demonstrative pronouns appearing in separate sentences. Two new sentence completion experiments examined how speakers select relative pronouns, which appear in the same sentence as their antecedent. The results were very similar to those obtained for demonstrative pronouns: Participants showed a strong tendency to select the pronoun that agreed in gender with the antecedent. However, occasionally agreement errors occurred, and these were more frequent when the sentence included another noun that differed in grammatical gender from the antecedent than when this other noun had the same gender as the antecedent. The error rates were the same regardless of whether the nouns were overtly marked for gender (by definite determiners) or unmarked (by indefinite determiners). These results show that the speakers' choice of pronouns is primarily based on abstract gender information, and not on properties of the phonological form of the utterance.

4. Argument Structure

As recently as 15 years ago, the notion of argument structure played a limited role in linguistics and psycholinguistics - it was often simply equated with the number of arguments taken by a predicate. But it has gradually moved into a central theoretical position, and it is now seen, in virtually every linguistic theory, as providing a critical clause-level interface between lexical semantic structure and syntax. Interest in argument structure has also had important consequences for how the lexicon is viewed. Earlier, the lexicon was seen largely as the repository of the idiosyncratic semantic information left over after everything that is systematic was factored out and assigned to syntax or morphology. But now we recognize that the information encoded in the lexical entries of verbs and other argument-taking elements is in fact quite systematic, defining broad patterns across lexical items within a language and often typological differences between languages.

The Argument Structure Project explores speakers' knowledge of argument structure through two types of empirical evidence: (1) cross-linguistic analyses and comparisons of argument structure, and (2) investigations of first language acquisition. Project members come from different theoretical backgrounds and work on a variety of languages, including at present Tamil, Inuktitut, Mopan, Tzeltal, Arrernte, Jaminjung, Oluta Popoluca, Ewe, English, Dutch, German, French, and Italian. By searching for regularities both across languages and in the course of acquisition, project members hope to learn more about which aspects of argument structure are universal versus variable, and which may be innate as opposed to learned.

Research carried out by the Argument Structure Project in 1996 is summarized under four topic headings: (1) The semantic-syntactic interface; (2) Argument realization; (3) Argument structure alternations; (4) Other work. For an additional study with close ties to this project, see A. Wittek under the Scope Project.

4.1 The syntactic-semantic interface

Studies of this topic have examined claims about the universality of links between predicate semantics and syntax, and explored the implications of cross-linguistic variability for two opposing hypotheses according to which children are assisted in language acquisition by inborn knowledge of semantic-syntactic correspondences: "Semantic Bootstrapping" (children use the meaning of verbs to hypothesize the syntactic frames they can appear in (Pinker, 1984, *Language learnability and language development*)) and "Syntactic Bootstrapping" (children use the syntactic frames verbs appear in to home in on their meaning (Gleitman, 1990, *First Language, 1*)). A particular subfocus within this topic has been the syntax and semantics of intransitive verbs.

In previous work (see Annual Report 1995), D. Wilkins has shown that, contrary to Gleitman's syntactic bootstrapping proposal, verbs meaning 'put' and 'look' do not necessarily have different argument structures crosslinguistically - in particular, in Arrernte (Pama-Nyungan, Australia), the 'put' and 'look' verbs both take three arguments, case-marked for ergative, accusative and dative. Children could not, then, simply use occurrence with three-noun phrases as a guide to differences in meaning between the two verbs. But counts from adult narrative texts revealed that the 'put' and 'look' verbs differ significantly in the surface occurrence and ordering of arguments. A child could in principle use these differences as a guide to meaning differences.

Two forms of new production data from fifteen Arrernte children aged 6-10 and five adults support this hypothesis. First, in naturalistic classroom situations, both children and adults regularly produced the 'put' verb with all 3 arguments. However, only adults ever produced the 'look' verb with 3 arguments, although the majority of their uses were in fact with 2 arguments (ergative and accusative). Children only produced 2-argument uses of 'look', as though it were a simple transitive verb. Second, in an elicitation task which provokes 3-argument use of the 'look' verb, all adults provided 3 arguments, while only nine children attempted to provide all arguments. Of these nine, four produced ungrammatical structures that marked the third argument as if it were an adjunct, rather than an argument. Arrernte children appear to be learning a meaning for

'look' that is not transparently related to its argument structure. Learning is in line with the statistical characteristics of adult speech: the argument children are having trouble with for 'look' (the dative) is the most commonly omitted one in adult production. Children have no trouble with the dative argument for 'put', but this is very frequent in adult production.

E. Schultze-Berndt continued her Ph.D. research on complex predicates in Jaminjung (Non-Pama-Nyungan, Australia), concentrating on verb classification and argument fusion. In Jaminjung, the verb (carrying obligatory verbal inflections) is semantically generic and comes from a closed class. It can form a simple predicate by itself or a complex predicate together with a co-verb. This other component (uninflected and formally neither a verb nor a noun) comes from an open class covering all presumably "verbal" meanings. The two components jointly determine the argument structure of the complex predicate. For example, the transitive verb of transfer *gana-rra-m* usually takes the theme as an object, but combined with the co-verb *yoorrg* 'show', the recipient is promoted to object status, as indicated by the verbal cross-referencing prefixes. Thus, to determine the semantics and syntax of verbs, one has to know the semantics of the co-verbs, including their argument structure. Since co-verbs do not occur as simple predicates, the only way to determine their meaning is to examine all possible combinations with verbs. They then clearly fall into classes: for example, co-verbs that combine with the stative intransitive verb *-yoo* 'be' must be stative and intransitive; co-verbs that only combine with transitive verbs are transitive or ditransitive. These predicates pose a paradox for the acquisition of verb meanings in light of the claim that there are universal mapping rules between syntactic argument structure and verbal semantics, allowing (syntactic or semantic) "bootstrapping", since the syntax and semantics of either component cannot be learned without already knowing the meaning of the other. This suggests that "bootstrapping" cannot proceed in a unidirectional fashion from either syntax to semantics or from semantics to syntax. The Jaminjung case, like other languages with complex predicates, also raises the problem that the units of meaning determining argument structure are not universally simple verbs.

As part of his Ph.D. research, J. Essegbey investigated how two current hypotheses in the literature apply to Ewe, a Kwa language spoken in southeastern Ghana. The first hypothesis, the Unaccusativity Hypothesis,

claims that all languages have two distinct classes of intransitive verbs, namely unergatives and unaccusatives. The second, more specific to Kwa languages, claims that all the verbs in these languages are transitive. In most Kwa languages, states of affairs that are usually expressed with intransitive verbs in European languages are encoded with a sequence of a verb and an obligatory noun. For example, in Ewe, the notion 'swim' is expressed as *fu tsi*. *Tsi* 'water' is a noun which behaves syntactically like other objects of prototypically transitive verbs. From a syntactic point of view, therefore, one cannot distinguish such verb + object sequences from other transitive constructions. There are some verbs in Ewe, however, that do not require obligatory objects. Most of these verbs (e.g. *bac[a* 'be bad' and *ge* 'drop') fall into the class of what are usually considered to be unaccusative verbs. Because unaccusatives are considered to have underlying objects in theories that use two levels of representation (i.e. deep and surface structure), some linguists have claimed that these verbs are also transitive. Their conclusion is therefore that all Kwa verbs are transitive. There are, however, many other verbs which do not require objects and yet fall outside the usual unaccusative class. Examples are *tsa* 'wander about aimlessly' and *dzo* 'jump involuntarily'. What all these "objectless" verbs seem to have in common is that the arguments they are predicated of do not have any control over the action they encode. Data from Ewe suggest therefore that at least one Kwa language does have intransitive verbs, although they constitute a *single* class, namely the lack of control class.

A. Sorace (U. Edinburgh) completed the research on unaccusativity and auxiliaries in Dutch that she carried out with W. Vonk (see Annual Report 1995). The data from two experiments using timed elicitation techniques largely confirm the hypotheses behind this work. There is clear evidence of acceptability gradients in native Dutch speakers' judgements on auxiliary selection, corresponding to lexical-semantic hierarchies subdividing the classes of unergative and unaccusative verbs, and comparable to the results obtained in Sorace's previous work on Italian (see Annual Report 1994) and French. Consistent with predictions, impersonal passives - although more strongly preferred with unergative verbs - are also moderately acceptable with change-of-location and some continuation-of-state unaccusative verbs, which incorporate the variable "internal control" in their semantics. The results of this project support the view that the syntactic phenomena related to unaccusativity display orderly variation, which

is best explained as the mapping of gradient lexical-semantic dimensions at the level of conceptual structure onto argument structure.

A Mayan languages discussion group has taken shape under the wing of the Argument Structure Project. The participants in this group (J. Bohne-meyer, P. Brown, E. Danziger, C. Stolz and R. Zavala) have been concerned with the ways in which argument encoding interacts with in-transitive predicate semantics in these languages.

Danziger's most recent work, for example, centers on the problem that Mopan Maya children who follow a "Syntactic Bootstrapping" strategy might be expected to have in identifying verbs in the Mopan speech string. In Mopan Maya, certain forms (e.g. *il* 'see', *tal* 'come') are easily identifiable as verbs on syntactic grounds. Their arguments are marked with pronouns affixed to the stem, and they take bound aspect and mood inflection. Other forms (those encoding 'action concepts', for example *alka* 'run', *chej* 'laugh', *siit* 'jump') also constitute a coherent form-class in the language. It is not clear, however, that this form-class is a class of verbs. In the class containing the "action concepts" such as RUN, the single participant is always marked by attaching a pronoun prefix. This prefix also functions as the possessive pronoun. The "action concept" forms never occur alone in a clause. They always follow another form, which itself indicates some time-related property of the clause (e.g. *tan* - durative action, *uch* = action in the remote past). This first form takes all of the bound aspect and mood inflection of the "action concept" clause, as well as inflection for its own third person argument. The "action concept" form itself never takes bound aspect or mood inflection. This combination of structural facts means that all Mopan "action concept" clauses can be parsed as showing possessed nominal arguments of semantically pale but aspect and mood-indicating main predicates.

| | | |
|---------|------------|---------------------|
| ... Ka' | uch-uk-0 | in-walka' |
| CONJ | REMOTE-SUB | JUNCTIVE-3 1-run |

| | |
|-----------------------------------|--|
| Free Translation (RUN as verbal): | '... that I should have run'. |
| Literal Gloss (RUN as nominal): | '... that my running should have happened'. |

Mopan children might not be able to identify the members of this "action concept" class as syntactic verbs. In order to take account of crosslinguistic variation of this kind, the categories of the bootstrapping hypothesis should be revised. Different languages apparently select for syntactic encoding certain construals - and not others - of real world events, from a universal set of different humanly possible construals.

In a project carried out at the MPI and UC Berkeley, H. Behrens (U. Cologne) compared the acquisition of complex predicates in German, Dutch, and English. These languages all allow either separable particle verbs like *stand up* or inseparable prefix verbs like *understand*, but they differ in the distribution, productivity, and frequency of these patterns. The meaning expressed in the Dutch particle verb *aankijken* "on-look" [= 'look at'], for example, is rendered in English with a verb plus PP: *look at X*. Behrens' comparisons of the acquisition of these structures within and across languages reveals that the course of acquisition cannot be predicted solely on the basis of the overarching structural properties of a language. Children follow language-specific courses in acquiring the sub-categorization frames of individual verbs, and this leads to general distributional differences. For example, although Dutch is structurally most similar to German, it behaves like English in using relatively more PPs than German. From a processing point of view, acquisition is not delayed by morphosyntactic complexity and the discontinuity of particle verbs. If they are semantically transparent, particle verbs are likely to be acquired before their simplex counterparts (e.g., *go away* before *leave*). Semantic compositionality thus seems to facilitate acquisition. In contrast, inseparable prefix verbs are not acquired by age four. Their difficulty may be due to not only their lack of semantic compositionality but also their stress pattern: unlike other content words, prefix verbs begin with an unstressed syllable, which inhibits word recognition.

4.2 Argument realization

Studies under this topic explore the relationship between verbal agreement, case marking, and representation of arguments as full lexical NPs, pronominals, or null.

S. Allen continued her work investigating argument representation in early Inuktitut (Eskimo-Aleut) spontaneous speech. Core arguments (subject, object) in Inuktitut must always be cross-referenced in verbal inflection (*ani-juq* go.out-3sg 'he/she went out'), while third person arguments may additionally be represented as independent lexical NPs (*Jaani anijuq* 'Johnny went out') or demonstratives (*una anijuq* 'this one went out'). Analysis of 2006 utterances from monolingual Inuit children aged 2;0-3;6 indicates that 6% of arguments are represented by lexical NPs, 11 % by demonstratives, and 83% by verbal inflection only. Further, patterns of argument representation in child Inuktitut are consistent with the pattern of Preferred Argument Structure (PAS; Du Bois, 1987, *Language* 63) found in several languages including child Korean (Clancy, in press, in: J. Du Bois, L. Kumpf & W. Ashby, Eds., *Preferred argument structure: Grammar as architecture for function*). PAS predicts that a clause will contain maximally one lexical argument and maximally one new argument. More than one lexical argument is represented in 0.2% of transitive clauses in child Inuktitut, while more than one new argument is represented in 0.01% of transitive clauses. PAS also predicts that lexical arguments and new arguments will appear predominantly in S(ubject of intransitive) and O(bject) positions but not in A(gent) position. The Inuktitut data show lexical arguments in 8% of S and O positions but only in 2% of A positions, and new arguments in 24% of S and O positions but only in 1% of A positions. Not surprisingly, the data show a link between argument representation and information flow, such that only 4% of arguments representing non-new referents are lexical while 20% of arguments representing new referents are lexical. The distribution of third person arguments across syntactic positions also matches the distribution of both lexical and new arguments.

Allen also investigated the effect on argument representation of various indicators of pragmatic prominence. These indicators included new mention, absence from physical context, contrastiveness in context, competition in discourse, and query target. Each of these factors was shown to affect argument representation in the expected direction, i.e. the argument is more likely lexical if its referent is pragmatically prominent. This result was also found in Korean data (Clancy, 1996, *Japanese/Korean Linguistics* 6).

These findings overall indicate that Inuktitut-speaking children follow a pattern of argument representation linked with syntactic position and information flow (as well as other indicators of pragmatic prominence) that has been found in many languages of varying typologies. In addition, Inuktitut-speaking children seem to be sensitive to both grammatical structure and discourse factors with regard to representation of arguments in their spontaneous speech.

R. Zavala began his dissertation research on inverse alignment and inverse voice in Oluta Popoluca (OP), Mixe-Zoquean, Mexico. In this language the core arguments of two-participant clauses are ranked according to the position they occupy along a prominence-based hierarchy. This hierarchy stipulates that Speech Act Participants (first and second person) outrank third person participants; and within the third person subset, the most prominent nominals in terms of animacy and topicality outrank the least prominent nominals. OP has two types of two-participant clauses: the Direct and the Inverse. When the most prominent participant coincides with the Agent the construction is coded as Direct. In contrast, when the most prominent participant coincides with the Theme or the Location the construction is coded as Inverse. Languages displaying this type of alternation are known in the literature as Inverse languages. Typologists working with Inverse languages have claimed that the Inverse/Direct alternation only occurs with Agent-Theme verbs (e.g. 'to kill') or with semantically three-participant verbs (e.g. 'to give'). Zavala's current research on the different OP verb types challenges this claim. Although the Inverse/ Direct alternation occurs with the predicted transitive verbs, it also occurs with Theme-Location unaccusative verbs (e.g. 'to exist in a location') and the passive version of three-participant verbs (e.g. 'something being given to someone'). With this set of verbs the Direct construction surfaces when the Theme is more prominent than the Location (e.g. EXIST FLEAS DOG-ADPOSITION 'there are fleas on the dog'). In contrast, the Inverse construction occurs when the Location is more prominent than the Theme (e.g. EXIST-INVERSE FLEAS DOG 'the dog has fleas'). Thus, the OP facts suggest that the claim that only transitive verbs can participate in the Inverse/Direct alternation has to be reconsidered.

4.3. Argument structure alternations

Children acquire productive knowledge of how verbs in their language can participate in alternative syntactic frames, and they often overgeneralize alternations to verbs that do not allow them. A continuing puzzle is how, in the absence of negative feedback, children can learn which verbs do *not* undergo a given alternation (see also Annual Report 1994).

During W. Croft's (U. Manchester) visit to the Institute, he and M. Bowerman continued their work on the acquisition of the zero causative in English. Children learn that transitive-intransitive pairs such as "I broke the window" and "The window broke" are related as a causative-noncausative pair, and then overgeneralize the pattern to produce errors such as "She giggled me" (for "She made me giggle", a periphrastic causative). For clues to exactly what causes the errors and why they eventually fade out (although adults also occasionally produce novel forms), Bowerman and Croft are examining Bowerman's longitudinal corpora of novel zero causatives and related forms produced by two children over a period of more than 10 years. Among other things they have coded both novel causatives and periphrastic causatives for the semantic class of the verb, the type of causation involved in the event described (important for the choice in adult speech between zero causatives and periphrastic causatives), and whether the verb has a suppletive causative counterpart (e.g., *kill* for *die*). Children produce many erroneous zero causatives with verbs that fall well outside the semantic classes of verbs associated with the zero causative in adult speech. Counter to certain existing hypotheses, these errors do not necessarily drop off more rapidly than errors with verbs belonging to semantic classes that do, in general, allow productive zero causative formation. Errors fade out relatively early with some verbs with suppletive causative counterparts, but continue for others. Bowerman and Croft are investigating the hypothesis that children unlearn the overgeneralizations "one verb at a time" on the basis of "ecological conditions of the grammar" such as token frequency, the existence of a suppletive causative verb, zero-related intransitives and adjectives, and other anomalies in the adult system that forms the input to the child.

4.4 Other work within the Argument Structure Project

For her Ph.D. research on the grammatical structure of Saliba, A. Keusen has worked on word order variation in negative clauses. Saliba, a Western Oceanic language of Papua New Guinea, is a nominative-accusative, head marking language with obligatory pronominal affixes on the verb. The predominant word order is Subject Object Verb (SOV) for lexical elements. Saliba shows a variation in word order with respect to the position of lexical subjects in intransitive negative clauses: Both Subject Negative Verb (S NEG V) and Negative Subject Verb (NEG S V) orderings are found. The determining factor for this choice seems to be the distinction between categorical versusthetic statements and the scope of negation which may exclude (S NEG) or include (NEG S) the subject. Subjects which precede the negative tend to be marked as specific, topical and/or contrastive, while subjects following the negative and which are within the scope of negation, are not. The word order variation correlates with differences in argument structure in that it only occurs with intransitive clauses while transitive clauses consistently showed S NEG ordering. This asymmetry can be attributed to discourse factors rather than to syntactic restrictions: in several frameworks,thetic statements have been assumed to consist of "only new" information. This, together with the tendency in discourse of introducing only one new participant at a time predicts thatthetic utterances are much more likely to consist of intransitive clauses than of transitives.

P. Brown continued working on two factors which play a role in children's ability to identify verb roots and ascertain the argument structure of verbs: structural characteristics of Tzeltal (Mayan) and the interactional context of language acquisition. In the Tzeltal community under investigation, very young children are not generally made the focus of adult interactive attention, nor is much effort expended to ascertain the communicative intentions of children beginning to learn to speak. However, a particular turn-taking convention operative in adult as well as child-directed speech plays an important role in structuring children's exposure to language: an interlocutor will repeat part of the preceding utterance as back-channel. The part repeated is generally the newsworthy or salient information in the preceding utterance; the effect is to display in nearly every pair of con-

versational turns the information deemed repeat-worthy, and in many cases to highlight the contrast between two parts of the verbal paradigm (see Annual Report 1995). Children's sensitivity to this conversational style, and their awareness of the appropriate part to repeat, is apparent starting from the one and two-word stage. Children begin with questionanswering repeats (e.g. Father: 'Have you fed him?' Child: 'fed'), and soon extend this to repeating assessments (Adult: 'He's tired from eating.' Child: 'Tired'). The Tzeltal children are using repetition interactively, in appropriate culturally-specific ways, to answer questions and affirm communicative intent. By the age of 3;6 to 4;0, children are able to play-act adult-style interactions, including their repetitions, using appropriate switches of person, deixis, evidentiality, and mood. The interactional pressure to develop this skill undoubtedly plays a role in children's early isolation of CVC verb roots, the identification of argument structure, and the ability to shift perspective.

During her month's visit to the Institute, E. Lieven (U. Manchester) worked with the Argument Structure Project on the development of multi-verb constructions in monolingual English-speaking children. She is comparing different theories of the development of the verb category, ranging from a lexically-based approach to a position that hypothesizes the early presence of a relatively abstract category of verb. As a result of her work at MPI, a special journal issue on the development of the verb in a crosslinguistic context is in preparation; it will include contributions from MPI scientists S. Allen, H. Behrens, and P. Brown, and MPI visitors S. Choi and K. Demuth, among others.

During his month's visit to the Argument Structure Project, R. Van Valin (SUNY Buffalo) completed the manuscript of a syntax textbook in which argument structure and the semantics of verbs play a central role. He used his contact with project members in part to explore and increase the range of crosslinguistic phenomena he considers in this work.

5. The Acquisition of Scope Relations

Since this is a new project, we will first outline its general aims, and then report on some pilot work. The project will analyze, for a selected group of scope-bearing elements (quantifiers, adverbials, several types of operators) and for a selected group of languages, (1) what the scope properties of these elements are in the adult language, and (2) how children acquire them. The focus will be on acquisition, but purely structural aspects will also be addressed. In particular, it is expected that the analysis of how children acquire these properties will also shed some light on what the eventual outcome of this process, the adult language, is like. Scope properties and the acquisition of scope relations, in particular, are not well-researched. There are exceptions, especially for existential and universal quantification and negation, but most of this work focuses on the lexical meaning of the scope-bearing elements rather than on scope properties as such (as indicated by position, intonation etc). There is also massive cross-linguistic variation of scope-properties and, for many languages the issue has hardly ever been addressed. In the first phase, three types of scope-bearing elements will be investigated.

A. NP quantification: Two types of quantifiers within NPs will be considered, "cardinal" (such as *a book, one book, two books, three books*, etc.) and "non-cardinal" (such as *every book, many books, some books*, etc.). There are many features of NP quantification, such as the definiteness-indefiniteness distinction, distributivity (as indicated, for instance, by *each*) and others. These will not be systematically investigated, but they will be included to the extent that they determine scope properties of quantified NPs.

B. Focus particles: The investigation will essentially be limited to four types of focus elements and their counterparts in different languages: *not, also, only, even*. Some of these elements have alternatives within a language (for example *also* and *too* in English, or *seulement, seul, ne ... que* in French). This variation, if scope-relevant, will also be examined.

C. Temporal adverbials, including positional adverbials, which indicate the position of a time span on the time line (*last fall, yesterday, after the*

autopsy); durational adverbials, which indicate the duration of a time span (such as *all night, for two hours, for a while*); frequency adverbials, which indicate the frequency of some time span(s), such as *often, twice, every night*, and finally "adverbials of the fourth kind", such as *again, almost, still*. This last group is a heterogeneous group, but they all can have scope over part of the meaning of a single word (as is illustrated by the two readings of *he opened the window again*) and therefore are of particular interest here. We also include more abstract scope-bearing elements, such as finiteness. Elsewhere, it has been argued that finiteness is best represented by an abstract operator FIN which serves to mark the assertion (or other illocutionary roles, in the non-declarative case). This operator has scope properties, thus, only a part of the entire meaning expressed by a sentence may be asserted.

Pilot work on the acquisition of scope at the MPI investigated English, German, and Dutch (see below). These languages will continue to be in the focus of the project, and further plans include research on Chinese, French, Inuktitut and Turkish.

A first subproject in the pilot phase dealt with structural properties of temporal operators (see C. above). In earlier work (see Annual Report 1994, 1995), W. Klein had suggested an analysis of tense and aspect in which intuitively appealing, but entirely metaphorical, characterizations (such as "seen in its totality, with boundaries") are reconstructed in terms of temporal relations between three time spans - time of utterance (TU), time of assertion (T-AST) and time of situation (T-SIT). This approach naturally accounts for subtle but noticeable differences between corresponding aspects in different languages, for example perfectivity in Russian vs. perfectivity in English. They reflect slight differences in the scope of operators which indicate, for example, how T-AST is related to T-SIT. In a recent study, this analysis was applied to the notoriously difficult problem of German Perfekt which has two very different readings - in contrast to the English present perfect, to which it is etymologically and structurally related. A sentence such as "Peter hat gearbeitet" can have a *perfectum praesens* reading as well as a *perfectum historicum* reading, as illustrated by the continuations in (1) and (2):

- (1) *Peter hat gearbeitet und ist müde.*
'Peter has worked and is tired.'

- (2) *Peter hat gearbeitet und wollte nicht gestört werden.*
 'Peter has worked and wanted not to be disturbed.'

In the first reading, it essentially corresponds to the English present perfect. In the second reading, it can take a temporal adverbial ("Yesterday at five", "when the phone rang", etc.), and an English translation would require a past tense ("Peter worked/was working").

As in English, the temporal meaning of the German sentence results from the interaction of two temporal markings: the finite component of the verb (here the present tense marking) and the "post-time marking", as indicated by the combination of *haben* + Past Participle. Both markings can be interpreted as operators, abbreviated by FIN and POST, respectively. FIN indicates here that T-AST includes TU, that is, an assertion is made about the present - it is true right now that p. This p can be construed in two ways, depending on the scope of POST: in principle, it can apply to entire proposition [I work] or only to the VP [work]. English has only the latter option, whereas German admits both:

- (1 ') FIN-TU Peter [POST-work]
 (2') FIN-TU POST [Peter work]

Informally speaking, (1') means that it is claimed for Peter right now that he is in the post-time of working, and according to (2'), the "right now" is claimed to be a time interval after a time interval at which Peter is working. The first reading does not make sense when the subject, here Peter, does not exist at the time of utterance - at that time, it has no properties. Thus, a sentence such as *Caesar has left Rome* should be odd in English, but not necessarily in German, where both scopes of POST are possible. And so it is.

Two subprojects studied the acquisition of quantifier scope. K. Drozd (in collaboration with F. Zwarts) continued investigating children's understanding of universal quantification. Previous studies by Drozd (see Annual Report 1995) revealed that Dutch children commonly judge the sentence *ledere jongen rijdt op een olifant* 'Every boy is riding an elephant' false unless all elephants as well as all the boys in context are participants in boy-riding-elephant events. These results suggest that children may not be establishing the asymmetrical scope dependencies

between subject and object NPs as intended, but are using a numerical or cumulative quantification strategy. In a first experiment, children were asked questions like (1) - (3) with respect to Picture A.

Picture A: girl 1 holding watering cans 1 and 2, girl 2 holding watering cans 3 and 4, and girl 3 holding watering cans 5 and 6.

- (1)) *Houden 3 meisjes 2 gieters vast?*
'Are 3 girls holding 2 watering cans?'
- (2) *Houdt ieder meisje 2 gieters vast?*
'Is every girl holding 2 watering cans?'
- (3) *Houden 3 meisjes iedere gieter vast?*
'Are 3 girls holding every watering can?'

Picture A supports a Subject Wide Scope (SWS) interpretation of (1) and (2). If children can construct a SWS interpretation, then they should say "yes" to both (1) and (2). There is no SWS interpretation of (3) consistent with Picture A. However, two numerical readings of the universal quantifier will produce a consistent match. Replacing *iedere* with a numerical total of 6 results in a question whose cumulative interpretation is consistent with Picture A ('A total of 3 girls are holding a total of 6 watering cans'). A numerical SWS interpretation can be recovered if *iedere* is replaced with a numerical total of 2 (resulting in question (1)). If children prefer a numerical SWS or cumulative interpretation of question (3), then they should say "yes" to (3) given Picture A and reject (3) if they prefer a scopal reading.

An examination of adult responses to such a task suggests there are two groups of adults. Both groups accepted (2) with respect to Picture A (100% yes) and tended to reject (1) (No: Group 1 70%, Group 2 88%) and (3) (No: Group 1 100%, Group 2 67%). But Group 1 preferred quantificational descriptions, replacing the propositions embedded in questions (1) and (3) with descriptions including adverbs of quantification (e.g., *Nee, 3 meisjes houden ieder een ballon vast* '3 girls each have 2 balloons'). In contrast, Group 2 preferred cumulative descriptions of (1) - e.g., *Nee, 3 meisjes houden 6 gieters vast* 'No, 3 girls are holding 6 watering cans' - and either quantified adverbials (like Group 1) or cumulative descriptions for (3), suggesting a general preference for numerical descriptions.

The children also accepted (2) (93% yes). However, unlike either adult group, they tended to accept (1) (80% yes) and (3) (65% yes). When rejecting (1), children showed a preference for case-by-case descriptions (e.g., *Nee, 1 meisje houdt 2 gieters vast*), rather than cumulative descriptions (Adult Group 2). Again unlike either adult group, the children preferred the numerical scope description for (3). These results suggest that children and adults prefer different descriptions of pictures with multiple actors and objects. Though children and some adults prefer numerical descriptions, children prefer numerical scopal descriptions while the adults prefer cumulative descriptions.

Krämer investigated how children (and adults) interpret definite and indefinite NPs in sentences such as (1) and (2):

- (1) *De twee jongens hebben een hond geaaïd*
 (2) *De twee jongens hebben de hond geaaïd*
 'The two boys have patted a / the dog'

The indefinite direct object *een hond* in (1) can be referentially dependent on the subject NP. Therefore, this sentence can mean that a total of two boys are patting a total of two dogs (interpretation A), or that a total of two boys are patting a total of one dog (interpretation B). The definite object in (2) cannot be dependent on the subject NP, hence only interpretation B is available. In a comprehension experiment, subjects matched pictures depicting scenes for interpretations A and B to stories concluding with sentences like (1) or (2). Adults allowed both A and B with the indefinite object, and only B with the definite object, as expected. The children, however, also accepted A with the definite object. When they were given only definite sentences, they reacted in a much more adult-like fashion. Apparently, four- and five-year-old children can only use the information provided by the definite article in an adult-like manner if they already expect its occurrence.

A second experiment investigated the interpretations of (3) and (4).

- (3) *De twee jongens hebben zachtjes een hond geaaïd*
 (4) *De twee jongens hebben een hond zachtjes geaaïd*
 'The two boys have patted a dog softly'

Sentence (3) has interpretations A and B. As to (4), it has been argued (Diesing 1992, de Hoop 1992) that a specific interpretation of the scrambled object NP is required, or strongly preferred. Surprisingly, neither adult nor child subjects showed any preference for B with (4). This points in the direction of object scrambling being a discourse strategy rather than a syntactic restriction on interpretation.

A final study on scope elements dealt with a subject hardly investigated so far, the acquisition of focus particles. In two experiments, Drozd and van Loosbroek analyzed children's understanding of simple sentences with the Dutch focus particle *alleen*, as in:

- (4) *Alleen het meisje heeft een mand*
'Only the girl has a basket'
- (5) *Het meisje heeft alleen een mand*
'The girl has only a basket'
- (6) *Alleen het MEISJE heeft een mand*
'Only the GIRL has a basket'
- (7) *Het meisje heeft alleen een MAND*
'The girl has only a BASKET'

Sentences (4) and (6) are true if the girl is the only member of a set of relevant alternatives who has a basket. In these sentences, presubject *alleen* is assumed to combine syntactically with the subject NP *het meisje*, which it takes in its scope. Within its scope, *alleen* identifies a focus element, e.g., *meisje*, which may be marked by contrastive intonation as in (6). Informally, focus intonation disambiguates the set of alternatives to be considered when interpreting the sentence. In sentences (5) and (7), preobject *alleen* takes the object NP *een mand* as its scope and *mand* as its focus. These sentences are true if the basket is the only member of a set of alternative objects that the girl has. In Experiment 1, children were asked to judge whether sentences like (4) and (5) matched pictures which either only verified the subject scope reading or only verified the object scope reading. In Experiment 2, children and adults were given the same conditions except that the appropriate focus for *alleen* was marked by focus intonation (examples (6) and (7)). The results for both experiments are presented in Table 5.1 and indicate that subject focusing is the dominant strategy for children, whether *alleen* appears in presubject or preobject position; even when the appropriate focus is disambiguated by intonation.

| | Expected Response | Subject-Focus Strategy | Object Focus Strategy | Random |
|---------------------|----------------------|---------------------------|--------------------------|--------|
| <i>Experiment 1</i> | | | | |
| 4-5 year olds | .00 | .82 | .13 | .05 |
| 6-7 year olds | .00 | 1.00 | .00 | .00 |
| Adults | .65 | .30 | .00 | .00 |
| <i>Experiment 2</i> | | | | |
| 4-5 year olds | .21 | .33 | .17 | .29 |
| 6-7 year olds | .11 | .59 | .23 | .07 |
| Adults | .96 | .00 | .00 | .04 |

Table 5.1: Percent response by response type, experiment and subject group

A smaller group of children adopt an object focusing strategy under the same conditions. While some adult speakers (40%) adopted the subject focusing pattern in Experiment 1, they were able to use focus intonation to recover the intended focus (96% expected response in Experiment 2). Focus intonation seemed to confuse rather than help the children (indicated by the increase in object strategy and random responses).

These results suggest that for children, the identification of scope and focus is perhaps a necessary condition, but clearly no sufficient condition for interpreting *alleen* sentences like adults. Children may also require that the intended set of alternatives be disambiguated by contextual as well as linguistic means.

A. Wittek began her dissertation project on the acquisition of the meaning of morphologically simplex and complex verbs, focusing on change of state verbs in German. They include several meaning components which may be differently accessible to various operators with scope, for example

adverbials or aspectual marking. In a comprehension task, children aged 4-6 were shown video clips depicting actions either containing or lacking the crucial meaning component of change of state verbs, namely the resultant state (e.g. a girl tries to wake a man; in one clip he wakes up, in the other he does not). Wittek hypothesized that morphologically complex constructions like *den Mann wachmachen* 'make the man awake' that make the resultant state explicit via a separate morpheme (*wach* 'awake') would be easier to comprehend than non-transparent simplex verbs like *den Mann wecken* ('wake the man'). This hypothesis was rejected since, in 30% of trials, children incorrectly agreed that simplex as well as complex change-of-state verbs could be used to describe scenes lacking the resultant state.

A second pilot study tested whether the scope properties of adverbs like *wieder* ('again') can be used as a linguistic device to diagnose whether a child has acquired the full meaning of a change of state verb. In the restitutive reading, *wieder* has scope only over the resultant state of the event: *sie hat den Mann wieder geweckt* 'she woke the man again' can mean that that the woman caused the man to again be awake, whereas the action as such is not necessarily repeated. Wittek set up an experiment making it relevant for subjects (age 4-7) to use *wieder* with a change of state verb in the production portion of a given trial. The comprehension portion of that trial checked the child's interpretation of that test verb. Wittek hypothesized that children who used *wieder* in the production portion would give a correct answer in the comprehension portion. The observed correlation was not significant, though the numbers go in the direction of the hypothesis.

6. Space

The Space Project investigates the nature of spatial parameters in natural languages and their relation to non-linguistic spatial cognition. In the 1995 Annual report, we selected work for report which concentrated on the linguistic representation of motion events. In this report, in addition to further observations on motion, we report on themes which have been running lines of enquiry within the Space Project, especially frames of spatial reference and topological spatial concepts, including a new cross-linguistic project on dimensional expressions.

6.1 Spatial frames of reference

Work continues on the relation of language to non-linguistic spatial cognition, part of which utilizes evidence from gesture and is accordingly reported under the Gesture Project. In the 1993 Annual Report, a correlation was reported between the linguistic frame of reference utilized to describe a small scale spatial array (see also Annual Report 1994) and the implicit use of the same frame of reference in non-linguistic cognitive tasks. Since then, data from further societies and tasks has confirmed this correlation. Levinson and L. Nagy (U. Hamburg) have reviewed the data and report the following patterns. Comparing speakers from six languages where Absolute (cardinal-direction) frame of reference predominates (Arrernte, Longgu, Belhare, Tamil-A, Hai//om, and Tzeltal) with those from four languages where the Relative (left/right/front/back) frame of reference predominates (Dutch, Japanese, English, Tamil-R), we find the predicted strong correlation of language and frame of reference in non-linguistic cognition across tasks. The results are significant both collectively and by pairwise comparison of groups. Figure 6.1. illustrates plots of the performance on two non-linguistic tasks for all speakers of Absolute languages vs. Relative languages (the x-axis represents a percentage of Absolute trials, the y-axis the percentage of subjects from each language type, Absolute vs. Relative).

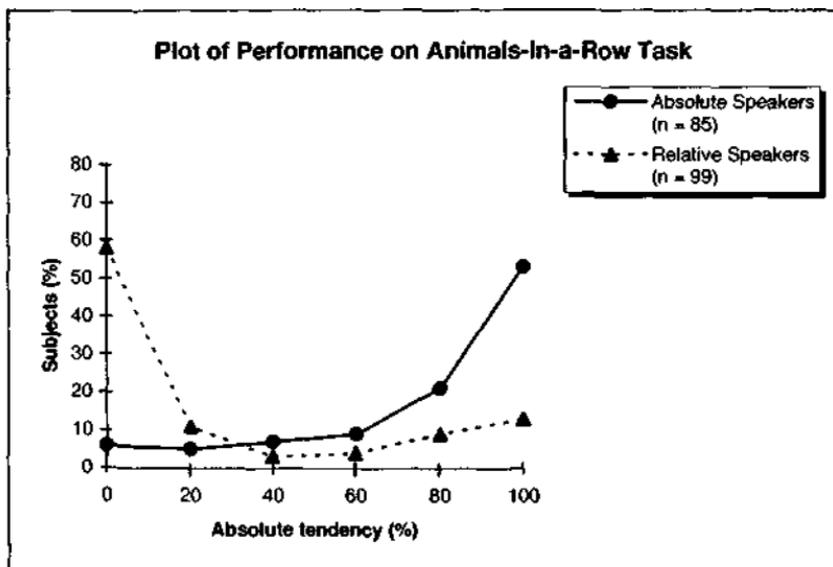
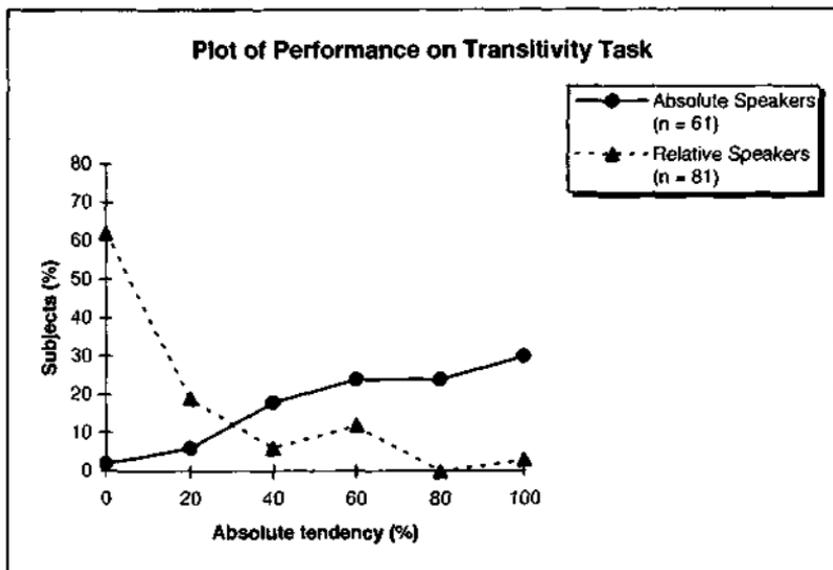


Figure 6.1: Comparison of Absolute vs. Relative language speakers in their performance on two non-linguistic spatial tasks

Further results show that, contrary to expectations derived from Western populations, across the whole sample there is no correlation of gender with results on these non-linguistic spatial tasks (with the exception of a mirror-image discrimination task, as reported by Danziger below). In only two language groups, both from the Indian subcontinent, was there a positive correlation between increased literacy and use of the Relative frame of reference in non-linguistic tasks.

Those communities which speak with an Absolute (or geographic) frame of reference tend to be small and non-urbanized. Conversely, communities which speak with a Relative (or egocentric) frame of reference tend, in our sample, to be more urbanized (but not e.g. in Pohnape, see Annual Report 1995). Pederson has found that some Tamil speakers regularly use the Absolute frame of reference, whereas other speakers use the Relative frame of reference for the same situation. Most speakers from rural villages speak with the Absolute frame of reference and most speakers from the city speak with the Relative frame of reference. However, this correlation is imperfect, which allows us to partially separate the factors of rural vs. urban environment from Absolute vs. Relative frame of reference in language.

For example, 74 Tamil subjects were typed for approximate living environment (rural/urban) as well as tested for spontaneous linguistic use of frame of reference Absolute/Relative/both/neither). They were then tested using a non-linguistic task requiring transitive inference (see Annual Report 1993:73-74,76). Both living environment and linguistic frame of reference proved equally good predictors of cognitive behavior. These results imply that the linguistic system and non-linguistic environmental factors are both important determinants of this cognitive behavior.

Of additional interest are seven Tamil subjects who did not use either frame of reference in post experimental interviews. Instead, they relied on demonstratives such as "this side" and "that side", even when it was clear from the situation that the hearer would be unable to visually determine which side was which. While such demonstrative use is not normally included in discussions of the Relative frame of reference, it is clear that the ascription of "this/that" is perspective dependent in much the same way as the Relative frame of reference. Such speakers should pattern more

like Relative speakers than like Absolute speakers on these tasks, which is confirmed for this small sample.

Danziger has investigated sociolinguistic differences between male and female speakers of Mopan Maya. Great differences in life experience and in cultural style divide men and women in this traditional society in Belize. Among these differences are certain habits of spatial language use.

In the context of an interactive game, across three pairs of partners, Mopan men consistently made use of terms for "right" and "left" to locate a Figure with respect to a Ground (i.e. speech participant-based). Across three pairs of partners, Mopan women generally did not use terms for "right" and "left". Instead, they referred to parts of the Ground, and located the Figure with respect to these (i.e. Intrinsic use). In Mopan women's speech, therefore, a single sentence often describes all horizontal rotations of a Figure-Ground complex equally well (consider English *The box is at the nose of the plane*).

Danziger investigated whether these gendered Mopan speech habits can be associated with differences in non-linguistic judgements about the "sameness" or "differentness" of mirror-image counterparts (cf. Levinson & Brown, *Ethos*, 1994). Mopan individuals were asked to judge whether or not one abstract line figure could be found as part of ("inside") another. One Good match, one Bad match, and the mirror image of the Good match were provided in random order for each of five full figures. All subjects were trained with transparencies to accept the Good match and to reject the Bad one. Subjects were at the same time explicitly trained to REJECT the mirror image match. Despite this training, many Mopan individuals continued to regard the mirror-image matches as good matches on the experimental trials. For Mopan, as in other cultures (Verhaeghe & Kolinsky 1991), literacy is a highly significant factor in performance on this mirror-image judgement task. But Mopan women are also significantly more likely to accept mirror-image parts than are Mopan men. Gender and literacy show only a marginal interaction in the sample. This evidence from Mopan Maya is particularly striking in that it associates variation in the use of spatial language with analogous non-linguistic aspects of spatial conceptualization, in a context where language variation can be identified within a single speech community.

New data from additional languages has been collected. For example, Schultze-Berndt investigated spatial frames of reference in Jaminjung, a Non-Pama-Nyungan language of the Northern Territory, Australia, taking into account data both from spontaneous speech and the research project's standardized games.

Jaminjung speakers use an Absolute system based either on the direction of a local waterway or on global drainage, depending on the scale (as has been previously reported for some Non-Pama-Nyungan languages but not confirmed with detailed data until now). While there are specific terms for 'upstream' and 'downstream', the general terms for vertical 'up' and 'down' can also refer to direction away from and towards the river, respectively. This system is used for large-scale route descriptions, or for specifying location with respect to the deictic center.

Unlike in other Australian languages investigated so far, an Intrinsic, not an Absolute system is used in Jaminjung to locate a static figure with respect to a ground. In the description of small-scale spatial arrangements the Intrinsic frame of reference predominates, and the Absolute terms serve only to indicate direction of motion or gaze.

Brown continued investigation into children's acquisition of Tzeltal Mayan, focusing on the Absolute 'uphill/downhill' system and the Intrinsic body-part system of spatial reckoning (see Annual Reports 1994, 1995). Examination of longitudinal records for three Tzeltal children aged 1;6-4;0 established that the vocabulary for the Absolute system - the motion verbs *molko* 'ascend'/'descend' and their derived forms, and the relational nouns *ajk'ollalan* 'uphill'/'downhill' - is firmly established in children's production, in contrast sets and in a variety of linguistic and situational contexts, by the age of 2;6 to 3;0. The Intrinsic vocabulary appears later, in its possessed form not until age 3;6. Except for a few frozen forms (*e.g.* *jolna* 'head-house' (i.e. roof), *pat na* 'back of house'), Intrinsic uses of the body part terms are extremely rare in the data even by age 4;0. Thus the conceptually complex ("Euclidean") Absolute system ('uphill/downhill in relation to it') is in use prior to the conceptually simpler ("topological") Intrinsic one ('at its inside/middle/top/underneath'). The Absolute system for these small children has limited productivity for describing spatial relations and motion in relation to local places; it is sometimes also used by children, from 3;6 on, to describe

movable objects in novel places on the flat (e.g. *ya jlebetik tal li' ta yanili* 'We'll look for it (lost ball) coming here at its downhill (side) [of a tree]'). The priority of Absolute over Intrinsic is not explainable either by input frequency or by grammatical complexity. To explore the productivity of this system, data from a referential communication task for six pairs of children was analyzed. The task involves a "Director" describing a spatial array of farm animals to a "Matcher", who recreates the array from the description. Children as young as 4;1 follow instructions couched in Absolute terms as the Matcher in this task (e.g. 'Place the cow uphillwards of the horse'), and children between the ages of 5;8 and 7;8 perform the task as Director in an adult-like manner with respect to the Absolute description of spatial relations. This productive use of the Absolute system in completely novel situations on tabletop space by at least the age of 7;8, seems to antecede Western children's analogous competence with the projective left/right part of their Relative systems. The pattern of acquisition of Tzeltal Absolute and Intrinsic systems provides evidence against a "universal" course of acquisition for spatial language based on a scale of cognitive complexity, in favor of a view that children are capable of learning cognitively complex frames of reference remarkably early.

6.2 The description of motion events

Wilkins explored one of Slobin's observations concerning the relation between the semantic typology of motion event expressions and the rhetorical structuring of motion descriptions in adult narratives (see Annual Report 1995:81-83). Slobin has claimed that the distinction between verb-framed and satellite-framed languages correlates with the degree of narrative attention devoted to the dynamics of movement in a motion description, with satellite-framed languages devoting greater attention to the dynamic structuring of motion events than verb-framed languages. Wilkins compared "Frog Story" narratives from speakers of a verb-framed language, Arrernte, with those Slobin and colleagues have collected for American English, a satellite-framed language. Results of the comparison reveal that, against Slobin's typological claim, Arrernte speakers build more complex motion paths and devote more attention to dynamic structuring than English speakers. The results, however, are in line with ethnographic observations which suggest that Central Australian Aborigines have a unique and special cultural concern for motion paths and journeys.

This suggests that cultural factors can override typological factors with respect to rhetorical structuring, and that we must further explore the interaction of semantic typology and culture in this domain.

In the course of his dissertation project on temporal coherence in Yucatec Mayan discourse, J. Bohnemeyer continued the investigation of possible links in the lexicalization of temporal and spatial relations in this language. It is a well-known fact that spatial terms form the most important grammaticalization source of temporal terms in the languages of the world. It has been hypothesized that the conceptualization of time might draw heavily on the use of spatial metaphor in the expression of time, and that the development of spatial and temporal cognition have a unified basis in the cognitive processing of motion events. The striking absence of temporal relators in both syntax (connectives, adpositions, etc.) and inflection (tense) in Yucatec represents a challenge to such ideas.

Bohnmeyer demonstrated that Yucatec prepositions linking source and goal expressions to motion verbs are radically indiscriminate with respect to spatial relations between the moving figure and the referential ground and merely serve to designate a spatial region of the ground object (e.g. *H òok ich le kàaha-o'* COMPL enter (ABS.3.SG) in DEF box-D2 'It entered (lit. in) the box', but also *H hóok' ich le kàaha-o'* COMPL exit (ABS.3.SG) in DEF box-D2 'It left (lit. in) the box'). Furthermore, video stimuli developed by S. Kita as well as objects of everyday use were employed to show that Yucatec motion verbs do not actually imply that the object selected as figure really moves. Moreover, these verbs also display a significant indeterminacy in the respective mapping of figure and ground on their argument structure. These facts clearly disconfirm the lexicalization of figure-ground relations in any single morpheme, which perfectly parallels the observations made above on the lexicalization of temporal relations. That is, just as no Yucatecan element lexicalizes a two-place temporal relation, so no element lexicalizes figure-ground relations in space.

6.3 Topological spatial concepts

6.3.1 Topological semantic categories in first language acquisition

Bowerman continued her collaboration with S. Choi (San Diego State U.) and L. de León (Reed College) exploring how children learn to encode spatial meanings. This work compares children exposed to different languages - English, Dutch, Korean, and Tzotzil (Mayan) - to determine the effects on acquisition of crosslinguistic differences in (1) the semantic categorization of space by spatial morphemes, and (2) where in a clause spatial meanings are characteristically encoded (e.g., in verbs [Korean], prepositions and particles [English, Dutch], or both [Tzotzil]). Bowerman and Choi finished analyzing the results of two studies using the preferential looking paradigm to explore infants' comprehension of words expressing topological relationships of surface contact, attachment, and containment (see Annual Report 1995). One of these studies shows comprehension of language-specific (English versus Korean) principles of spatial semantic categorization by 18 months of age. Evidence for such early language specificity raises difficult questions about the acquisition process; e.g., do learners control multiple cross-cutting spatial categories prior to language, from among which they "simply" select the ones encoded by their language, or do they actually construct spatial semantic categories under guidance from the linguistic input?

Working together with L. McDonough and J. Mandler (both UC, San Diego), Bowerman and Choi began adapting materials from their English-Korean preferential looking study to explore what topological spatial categories are available to *prelinguistic* infants. In a preliminary experiment, babies from 9 to 14 months (average age 12 months) were shown six pairs of video scenes in which diverse objects were placed loosely on top of other objects, e.g., three-dimensional sponge-like letters on a table versus Lego persons on a toy staircase. After familiarization with these various actions of "putting loosely on top", the infants were presented with two sequential test pairs, each showing an additional action of "putting loosely on top" versus an action exemplifying a new spatial relationship, "putting tightly in" (pegs being placed on a board versus pegs being placed into holes in a board; books being stacked on top of each other versus books being put into fitted boxes). No language accompanied

presentation of these scenes. If the infants recognized an abstract similarity across the actions they had already seen, they could be expected to respond to the members of the test pairs differentially, although- since habituation had not taken place- it was not a priori obvious whether they would look longer (relative to a control group of children who had not been familiarized with actions of "putting loosely on top") at the scene depicting a novel spatial relationship or at the scene depicting an additional instance of the spatial relationship they had seen before. For the books pair (but not the pegs pair), the children looked significantly longer than the control group at the additional action of "putting loosely on top", thereby revealing their grasp of what the previously-seen actions had in common with each other, and with this new action.

Since both English and Korean make a contrast between "putting something loosely on top" and "putting something tightly in", demonstration of prelinguistic sensitivity to the distinction does not in itself provide clues to the origin of cross-cutting language-specific principles of spatial classification. But evidence that the preferential looking paradigm can reveal a prelinguistic grasp of this relatively straightforward contrast suggests that the technique may be useful for exploring whether prelinguistic babies appreciate more subtle and crosslinguistically variable principles of spatial semantic classification.

6.3.2 German prepositions

In his previous Ph.D. research on the meaning of German topological prepositions, R. Nüse found that the reading of PPs was influenced by the spatial features of the objects denoted in the PP. In the case of PPs with *auf* for example, which allow an "on top" and an "on front" reading, the salience of these readings depends on the orientation of the salient *surface* of the relatum. *Auf dem Wegweiser* 'on the sign-post', for example, has the "on front" reading as its salient reading, while *auf dem Auto* 'on the car' is preferably interpreted as "on the top of the car". This was taken as evidence that the meaning of a preposition specifies a region of the ground object in which the figure object is located (see Annual Report 1995, p.103f.).

Nüse investigated whether this difference in readings also affects processing when the reading required by the figure does not match the salient reading of the PP. For example, in pairs of sentences like:

Auf dem Wegweiser ist eine Aufschrift aus roten Buchstaben
'on the sign-post is an inscription in red letters'

Auf dem Wegweiser ist eine Amsel mit einem Wurm im Schnabel
'on the sign-post is a blackbird with a worm in its beak',

the reading required by *Aufschrift* matches the salient reading of *auf dem Wegweiser* (which is the "on front" reading), while that of *Amsel* does not (since it demands the "on top" reading), which indeed leads to differences in both reading times and ERPs of these words. By contrast, the reverse pattern of results is obtained when the PP at the beginning is *Auf dem Auto* instead of *Auf dem Wegweiser*. Thus, the differences already found in paper and pencil tasks also show up when using on-line measures.

6.3.3 Dimensionais

C. Stolz continued to lead a subproject on the typology of dimensional expressions. During a field trip to Yucatan, she cross-checked and verified the hypotheses put forward in her PhD thesis on dimensional expressions in Yucatec Maya. In collaboration with E. Danziger, a new tool was designed for the crosslinguistic elicitation of dimensional expressions, an interactive matching game called "Bloxes". An earlier elicitation tool, "Suggestions for the Field Elicitation of Dimensional Expressions", was also improved and extended. During 1996 further field data from different languages was collected, and there are now enough reliable data for the first cross-linguistic generalizations to emerge.

A preliminary analysis of these data was undertaken, with initial focus on the linguistic expression of the vertical dimension (v.d.) of objects. The focal question pursued was how in the languages under consideration, people talk about what in English would be described as the "height" or "tallness" of objects. So far, data from the following 9 languages from 9 different language families have been analyzed (the names of the researchers who provided the data are given in brackets): Arrernte (Wilkins),

Ewe (Essegbey), Jaminjung (Schultze-Berndt), Japanese (Kita), Kgalagadi (Neumann), Kilivila (Senft), Popoluca (Zavala), Yele (the language of Rossel Island, Levinson), and Yucatec Maya (Stolz). The encoding of v.d. in different languages is sensitive to verticality in different degrees. Hence, a typological scale can be established, with respect to the following three criteria: (1) Is there an expression for v.d., i.e., a translational equivalent of "high"? (2) If yes, does the expression for v.d. belong to the same distributional class as the expression for the maximal axis (m.a.), i.e., a translational equivalent of "long"? (3) If yes, does the expression for v.d. override the expression for m.a. if both dimension assignments are possible? The languages under consideration can be grouped into four different classes (see Table 6.2):

| I | II | III | IV |
|--|---|--|------------------------------|
| Ewe Japanese | Yucatec Popoluca | Kilivila Arrernte Jaminjung Kgalagadi | Yele |
| Vertically ← sensitive | | | Vertically insensitive → |
| overriding strategy: | coexisting strategy: | modifying strategy: | orientationless strategy: |
| same distribu- tional class v.d. overrides m.a. obligato- rily | same distribu- tional class v.d. does not over- ride m.a. obligatorily | different distribu- tional class v.d. modifies m.a. when a contrast must be made | no expression of v.d. |

Table 6.2: Typological scale of the linguistic encoding of the vertical dimension (v.d.)

The scale shows that, in the encoding of v.d., there is much more crosslinguistic variation than was previously assumed possible. Previously, only the overriding strategy of Type I languages, exemplified in the sample by

Ewe and Japanese and also known from German or English, has been described in the literature. Particularly the existence of the Types III and IV is a new finding. Type III languages encode v.d. only when an orientational contrast has to be made explicit, and the expression of v.d. belongs to another distributional class than the expression for m.a. and frequently modifies the latter one, but does not replace it. In Kilivila, for instance, v.d. is encoded by a numeral classifier which if necessary is preposed to the expression of m.a., which like other expressions for proportion-based dimension is an adjective. In Yele, the only Type IV language so far, no expression for v.d. (i.e. *high* distinguished from *long*) could be identified at all.

To give some idea of what, for example, a type III system of dimensionals looks like, consider the following data collected by Senft on Kilivila, the language of the Trobriand Islands. The data comes from the Bloxes interactive elicitation task. Kilivila dimensional adjectives differentiate between 'small' (*sisikwa*) and 'wide' (*-beyaya*) surfaces of 3-dimensional objects like boxes and blocks (the dash before the Kilivila expressions indicate that these adjectives obligatorily need a classifier that is prefixed to the stem). The modification strategy is generally prevalent, so that for example wider surfaces can be differentiated with modifying adjectives, as being 'short' (i.e. *-beyaya* with *-kukupi*='a. short wide surface') or as being 'high/ long' (*-beyaya* with *-vanaku*='a high/long wide surface'). Smaller surfaces are differentiated in a similar way (*sisikwa* with *-kukupi* vs. *-sisikwa* with *-vanaku*). Moreover, we find additional modifying adjectives that express the concepts 'small' (*-kekita*), 'big' (*-veaka*), 'thick' (*-popou*), 'flat/thin' (*-karaya* and its variants *-kakaraya*, *-karat*), and 'thin' (*-kapatata*). Some special further features of the system include the fact that the adjective *-tarabwabwada* refers to the sides of open boxes; this adjective originates in the noun *tarabwabwada* that refers to 'sideboards of canoes'. Furthermore, cylinders and rolls are differentiated with respect to their long and short extensions. The adjective *-bobuta* refers to all their surfaces.

Turning again now to the encoding of the vertical dimension as explored in the cross-linguistic summary above, we find the following interesting result: Dimensional adjectives in Kilivila belong to the class of adjectives that must be used with classifiers that are prefixed to the stem (e.g.: *toveaka* consists of the classifier *to*- 'human/man' and the adjective *-veaka*

'big' and can be glossed as 'human/man-big'). If there is no need to contrast one dimension with other dimensions, dimensional adjectives just take a general classifier. For example the classifier for 'part, piece', *pila-*, as a prefix refers to the object that is described by the adjective in a rather general, unspecified way. However, if speakers want to encode the vertical dimension for contrastive reasons, they prefix to the adjective that refers to the maximal extension the classificatory particles *he-* or its variant *kai-*. This classifier encodes (among other things) the concept 'rigid vertically long objects' and is used to refer to 'trees', for example. Thus, in Kilivila the vertical dimension is encoded within a different formal class, namely the classifiers, and not within the class of adjectival stems like the other two dimensions.

6.3.4 Shape: language and cognition

In earlier research exploring cognitive correlates of grammatical patterns, J. Lucy found that adult English speakers showed relatively greater attention to the number and shape of various referents in nonverbal classification and memory tasks. By contrast, on the same tasks, adult Yucatec Maya speakers showed less attention to number overall, and a more restricted range of attention and less emphasis on shape. Current work by Lucy and S. Gaskins concentrates on using the developmental onset of these patterns as a diagnostic instrument to explore the relationship between language and thought in childhood: at what age and in what manner do these language-related cognitive differences arise?

One study will serve to illustrate the approach. Speakers are shown sets of three objects: one identified as a "pivot" and two others as "alternates". One alternate shares shape and the other shares material with the pivot. For each triad, respondents are asked to indicate which alternate is "most like" the pivot. The question is whether, across a set of items controlled in various ways, respondents prefer shape or material as a basis for classification.

Adult English speakers strongly prefer shape whereas adult Yucatec speakers prefer material - patterns that align with the overall lexical semantics of the two languages. Similar classification tasks were given to children aged 7 and 9. The 7-year-olds from both groups strongly favored

shape choices, choosing material only 11 % of the time. At age 9, English-speaking children also preferred shape much like English-speaking adults (only 17.8% and 22.8% material choices respectively), whereas Yucatec-speaking children shifted markedly toward the characteristic adult Yucatec pattern of preferring material (41.7% and 61.1% material choices respectively). The statistically reliable differences between English and Maya speakers suggest that language-specific classification preferences appear in cognition between ages 7 and 9.

This comparative developmental approach is fruitful in several ways. The language-specific pattern would not be visible from the English data alone since the young children's and English adults' patterns are in harmony. It would also never come to light if, in the absence of a suitable diagnostic, one restricted research attention on language and thought to the earliest years. Indeed, the shift is late enough that it seems unlikely to be due to some simple mechanical "spread of effect" from linguistic habits in place for many years. It seems more likely that there is a specific developmental shift at work bringing verbal and nonverbal cognitive domains into a new interfunctional relationship.

Shape is often a central semantic property of classifiers. Senft published a book on the classifiers of Kilivila. Common among the world's languages is the phenomenon of nominal classification, whereby particular nouns or their referents are assigned to certain classes signaled by a classifier typically inside the noun phrase. The book describes and develops a grammar of classificatory particles (or numeral classifiers) in Kilivila, an Austronesian language unusual in having a full system of up to 200 numeral classifiers. In fact these particles encode a great deal of highly specific information besides shape, with special particles not only for e.g. "conical bundles of taro", but also "teeth", "parts of a song", etc. Based on anthropological-linguistic fieldwork in the Trobriand islands, the book provides a linguistic characterization and much quantitative data concerning the use of 88 of these particles by both adults and children. The book emphasizes the role of classifiers in social contexts and describes and analyzes the inventory of classificatory particles in Kilivila, with a great deal of further information about their acquisition, their usage, the changes affecting the system, and their semantics.

7. Gesture

Pointing gestures were the main focus of the Gesture project, and they were investigated from different perspectives. J.P. de Ruiter experimentally investigated the synchronization of speaking and pointing. S. Kita and S. Levinson investigated two culture-specific ways of computing the target direction in pointing to an invisible location. In this study, Japanese speakers, highland Mayans, and Australian Aborigines were studied. Wilkins studied meta-knowledge about various kinds of pointing in an Australian Aboriginal society. Another development is Kita's experimental investigation of the communicative functions of gestures.

7.1 The Synchronization of speech and pointing gestures

De Ruiter continued to investigate the synchronization of speech and pointing gestures. In a new experiment, subjects were shown horizontal arrays of 4 pictures. Their task was to single out the object indicated by a flashing LED by describing the picture (e.g. "the green crocodile") and pointing to it. In addition, subjects were asked to put contrastive stress on either the color name or the object name. If the 4 presented objects were identical but differed in color, subjects had to stress the color name. If there were 4 different objects with the same color, subjects had to stress the object name. This way, contrastive stress and lexical stress could be varied independently. As in previous experiments of this kind, it could be demonstrated that the timing of speech adapts to the timing of the accompanying gesture. However, the experiment also revealed that the timing of gesture adapts to properties of the accompanying speech.

The results show that the location of the contrastive stress (adjective vs. noun) influences the timing of the pointing, in such a way that there is an attempt to synchronize the gesture with the contrastive element in the speech. The location of the syllable with lexical stress (word final or word initial) had a small effect on the timing of the pointing, but only when the contrastive stress was on the adjective. This finding suggests that lexical

stress only has an effect on the gesture timing when phonological information is available during the execution of the pointing gesture.

An analysis of the hesitations and interruptions in the data revealed interesting dependencies between gesture and speech. In speech errors, the gesture adapts in such a way that the relative timing of speech and gesture is maintained, even when the speech is interrupted or delayed. This adaptation of the gesture occurs both in the planning phase and during the execution of the gesture.

7.2 Gestural indication of routes and locations: a cross-cultural perspective

Gesture and bodily movement can be very revealing of the "frame of reference" underlying spatial cognition. In close relation to issues in the Space Project, especially with regard to the distinction between Absolute and Relative frames of reference, two studies were undertaken. In the first, very careful observation by Kita of the use of the body during the production of route-directions in Japanese seems to reveal rather directly the use of bodily coordinates for spatial calculations in speakers of Relative languages.

The route direction data were collected on the campus of a university in Tokyo. Informants were asked to explain how to get to two locations in and out of the university, which are about 400 meters away. The majority of the informants' gestures expressed the location of landmarks and streets to be traveled, direction of locomotion, and turn directions. Two classes of body movements were analyzed: (1) body rotation that indicates turn directions, (2) gestures that point to an invisible location.

It was observed across informants that, prior to the utterance (gesture-speech complex) that expresses an invisible turn, the body is rotated so that it would align better with the orientation of the segment leading up to the turn. This suggests that there is a bodily representation of the turn sequence of a route, where rotating the body for a turn primes the retrieval of the next turn direction. The priming mechanism is utilized in preparation for the utterance that expresses the direction of an invisible turn.

There are a few observations general across informants, regarding pointing at an invisible location, which indicate that there are two stages in the computation of the direction of an invisible location. First, as a preparation for such pointing, the body rotated so that it was faced roughly in the direction of the target. The more efficient direction of the body rotation was chosen; namely, the turn angle did not exceed 180 degrees. This indicates that at the initial stage there is dead-reckoning of the target direction at least at a coarse level. Before starting the stroke phase of the pointing, the candidate direction was always visually probed. This indicates that there is visually based fine-tuning of the computation of the target direction.

In contrast, as reported in the Gesture project for 1995, Absolute speakers when pointing to places do not tend to shift the body, and do not necessarily gaze in the direction pointed. This apparently effortless ability to point to named locations from any point was further investigated by Levinson using data collected over three years, with additional data from Pederson (Dutch) and Widlok (Hai//om). Comparison was made between subjects in four cultures, three of which employ languages which predominantly use Absolute linguistic expressions for spatial description: Guugu Yimithirr speakers in Queensland, Australia, Tzeltal speakers in Tenejapa, Mexico, and Hai//om speakers in Namibia. Data for Relative Speaking language communities was obtained from Dutch subjects, supplemented by published material on English-speaking subjects. The method involved taking subjects far into unfamiliar wooded country with limited visibility (except in the Tzeltal case, where a variant procedure had to be employed), and asking them to point to a range of familiar locations at distances from 2-200 km. Readings taken with a prismatic compass were compared to actual directions ascertained by map and (in the case of the Kalahari situation examined by Widlok) GPS navigational equipment. The results were analyzed using the methods of circular statistics employed in studies of animal spatial behavior. The results showed that the Guugu Yimithirr and Hai//om subjects were able to precisely dead-reckon their current location and thus point accurately to other places (mean estimates of direction were only 3 and 8 degrees off target for the respective samples

with low mean angular deviations). Tzeltal subjects, who live in much more restricted terrain, were examined within an unfamiliar windowless house. They showed a systematic skewing of estimates in line with the walls of the house, but were otherwise remarkably consistent. In all three samples, all subjects were consistent and in close agreement with each other. In contrast the estimations of Dutch subjects were widely distributed and indeed were not distinguishable from random pointings.

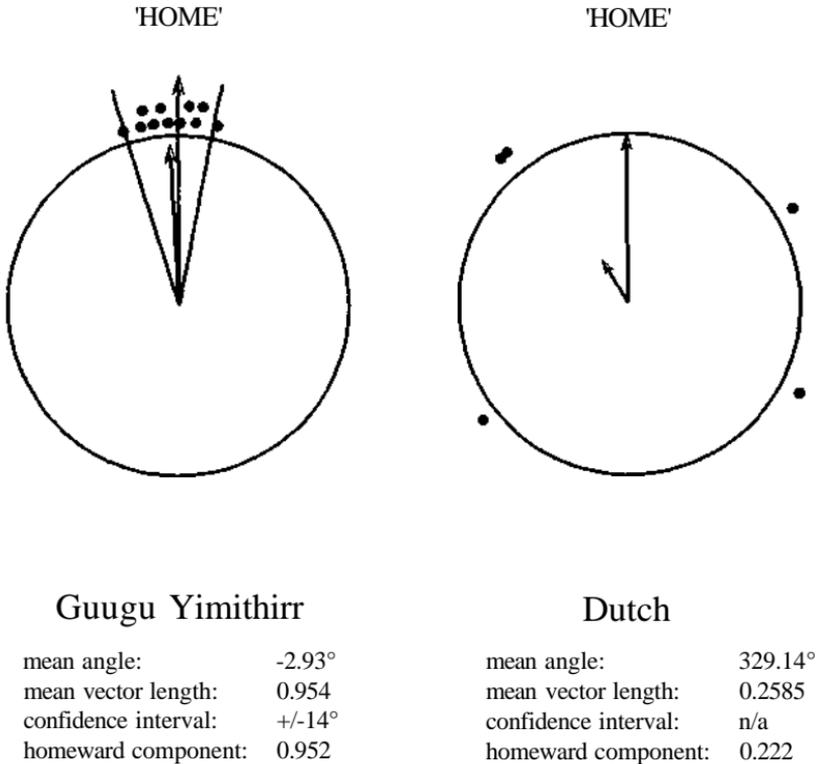


Fig. 7.1: Guugu Yimithirr vs. Dutch circular diagrams

We may conclude from these findings that speaking a language which employs absolute linguistic expressions in everyday speech correlates with heightened navigational abilities, presumably in part because speaking such a language requires all members of a community to constantly compute direction for possible future speech encoding. These experimental findings confirm the apparent precision of spontaneous gesture produced in conversation in communities where Absolute linguistic descriptions of direction are the norm.

In Figure 7.1, the long arrow indicates the target or "home" direction. The dots indicate the mean of each individual's estimates (from 7 to 20) of direction, with their angular deviation from the correct "home" direction. The short arrow indicates the *mean vector*, such that the longer the arrow the greater the concentration of estimates; the homeward component of this vector is a measure of accuracy.

7.3 Meta-knowledge about pointing among the Arrernte

As part of his continuing research on pointing gestures among the Arrernte of Central Australia, Wilkins explored Arrernte speakers' own meta-knowledge concerning pointing. This research, coupled with observations of actual deployment in day-to-day interaction, show that Arrernte pointing is a structured semiotic field. Arrernte speakers recognize three parts of the body used for pointing: the hand, the mouth and the eyes. An eye-point is made by first catching someone's eye and then visibly moving one's eyes towards a particular referent (typically without accompanying head movement). This is considered a "secret" point used between close familiars, and the referent is always visibly available in local space. The mouth point is made by protruding both lips, orienting them towards the referent and slightly tilting the head back. This is also only used with close familiars, but need not indicate secrecy and can be used to locate a referent that is not visible from the current location. Manual points are considered fully public gestures which are regularly used in the most formal of situations (ceremony, oration). Arrernte speakers divide manual points into three (largely functionally-defined) types: the "one finger" point (either middle or index finger) used to locate the fixed position of a single

referent; the "wide hand" point used to localize multiple entities that are spread out over an area; and a "flat hand" point used to indicate the orientation of a linear entity like a creek or path segments traveled.

7.4 Listeners' up-take of gestural information

Kita experimentally investigated the question of listeners' up-take of information from conversational gestures. In the experiment, the speaker viewed several short animated cartoons and told the stories of the cartoon to the listener, who had not seen them. After hearing the story, listeners (to their surprise) were asked to draw eight scenes in the cartoons. The drawing was coded with respect to the left/right direction of target movements in the scenes, and categorized as "matching" or "not matching" the speaker's gestures. A drawing was scored as a "match" when the direction of the target movement in the drawing is the same as the one represented in the speaker's gestures, taking the listener's point of view (in other words, listener-left corresponds to speaker-right).

In order to assess how much left/right direction could be extracted from the speech alone (note that there were very few cases of explicit mentioning of left and right), the same drawing task was administered to another group of subjects who listened to the sound track only of the video recordings. The results indicate that the ratio of "matches" was significantly higher for the live-encounter condition (60%) than for the audio-only condition (51 %), in which the ratio was at the chance level.

Unlike previous experiments in the literature, the current experiment involves live face-to-face interaction, whose goal is to talk and to understand the talk. This allows us to be more confident in extrapolating the result to natural conversational settings. The information to be taken up by the listener is the lateral direction of a movement (left or right) in a retelling of an animated cartoon. This information has little practical significance unlike such information in route directions. If it is routinely taken up, it suggests that the information up-take is automatic. It is concluded that in a normal conversational setting, people commonly and automatically take up information that is only present in gestures.

8. Sentence and Discourse Integration

This project aims to investigate the time course of the integration of information in sentence and discourse understanding. In language comprehension, lexical, syntactic, semantic and pragmatic information, as well as world knowledge, play a role in constructing a representation of sentences and discourse. Information from these different sources is not equally available at different moments in time during the comprehension process. Depending on the availability of information, different kinds of integration processes take place.

A number of issues relating to different levels of linguistic information have been studied in 1996. The use of syntactic and semantic information was investigated through an examination of how two types of structural ambiguity were resolved and through a study of modifier attachment preferences. Structural information and world knowledge factors were investigated in a study of the principles regulating pronoun assignment. The role of lexical information and world knowledge in discourse understanding was addressed through research concerning different expressions that contribute to the integration of discourse, in particular referential expressions and conjunctions.

8.1 Semantic and syntactic integration processes during comprehension

In the collaboration between the Neurocognition of Language Processing Project and the Sentence and Discourse Integration Project, a series of EVM and ERP studies was completed by C. Brown, P. Hagoort, W. Vonk, and J. Hoeks (U. Nijmegen). These studies examined the resolution of syntactic ambiguities and the processing of long distance dependencies (for design and materials see Annual Report 1995). The syntactic ambiguity consisted of a conjoined-NP vs. an S-conjunction reading. Syntactic ambiguity effects were tested in three sentence context conditions: (1) sentences that were semantically neutral with respect to the conjoined-NP and S-conjunction interpretation; (2) sentences in which the NP-conjunc-

tion reading resulted in a selection restriction violation given the lexical specifications of the main verb; and (3) sentences in which the two nouns in the conjoined-NP were asymmetric in their animacy characteristics.

A total of 300 subjects were tested in the experiments on syntactic ambiguity, with a testing time of three to three and a half hours per subject. In the neutral condition (1), a significant effect was observed in First Pass Gaze Duration and in Regression Path Duration at the word following the finite verb which disambiguates the syntactic structure towards the S-conjunction reading. The ERP study revealed a small, but reliable Syntactic Positive Shift (SPS) on the finite verb itself. Although EVM and ERP effects were measured at different words, the results nicely converge: The First Pass Gaze effect shows up from about 450-700 msec after the onset of the critical verb, and the SPS was obtained in the 500-800 msec window of that verb. Together the results suggest that in the absence of biasing semantic information a preference exists to interpret the ambiguous string as a conjoined NP.

In sentences in which a conjoined NP resulted in a restriction violation (2), no effect of the syntactic ambiguity was observed either in the EVM measures or in the ERP data. Presumably, the lexical information completely overrode the syntactic preference. Finally, in the sentences with an animacy asymmetry (3), an SPS effect was observed at the second noun of the conjoined NP. This indicates that the semantic information (i.e., animacy) was used immediately to reanalyze the initially assigned and structurally preferred conjoined-NP reading. Together, these results strongly suggest that purely structural preferences exist in sentence processing, but these preferences are modulated or overridden by semantic information.

As for the establishment of long-distance dependencies which were tested in sentences containing filler-gap relations (see Annual Report 1995), the final analyses of the EVM and ERP data are at present ongoing.

8.2 Modifier attachment

In a questionnaire pilot study, L. Frazier (U. Massachusetts, Amherst) and Vonk studied modifier attachments in Dutch. They investigated perceivers' preferences for high vs. low attachment of relative clauses and of prepositional phrases to a complex NP. Modifiers appear to associate into the current thematic processing domain: More attachments of a relative clause were made to the lower potential head in a complex NP when that head was introduced by a theta-assigning preposition, such as *with* in *the friend with the colonel who lives in Amsterdam*, than when it was introduced with a non-theta-assigning preposition, such as *of* in *the friend of the colonel who lives in Amsterdam*. The preference for high attachment of the relative clause in the last case appeared to be not significantly different if a supposedly non-restrictive interpretation of the relative clause was made grammatically impossible by using quantified heads, as in *every friend of the colonel who lives in Amsterdam*. Finally, it turned out that the existence of an alternative genitive construction (in which lower potential heads are -s marker taking vs not -s marker taking) did not change the attachment preferences for prepositional phrase modifiers to the complex NP: There was no greater tendency to attach to the lower NP in a complex NP such as *de vriend van mijn oom* 'the friend of my uncle', for which the alternative *mijn ooms vriend* exists (the attachment would be unambiguously to *vriend*), than in a complex NP where there is no such alternative available, such as in *de vriend van de actrice* 'the friend of the actress'.

8.3 Pronoun resolution and pragmatic knowledge

G. Flores d'Arcais has continued his work on a project which investigates some of the principles regulating the resolution of pronoun interpretation for pronouns that refer back to sentences with two full NPs. Given sentences such as (1),

- (1) The doctor examines a patient. He wears a white coat.

he studied the assignment of the pronoun to the first NP or to the second NP. Pragmatic factors tend to induce the listeners to assign the pronoun "he" to NP1, because one knows that doctors use white coats. In the continuation of the project, Flores d'Arcais has used similar Italian sentences with Italian adults and children to examine the influence of structural and pragmatic factors. These show a differential effect: decisions based on strong pragmatic constraints are fast and uniform, while weak pragmatic constraints lead to more variation in the latencies, as if readers are uncertain about which factor to rely on. In several cases the reader seems to base his/her decision on structural principles, while in other cases pragmatic elements seem to guide more strongly the choice of pronoun assignment. In previous work, Flores d'Arcais has focused on the strength of the "weak" pragmatic factors (see Annual Reports 1994,1995). In more recent work, he was able to show the following form of the interaction between pragmatic and structural factors: While for young children pragmatic factors are strongly dominant, their influence diminishes, but initially much less strongly than at older ages. This lack of linearity of the interaction is presently being investigated.

8.4 Different functions of alternative anaphoric expressions: Demonstrative NPs

Vonk, in collaboration with L. Hustinx (U. Nijmegen), completed a series of experiments on the discourse function of superordinate demonstrative NP anaphors (e.g., 'this bird' referring to an earlier introduced 'sparrow') with a reading time study. By reading a demonstrative anaphoric superordinate NP ('this bird') instead of a definite one ('the bird'), the discourse referent is classified within its natural class and a contrast is made with the complement set of the class, thereby activating the other members of the class. This process will take time. The reading times for sentences with the demonstrative anaphor were longer than those for sentences with the definite anaphor. Moreover, a sentence that followed the sentence with the superordinate anaphor and that continued with (one of) the other exemplars as the topic took less time to read if it was preceded by a demonstrative anaphor than if it was preceded by a definite anaphor. These results suggest how the reader indeed exploits the demonstrative anaphor in building the representation of the text: Demonstrative noun

anaphors have an identificational function in activating their antecedents, just as their counterparts, the definite NPs, have, but they additionally have a contrastive interpretation by activating the complement set of the antecedent.

8.5 Inference processes and discourse integration

Vonk, L. Noordman (U. Tilburg) and R. Cozijn (U. Tilburg) continued their research on causal conjunctions. In understanding consecutive clauses in a text, the reader has to derive the relation between the current clause and the previous clauses. This relation may be expressed by a conjunction, as in *History is not a science, because in history particular facts are more important than laws*. The conjunction *because* has at least two functions: an integration function and an inference function. In its integration function, the conjunction indicates that the two clauses are integrated by a reason relation. This reason relation does not have to be derived from the propositions in the clauses, but is indicated by the sheer presence of the conjunction. But, to justify the reason relation, an inference is required. In the example cited above, the required inference is: "in science laws are more important than facts".

Integration deals with relating the propositions in the clauses to each other and leads to a prepositional representation. Inferences require, in addition, the activation of world knowledge, and lead to a more elaborated mental representation. Accordingly, inferencing is assumed to take place in sentence understanding later than integration. As an integration device, the conjunction should speed up the reading process; as a trigger for an inference, it should slow down the reader. These hypotheses were tested in an experiment using eye movement registration. Because previous studies indicated that the occurrence of inferences depends on the reader's knowledge, texts were used that deal with familiar situations. The target sentences were presented in two conditions: as two clauses connected by the conjunction *because* (as in *He suffered a considerable delay, because a traffic jam had developed on the freeway*) and as two clauses without a conjunction and separated by a full stop. It was expected that the presence of a conjunction facilitates the integration of the words with the previous

clause as soon as they are read, and therefore speeds up reading. On the other hand, a conjunction triggers an inference that is made later in the clause, thus increasing the reading time at the end of the clause. The First Pass Forward Gaze on the words following the (place of the) conjunction was indeed shorter when the sentence contained a conjunction, whereas this Gaze on final words was longer. The results confirm the predictions based on the integration function as well as on the inference function of *because*.

9. Neurocognition of Language Processing

9.1 The neural architecture of language processing

9.1.1 The neural architecture of syntactic processing

P. Indefrey, C. Brown and P. Hagoort, in collaboration with H. Herzog (Institut für Medizin, Forschungsanlage Jülich) and R. Seitz (Heinrich-Heine-U. Düsseldorf) completed the data analysis of a PET experiment on sentence processing (see Annual Report 1995). All syntactic tasks activated a cortical area at the dorsal border of the pars triangularis of the left inferior frontal gyrus (Broca's area), extending anteriorly into the middle frontal gyrus (Figure 9.1a, b, and e). The more complex sentence production task in addition activated the right hemisphere homologue of Broca's area (Figure 9.2b and c). This area was even more strongly activated for both error detection tasks (Figure 9.2d and e). When the syntactic error detection task was directly compared to the sentence production task, additional activation was seen in bilateral inferior frontal areas, as well as in the left temporoparietal junction (Wernicke's area) and, to a lesser extent, its right homologue (Figure 9.1f and Figure 9.2f). All tasks activated superior parietal areas.

These findings demonstrate that, after controlling for possible confounds of lexical semantic processing, the dorsal part of Broca's area and adjacent areas are a neural correlate of syntactic processing. They also show, however, that some of the cortical activations induced by syntactic tasks are not necessarily syntax-specific but may rather reflect the contribution of additional general cognitive components. This holds in particular for the activation of the right inferior frontal gyrus homologue of Broca's area.

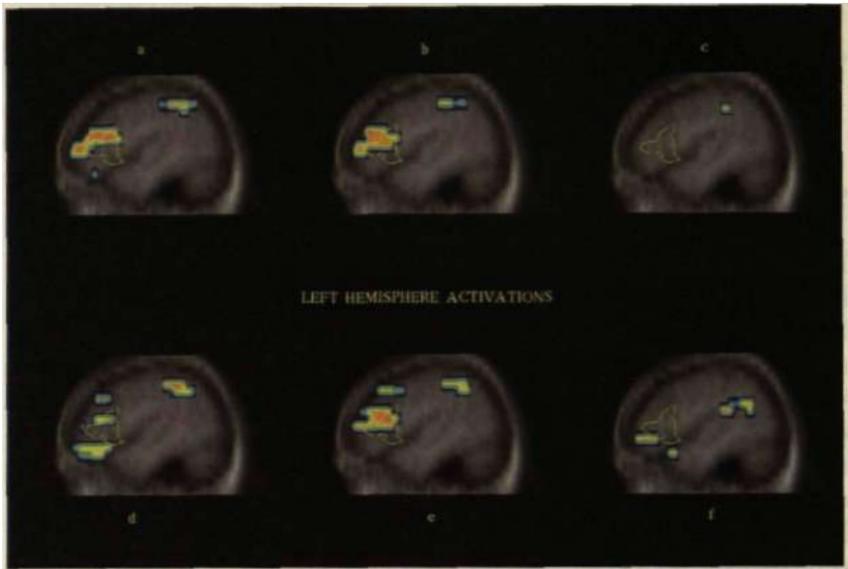


Figure 9.1: PET experiment on syntactic processing. Subtraction images showing significant ($p < .05$) rCBF increases projected onto the mean standardized anatomical MR image of the 10 subjects. All sagittal slices taken 49 mm left from midline. Pars triangularis of inferior frontal gyrus (Broca's area) drawn in from the CBA anatomical database. Comparisons: (a) production of pseudoword subject relative clause (SRC) sentences - pseudoword pronunciation (PP) (b) production of subject and object relative clause (SRC+ORC) sentences - PP (c) production of SRC+ORC sentences - production of SRC sentences (d) graphemic error detection - PP (e) syntactic error detection - PP (f) syntactic error detection - production of SRC+ORC sentences.

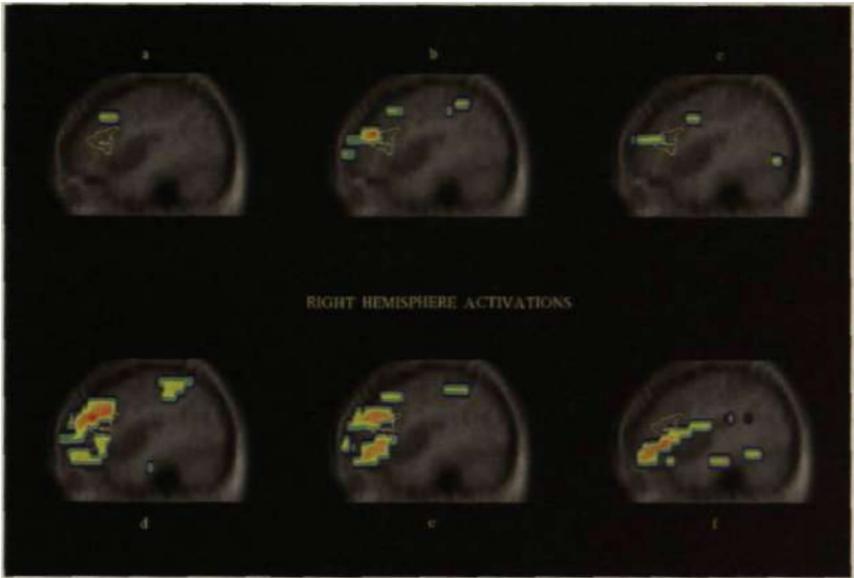


Figure 9.2: PET experiment on syntactic processing. Data analysis as in Figure 9.1. All sagittal slices taken 37 mm right from midline. Pars triangularis of inferior frontal gyrus (Broca homologue) drawn in from the CBA anatomical database. Comparisons: (a) production of pseudoword subject relative clause (SRC) sentences - pseudoword pronunciation (PP) (b) production of subject and object relative clause (SRC+ORC) sentences - PP (c) production of SRC+ORC sentences - production of SRC sentences (d) graphemic error detection - PP (e) syntactic error detection - PP (f) syntactic error detection - production of SRC+ORC sentences.

9.1.2 The neural architecture of morphological processing

Indefrey, Brown and Hagoort, in collaboration with Herzog, Seitz and M. Sach (Heinrich-Heine-U. Düsseldorf) completed the data acquisition of a new PET experiment on morphological processing.

While traditionally a distinction has been made between regular (cook-cooked) and irregular inflections (sing-sang), more recently connectionist models have been proposed in which the inflectional system is unified, with regular and irregular inflections represented in the same "neural" network. The PET experiment was designed to determine whether the same or different cortical loci subserve regular and irregular inflection.

Twelve native speakers of German were presented with neutral sentence frames like *Er hat etwas ...* or *Er ... etwas* ('He has something...' or 'He ... something'), followed by base-form verbs, such as *kochen* ('to cook', regular verb) and *sehen* ('to see', irregular verb). In the inflection conditions, subjects had to produce correct sentences. This required insertion of the verbs in their regular or irregular past or perfect participle form (e.g., *Er kochte/sah etwas* or *Er hat etwas gekocht/gesehen*; 'He cooked/saw something' or 'He has cooked/seen something'). As a control condition, the verb was presented in its inflected form, so that identical sentences were produced but no inflectional processing was required. Verbs were also varied with respect to the frequency of the inflected forms in spoken language, since this could have an impact on lexical retrieval.

While in the PET experiment the different possible regularity/frequency combinations had to be presented in separate conditions, in a preceding reaction time study (20 subjects) the same stimuli were presented in non-blocked random order, in order to obtain independent evidence for a differential processing of irregular and regular morphology. Irrespective of the frequency of the past tense or the participle, there was a significant main effect for regularity. Irregular verbs resulted in longer voice onset times than regular verbs, suggesting that different processing components might be involved for regular and irregular verbs. This result was replicated by the voice onset times measured immediately before and during the PET experiment, indicating that the blocked design did not alter the morphological processing. The PET data are currently being analyzed.

9.1.3 An fMRI validation study

In 1996 a new collaboration with the *Forschungsanlage Jülich* on functional MRI imaging began. Indefrey, in collaboration with A. Kleinschmidt (Heinrich-Heine-U.) and S. Posse (Institut für Medizin, Forschungsanlage Jülich) has begun the data acquisition for a validation study aimed at replicating the results obtained on visual lexical processing at the fMRI unit in Göttingen (see Annual Report 1995).

9.1.4 A MEG investigation of the syntactic positive shift (SPS)

Brown and Hagoort, in collaboration with K. Alho, M. Cheour-Luhtanen, R. Näätänen (all of U. Helsinki), and R. Ilmoniemi (BioMag Laboratory, Helsinki U. Central Hospital) implemented an experiment on the Syntactic Positive Shift (SPS), using the 122-channel whole-head magnetometer at the BioMag Laboratory in Helsinki. In terms of its design and material, the experiment is a replication of an earlier ERP study in which the SPS was observed with various kinds of grammatical violations (see Annual Report 1991). The MEG experiment served three main purposes. First, to try to establish a magnetic counterpart to the by now well-established SPS in the EEG. Second, if successful in discovering an SPS in the magnetic field, to attempt a neuronal source characterization, as one step towards discovering the neural underpinnings of the SPS. Third, to compare the magnetic profile and the source characterization of the SPS with the so-called P300 component, as elicited in a non-linguistic oddball paradigm (in our version of this paradigm, the same subjects that participated in the MEG language experiment saw a random sequence of triangles and squares, in a 1:5 distribution, with the instruction to count the triangles). The motivation for comparing the SPS and the P300 in this way was to investigate whether the neurophysiological characteristics of the SPS are distinct from those of the P300. This comparison is important for establishing whether the SPS is specific to syntactic processing, or a reflection of more general cognitive processes.

To date, MEG data (and 13 channels of coregistered EEG data) are available for five subjects (out of a total of eight subjects tested), both in the SPS experiment and in the P300 experiment. These data are currently being analyzed. In the time window that is associated with the SPS in the

ERP waveforms, the MEG showed an effect for a subset of the subjects. The MEG effect is most prominent over left temporal sensors, but more data and further analyses are required before any conclusions can be drawn. This work is ongoing.

9.2 Semantic and syntactic integration processes during comprehension: ERPs and parsing

9.2.1 When syntax and semantics meet: An ERP study

P. Hagoort and C. Brown, in collaboration with A. Deckers, J. Haasen, and K. Remmerswaal, did a study in which combined semantic and syntactic violations were used to determine the interplay between semantic and syntactic processing. Psycholinguistically motivated ERP research has found at least two distinct ERP components related to sentence processing. One component is the N400. The amplitude modulation of this component indicates the ease of semantic integration. A qualitatively different component is the Syntactic Positive Shift (SPS). The SPS is elicited by a word in the sentence that renders the (preferred) structural assignment impossible. In this study we exploited the independence of the neural generators underlying the N400 and the SPS. According to Helmholtz' superposition rule, contributions of independent neural generators are additive in scalp-recorded ERPs. This feature of brain potentials allowed us to test (1) whether the processes of semantic integration and syntactic assignment are independent, and (2) if they are not independent, what the nature of their interaction is.

These issues were approached in an experiment in which we presented subjects with sentences containing semantic violations, syntactic violations, or combined semantic and syntactic violations. Violations were either in the first or the final NP of the sentence. The syntactic violation concerned the grammatical gender agreement between the article and the noun in Dutch. The semantic violation concerned the pragmatic implausibility of the adjective-noun combination. This resulted in the following four conditions:

Correct:

De kapotte paraplu Staat in de garage.
 'The broken umbrella is in the garage.'

Syntactic Violation:

Het kapotte paraplu staat in de garage.
 'The (wrong gender) broken umbrella is in the garage.'

Semantic Violation:

De formele paraplu staat in de garage.
 'The formal umbrella is in the garage.'
 NB: In Dutch, *formele* is an odd adjective to have with *paraplu*.

Combined Syntactic and Semantic Violation:

Het formele paraplu Staat in de garage.
 'The (wrong gender) formal umbrella is in the garage.'

The results are very clear. The syntactic and the semantic violation effects are not additive. This implies interaction between the semantic integration and the syntactic assignment process. The N400-effect to the semantic violations was clearly enhanced by an additional syntactic violation. This suggests that semantic integration becomes more difficult in the presence of a syntactic assignment problem. In contrast to the syntactic enhancement of the N400-effect, the SPS was not affected by an additional semantic violation. This implies that in the absence of alternative structural options, the syntactic assignment process is independent of the simultaneously ongoing semantic analyses and integration processes.

9.2.2 N400 and SPS during listening to speech

In this study, C. Brown and P. Hagoort investigated whether similar effects to semantic and syntactic violations are observed in speech as in reading. The results showed that both N400 effects and SPS were very similar in the two modalities. In contrast to reading, in speech the N400 effect was preceded by an earlier negativity (N250). This negativity is presumably related to the process of lexical selection, in which context information is used to reduce the set of word forms (lexical candidates) that is activated on the basis of the input signal.

Next to an SPS, two of the three syntactic violations also resulted in a relatively early negativity. This negativity had a (left) anterior distribution. Friederici et al. (1996) have recently proposed that left anterior negativities are only seen in the case of a word category violation. This proposal is not supported by our data, since the early negativity was also seen to a violation of the agreement between the subject noun phrase and the verb, which is a morphosyntactic violation, but not a word category violation.

9.2.3 Discourse effects on parsing

J. van Berkum started his ERP research on referential context effects in parsing. One of the major tasks of the human sentence processing mechanism is to assign a structural analysis to the incoming string of words (parsing). However, because sentences are usually processed word by word, it is often possible to parse the available input in more than one way at a particular point in the sentence. In *Scott told the Martian that...*, for example, *that* can be analyzed as the beginning of a complement clause (e.g., *Scott told the Martian that there was nothing to be afraid of.*), or as the beginning of a relative clause (e.g., *Scott told the Martian that had waved his laser gun to calm down.*). Many studies have shown that the parser, when faced with such a temporary ambiguity, initially commits itself to just *one* structural analysis. In the syntactic ambiguity above, the complement clause analysis is usually pursued first. What is much less clear, though, is what makes the parser prefer one particular candidate analysis over another. Several researchers have argued that, in the case of a syntactic ambiguity, the parser initially only computes the least complex structure. Others have suggested that the parser first pursues the analysis whose structure has the highest frequency of occurrence in the language.

In both accounts, a core assumption is that the parser can only choose between alternatives on the basis of (simplicity or frequency) information defined at the level of phrase structure, i.e., of information within the parser's "proper domain". A third account, however, holds that the parser can also make use of relevant information at the level of the discourse, e.g., information on the set of referents that a noun phrase may refer to. When faced with *Scott told the Martian that...* in the context of *two* Martians, for example, the parser may well prefer a relative - rather than a complement - clause analysis, since a relative clause is often used to

specify the referent more clearly (e.g., *the Martian that had waved his laser gun*).

In collaboration with C. Brown and P. Hagoort, van Berkum is currently exploring the latter possibility by means of ERP methodology. The requirements of ERP analysis necessitated the construction and validation of a considerable amount of material (some 500 stories). A first ERP experiment has been completed. The data are currently being analyzed.

9.3 ERP evidence on the time course of grammatical and phonological encoding during speaking

M. van Turenout continued her research on using ERPs to examine the time course of processes involved in speech production. In a new series of experiments, the lateralized readiness potential (LRP) was used to investigate the time course of grammatical and phonological processing during noun phrase production. The LRP is a movement-related brain potential that is directly related to the differential preparation of response hands.

The subjects in the experiment were presented with colored pictures and they were instructed to name the pictures using a no-determiner noun phrase. On half of the trials a syntactic-phonological classification task had to be performed before naming. This classification task consisted of a conjunction of a go-nogo decision and a pushbutton response with the left or right hand. The decision whether to give a left or a right hand response was determined by the grammatical gender of the noun describing the picture. The decision whether or not to carry out a response was determined by the first phoneme of the noun describing the picture.

The results are shown in Figure 9.3a. An LRP developed not only for go-trials, but initially also for nogo-trials in the absence of an overt response. The go and nogo LRP started to develop at the same rate at 370 ms after picture onset, and after 40 ms they started to diverge. This indicates that the grammatical gender of a word was available to the response system earlier in time than a word's initial phoneme. As a consequence, preparation of response hand could start before phonological

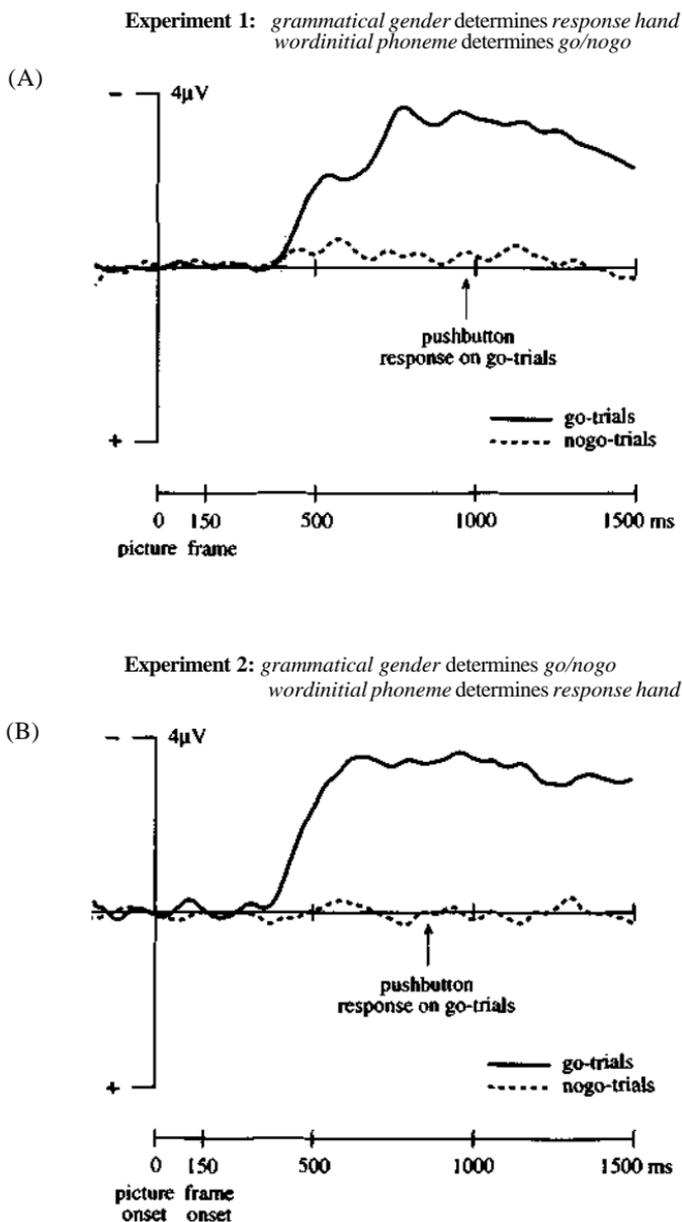


Figure 9.3: Grand averaged LRPs on go- and nogo-trials. In Figure A, the syntactic decision determined response hand, and the phonological decision determined go/nogo. In Figure B, the task configuration was reversed.

information informs a participant about whether or not to carry out the response. In a second experiment, the task configuration was reversed. Now, the word initial phoneme decision determined response hands, and the gender decision determined whether or not a response should be given. If syntactic information is indeed available earlier than phonological information, then an LRP should develop only on go-trials, and not on nogo-trials. As shown in Figure 9.3b, precisely this pattern of results was obtained.

Together, these results demonstrate that during noun phrase production, grammatical processing precedes phonological processing in time. Moreover, the data allow us to speculate that an additional period of at least 40 ms is needed to retrieve a word's initial phoneme once its lemma has been retrieved.

9.4 ERP studies on language disorders

9.4.1 ERP characteristics of open and closed class words in Broca's aphasics with agrammatic comprehension

During 1996 M. ter Keurs completed the ERP data acquisition and analysis of an experiment which focused on the ERP characteristics of open and closed class words in agrammatic aphasics. Their comprehension deficit has been claimed to be related to an impairment in the processing of closed class items.

In the experiment, open and closed class words were presented in a short story, thereby capitalizing on the syntactic function of closed class words (see Annual Report 1995). The data of fourteen agrammatic patients and four non-aphasic patients with a right-hemisphere lesion have been analyzed. On the basis of their results on a syntactic off-line test (see Annual Report 1994), the agrammatic patients were divided into a group of seven High and a group of seven Low Comprehenders.

The ERP results for the control subjects (elderly normals and non-aphasic patients) showed that there are clear electrophysiological differences in the processing of open and closed class words. The agrammatic aphasies

showed a different pattern. Low Comprehenders did not show any significant differences in the processing profiles for the two word types, indicating that in these patients open and closed class words were not differentially processed. The High Comprehenders did show some differential processing, although at a later point in time than the control subjects.

In a follow-up study, open and closed class words are presented in a list. In this way the purely lexical contribution in the ERP processing profiles of open and closed class words can be determined. This will allow a more precise determination of the locus of the processing impairment of closed vs. open class words in the agrammatic aphasics. The ERP data of nineteen normal elderly control subjects are currently being analyzed.

In collaboration with Th. Knösche, D. Stegeman, and G. Uijen (members of the Working Group on Neuronal Source Characterization), a new approach was used for characterizing the neural generators of ERPs related to open and closed class words (see Annual Report 1995). This approach is the minimum-norm least-squares procedure as developed by Th. Knösche (1996) at the Technical University, Twente. This model was applied to the ERP difference waveform of open and closed class words. Initial results show activity from occipital sources for the visual evoked potentials, and in addition activity from fronto-temporal sources, presumably related to the differences in processing between open and closed class words.

9.4.2 Syntactic ERP effects in agrammatic comprehenders

M. Wassenaar completed the ERP data acquisition and analysis of an experiment on on-line syntactic processing in Broca's aphasics with agrammatic comprehension. The data of 10 agrammatic patients, 5 right hemisphere patients, 12 age-matched control subjects, and 12 young control subjects were analyzed. The ERP experiment focused on syntactic integration processes across and within phrasal boundaries, in syntactically simple and complex constituent structures. The subjects were presented with spoken sentences containing violations of phrase structure rules (transpositions of adverbs and adjectives in Adv-Adj-N sequences), and violations of subject-verb agreement.

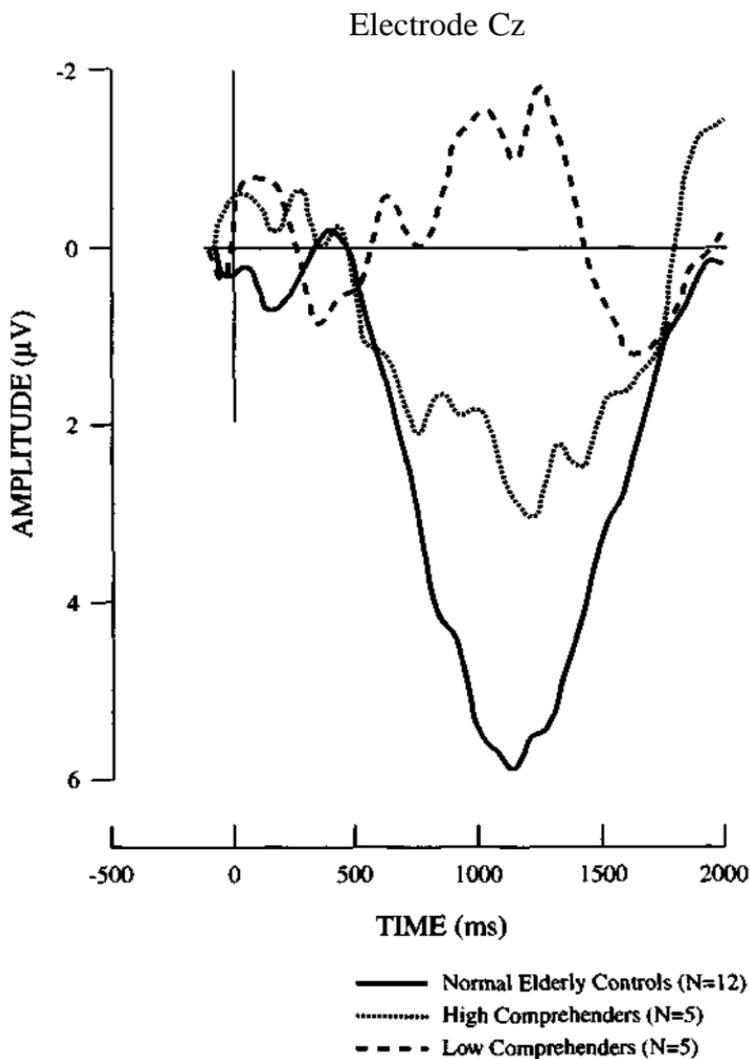


Figure 9.4: Grand average difference waveforms (phrase structure: incorrect minus correct) for one representative electrode site, for Normal elderly Controls (solid line), High Comprehenders (dotted line), and Low Comprehenders (dashed line).

In the control groups (normal elderly controls, young subjects, and right hemisphere patients), SPS (Syntactic Positive Shift) effects were found for the phrase structure and subject-verb agreement violations. The latter effect was not modulated by syntactic complexity.

The aphasic patients were divided into two groups (High versus Low Comprehenders) on the basis of their performance on a syntactic off-line sentence picture matching test (see Annual Report 1994). On this off-line test both the High (N=5) and Low Comprehenders (N=5) showed a significant decrease in comprehension with increasing syntactic complexity, with the Low Comprehenders performing significantly worse than the High Comprehenders. The quantitative difference on the off-line test was accompanied by a qualitative difference in their ERP data. This can be seen in Figure 9.4. The High Comprehenders showed an SPS with the same latency but a smaller amplitude than the control subjects for both the phrase structure and the agreement violations in the simple constituent structure. The effect for the agreement violations in a complex constituent structure failed to reach significance. This pattern of results indicates that the High Comprehenders still have available, at least in part, the processing machinery for the assignment of syntactic structure.

In contrast to the High Comprehenders, some Low Comprehenders showed a delayed positive shift for the phrase structure violations, which indicates a considerable delay in the time course of their syntactic integration. Other Low Comprehenders showed no SPS but an N400 effect instead, suggesting the use of a compensatory semantic strategy for sentence interpretation. In the Low Comprehenders no effects were found for the agreement violations.

In addition, a follow-up experiment was designed and implemented. In this experiment violations of phrase structure rules and subcategorisation violations are embedded in 'syntactic prose' (in our case the constraint that obligatory intransitive verbs cannot take a noun as direct object is violated). Syntactic prose refers to sentences which are semantically incoherent but syntactically legal. The ERP measurements are currently being carried out.

10. The Structure of Learner Varieties

This project involves the cooperation of several European research centers and focuses mainly on second language acquisition (see also previous Annual Report). Two aspects of the research on learner varieties are reported on here: (1) referential movement, that is, the way in which information from various cognitive domains is introduced and maintained in coherent texts, and (2) scope phenomena, in particular focus particles and negation.

10.1 Referential movement

H. Hendriks continued her work on the development of discourse cohesion in child first vs. adult second language acquisition. Part of this work is done in collaboration with M. Hickmann (U. René Descartes), and is jointly supported by the MPG and CNRS. Data used for this project are narratives produced under identical conditions by monolingual 4- to 10-year-olds and adult speakers (English, French, German, and Chinese) and by Chinese adults acquiring German as a second language.

After having analyzed referent introductions (of space and person) in narrative discourse (see previous Annual Reports), Hendriks has now moved on to maintenance of reference to person and space. Once new information has been introduced in discourse, one can refer to it with less "weighty" means, i.e., bare nouns, pronouns, zero anaphora. The more familiar a referent is considered to be in discourse, the easier it is to retrieve for both listener and speaker and the more reduced the referring expression may be. Native speakers of German and Chinese gradually (with age) start using more reduced forms when maintaining reference to person and space. In the child data, ambiguous reference (to person) sometimes occurs as a result of forms that are more reduced than the discourse allows, whereas native adults almost always avoid this kind of problem by a careful choice of the different possible forms. These ambiguities are more frequent for reference to space than for reference to person. In reference to space speakers seem to rely on inferences much more than for reference to person (both when introducing referents and when maintaining reference).

Whereas children sometimes use forms that are too reduced in reference maintenance, adult Chinese learners of German show the opposite usage pattern. It was originally hypothesized that Chinese adults might avoid German personal pronouns, since they mark a lot of information (case and gender) in a complex way that the Chinese speakers are not at all familiar with in their L1. Furthermore, because the Chinese system itself allows high frequency use of zero anaphora, the expectation was that Chinese adults might turn to using zero anaphora (not allowed as frequently in German) to avoid grammatical problems in their German. However, this did not prove to be the case. Adult Chinese learners of German mainly use full nominal expressions when maintaining reference to person and space in German, in contexts where German native speakers would use pronominal forms or zero anaphora. It is concluded that adult speakers use this strategy because they are very aware of the narrative situation of the task (no mutual knowledge), and see the full form as being the only acceptable one to pass on the complete necessary information.

In the domain of temporal reference, Chinese learners of German have to acquire a large number of inflections marking tense. Chinese itself does not possess such inflections, and instead possesses a kind of optional aspectual marking by means of particles. It was found that, at the lowest level of proficiency, the L2 learners look like German native adults, in that they frequently use *Praesens* inflections for all types of verbs and discourse contexts. With increasing proficiency, they start to use more diverse inflections. However, when applying these more diverse forms, they diverge more and more from the target language structure, in which 80% of the forms are *Praesens*. In contrast, their usage is very much dependent on the Aktionsart of the verb, i.e., bounded verbs are always marked with *Perfekt* and *Plusquamperfekt* inflections, and unbounded verbs are frequently marked with the *Praeteritum*. These findings show that, although these adult Chinese learners of German are acquiring more target-like forms, they are nonetheless moving further away from the target language in terms of the function of these forms.

Hickmann's analyses of monolinguals' corpora show that the marking of the given/new distinction is a late development (6/7 years) in all languages. In addition, in languages with relatively little bound morphology for categories like case and gender (e.g. English, Chinese), children reserve clause structure for grammatical organization, relying on

functionally less complex "locative" devices to mark newness, even when they are optional (as in Chinese). In all groups, reference maintenance is determined by two main factors: (1) clause-internal position by syntactico-semantic role, and (2) form by the presence/nature of coreferential relations across clauses. Various referent effects also occur. Thus, newness markings are less frequent with introductions of spatial anchors, which fall into two main types depending on clause semantics (role, predicate) and discourse factors (early/late first mention, grounding): indefinite, nonlocative, static, early, and foregrounded versus definite, locative, dynamic, late, and backgrounded. Finally, crosslinguistic variations in the expression of spatial information show the impact of reference maintenance (reduction of referential forms) and in the richness, compactness and type of predicate information (more static predicates in French and Chinese, and more varied coding of manner, direction, deixis, and cause with location changes in English, German and Chinese).

M. Starren continued her dissertation research (funded by NWO) on the organization of temporality in learner (SLA) and native speaker discourse. In this study it was found (see Annual Report 1995) that Moroccan-Arabic and Turkish learners of French and Dutch (European Science Foundation database) manage to locate an event in time by placing temporal adverbials (T-ADV) in utterance-initial position. In contrast, to specify the duration of the event-time (T-sit, Klein 1994), they put T-ADVs close to the event-specification itself (normally the VP), in a non-initial position which only gives scope over the VP. Further analyses revealed that our Turkish informants utilize the same structural (scope) properties in building up the target morpho-syntactic system for establishing aspecto-temporal reference. The Turkish informants put the 'verbal' aspecto-temporal marker *is* in initial position to locate the whole utterance in time and a second *is* in non-initial position to specify only the event-time:

- (1) *dan is de politie is gaan in die water*
 then is the police is go in that water

Later on in the acquisition process, the initial *is* develops into a present tense marking and is differentiated from the past tense marker *was* which is used to locate the whole utterance in present or past time:

- (2) *toen was die politie pakken hem*
 then was that police catch him

In order to specify only the situation/event time (T-sit), the Turkish learners put the verb-related marker *is* in front of the verb - the event specification - in non-initial position. This non-initial *is* contrasts in later stages with the "verbal" marker *heeft* (from "to have") giving the utterance a perfective aspectual character (in contrast to the imperfective *is* in example (1)):

- (3) *nou is hij heeft gezien die man*
 now is he has seen that man

10.2 Scope phenomena

R. Dietrich's contribution to the Structure of Learner Varieties Project is a comparative analysis of the syntax of negation of Italian learners of English and German. During his visit, he finalised an extended exploration of the German data from the European Science Foundation project *Second language acquisition by adult immigrants*, and the results were documented for cross-linguistic comparison. The main observations are that (1) the holophrastic negation *nein* does not seem to play a considerable part in the acquisition of German sentence negation by adult learners, and (2) that the acquisition of the syntax of negation is a process of continuous differentiation of the parts of speech of the utterance by the learner, beginning by negating the sentence as a whole and ending with the level of lexical constituents.

In a picture description task performed by 40 native speakers and advanced learners of French and Italian, Perdue (U. Paris 8) in collaboration with Watorek (U. Paris 8) examined the distribution and role of the additive particles *aussi/encore* and *anchelancora*. Main structure utterances of such texts relate a *theme* and a *relatum*, as in this French example:

(1) [_{RELATUM}*dans la rue*] *il y a* [_{THEME}*une femme*]
 'in the street there is a woman'

It was found that text coherence typically demands that either the theme or the relatum be kept constant as information is added in the other domain. The particles analyzed reflect this informational structure. The syntactically preferred position for both groups of *native* speakers is post-verbal. In this position, *aussi* ('also'), for example, has wide scope over theme and relatum:

(1') *dans la rue il y a aussi une femme*

In context, however, the information structure, reflected in the topic/focus structure of the utterance, determines whether *aussi* affects theme or relatum. Certain variants of (1') - or its Italian equivalent - make this more explicit - either the relatum in focus (F) appears immediately after *aussi*:

(1'') *il y a aussi [[^]dans la rue] une femme*

or the relatum in topic is left implicit:

(1''') *il y a aussi [_Fune femme]*

The remarkable difference between native speaker and learner performance was the much more frequent use of these variants by the *learners*. These results indicate that even advanced learners tend to give more weight, in constructing their discourse, to topic/focus structure, whereas native speakers tend to use the preferred syntactic position of these particles.

11. Research Group on Structural Grammar

Common ground for the activities of the Research Group on Structural Grammar during its final year was the continuing program on Minimalism and the Lexicon (see Annual Report 1995). This program concerns not only the degree to which properties of lexical knowledge depend on representational economy and parsimonious organization, but also the syntactic and semantic prerequisites and consequences of these conditions. Hence, alongside problems directly concerning the organization of lexical information, questions of its syntactic prerequisites and effects, its abductive interpretation, and its conceptual embedding have also been pursued. Some of these problems will be taken up within the research project Grammar and Ontology, to be supported by the Max Planck Society in 1997-1999, which deals with the type of interpretation associated with categories such as gender or proper names and structural conditions such as argument configuration or scope of modification.

11.1 Reducing lexical information

M. Bierwisch continued research on issues of economy in lexical information. Among the problems he pursued is the question of whether cases like (1a) and (1b), which are in one respect parallel to those in (2), should be accounted for by treating the relation between *bei* and *zu* as an instance of suppletion, comparable to cases like *go* vs. *went* besides alternations like *walk* vs. *walked*, or *bad* vs. *worse* alongside *short* vs. *shorter*.

- | | | |
|-----|----------------------------------|-------------------------------------|
| (1) | (a) <i>Karl war bei mir</i> | 'Karl was <i>at</i> my place' |
| | (b) <i>Karl kam zu mir</i> | 'Karl came <i>to</i> my place' |
| (2) | (a) <i>Karl war in der Küche</i> | 'Karl was <i>in</i> the kitchen' |
| | (b) <i>Karl kam in die Küche</i> | 'Karl came <i>into</i> the kitchen' |

(b) [+Obl] to λx in the Argument Structure $\lambda x \lambda y$ of E elsewhere.

(5a) assigns the Accusative to directional prepositions, (5b) provides the default Dative elsewhere. With these conditions, which allow deviations from the standard pattern only at extra price, (3) can be simplified to (6):

(6) /in/ [-V -N] $\lambda x \lambda y$ [[(FIN) y] LOC [INT x]]

According to (6), prepositions like *in* are optionally directional. If FIN is chosen, the assignment of Accusative follows automatically from (5a). Arbitrary deviations from this pattern would be possible only by special marking. Notice also that the conditions in (5) and entries like (6) do not rely on the use of variables imported from phonology, where they have been dispensed with for independent and significant reasons. This suggests that lexical information should not rely on this suspiciously strong mechanism either. This, however, has interesting consequences for the initial problem concerning the status of *bei* and *zu*. In (4), they have provisionally been collapsed into one entry by means of the a-notation, which presumably should be avoided. This then leads to the following entries, which cannot be collapsed into one lexical item, if the a-notation is not available any more:

(7) (a) /bei/ [-V -N] $\lambda x \lambda y$ [y LOC [PROX x]]

(b) /zu/ [-V -N] $\lambda x \lambda y$ [[(FIN) y] LOC [PROX x]]
 |
[+Obl]

While *bei* does not require lexical Case information, as Dative now follows from (5b), *zu* would wrongly get Accusative by (5a) and must therefore be marked for Dative, which turns out to be lexically marked for *zu* as a directional preposition. With respect to the initial question, we are led, albeit in fairly indirect ways, to the assumption that *bei* and *zu*, in spite of their similarity, are not suppletive realizations of one item, but rather separate, though related, entries. This conclusion is of interest

insofar as it depends on more general observations about the structure of lexical information.

Continuing the search for lexical invariants, J. Dolling dealt with semantic problems of copulative constructions like (1) - (5).

- (1) John is the president
- (2) Fido is a dog
- (3) The dog is an animal
- (4) Mary is intelligent
- (5) The ring is gold

According to traditional views, the type of conceptual interpretation of these examples is fundamentally different. In a rough approximation, the relevant distinctions can be expressed as follows, where terms are given in lower case and relations in capital letters:

- (1'') John IDENTICAL_TO the_president
- (2'') fido INSTANCE_OF dog
- (3'') dog SUBKIND_OF animal
- (4'') mary EXAMPLE_OF intelligent
- (5'') Vx [x INSTANCE_OF gold & x SUBSTANCE_OF the_ring]

Even though Dölling agrees with the assumption that (1) - (5) must conceptually be distinguished along the lines indicated in (1'') - (5''), he argues that this is not based on different lexical specifications of the verb *be*, but follows from independently motivated variations governing the interpretation of the lexically underspecified predicatives. More specifically, the pertinent lexical entries are subject to parametric variation, with particular parameter-values inducing the application of type-shifting operators. On the basis of these devices, which are shown to be necessary for more general reasons, the lexical characterization of the copulative verb *be* is nothing but the link connecting a predicative to the term represented by the subject nominal.

11.2 Economy principles and syntax

Pursuing research into the properties of finite auxiliary verbs (including copula "be"), of elliptical constructions, and of right-left asymmetries, C. Wilder developed an account of contracted and "full" forms of English finite Aux which sheds new light on the notion "clitic" and its role in syntax and phonology. Word order facts, as in (1a), and distributional restrictions - exclusion of contractions from negated clauses, as in (1b), and yes-no questions - have no phonological explanation, but show that contracted Aux is subject to syntactic licensing:

- (1) a. John {s}often {is *'s }in his office
 b. *John 'sn't coming

The property barring the contraction in (1b) is the presence of a syntactic morpheme hosting negation (Laka's S). The basic semantic contribution of this morpheme is to introduce the "alternative propositions" required by yes-no questions and sentences with negated or focused Aux, but not neutral declaratives or wh-questions. The distribution of contractions is additionally governed by prosody; in string final position or preceding an ellipsis site, the full form is required independently of whether £ is present in syntax (2b):

- 2) a. Where's John _ today?
 b. I don't know where John {is / *'s }_ (today).

Such paradigms indicate that, although enclitic on the surface, contracted forms must undergo abstract proclisis, blocked by deletion sites and movement traces. Recent work by Inkelas & Zec and Selkirk shows abstract proclisis to be a general phenomenon applying to function words in the mapping of surface syntactic structure to prosodic structure. Contracted forms are thus subject to three stages of "cliticization": head-movement in syntax, yielding "second position effects" (1a); proclisis in the syntax-prosody mapping; and late phonological enclisis.

Continuing his dissertation, entitled "Generalized Transformations and Beyond", H.-M. Gärtner provides a critical reconstruction of Noam Chomsky's "Minimalist Program" (MIT Press, 1995). Among the more general claims, it is argued that competence theories of natural language syntax do not include economy/optimization principles and that more fundamental issues of simplicity and elegance must not fall into a theoretical vacuum, i.e. into the realm of ill-defined constructs. Consequently, the bulk of the dissertation is spent on elaborating a formally transparent version of minimalist syntax, on the basis of which more conceptual claims could be discussed fruitfully.

Technically, a unification of the traditional base and transformational components of syntax will be presented which (1) side-steps a number of problems inherent in the original minimalist program and (2) raises interesting questions about the level of abstraction which competence theories of natural language syntax should be located at. The latter issue involves: (1) the content of the intuitive notion of positions, (2) the use of set theory in syntactic theories, and (3) the level-specificity of syntactic objects.

Dealing with pronominal clitics in Bulgarian, I. Zimmermann observed that these elements show up in topic positions, their relative ordering corresponding to the unmarked ordering of dative and accusative complements of lexical heads. Pronominal clitics are furthermore shown to cluster with clitic auxiliaries as well as with the clitic determiner. This behavior corresponds to a significant parallelism between the structure of DP and CP with regard to functional categories and the related mechanisms of feature checking.

In another part of her work, Zimmermann compared constructions of German with *so* and relative clauses with *wie*, both of which show up in predicative, modificational, or sentence adverbial function. The syntactic and semantic properties of *so* and *wie* are shown to be the same, but there are special types of semantic composition giving rise to the different readings.

11.3 Accounting for systematic polysemy

Continuing his research on Lexical Pragmatics, R. Blutner aims to give a systematic account of pragmatic phenomena that are intimately connected with the semantic underspecification of lexical items. His approach combines a constraint-based (compositional) semantics with a general mechanism of conversational implicature (see Annual Report 1995). It is currently possible to show how the framework can be used: (1) to treat systematic polysemy and the restriction problem, (2) to give the exclusive interpretation of n-ary disjunctions (McCawley has shown that the traditional approach based on Horn-scales breaks down as soon as we consider disjunctions having more than two arguments), and (3) to give a general explanation for the principle that "unmarked forms tend to be used for unmarked situations and marked forms for marked situations".

A. Strigin worked on his *Habilitationschrift*. The main theme of his work is a theory of abductive interpretation of lexical items facing such problems as regular polysemy, manifest in cases like (1),

- (1) (i) We rose when the queen entered the *room*
- (ii) The *room* burst into flames
- (iii) The *room* burst into applause
- (iv) The argument left no *room* for disagreement

verb alternations like (2),

- (2) Max broke the vase/the vase broke

and the interpretation of adjuncts.

The interpretation of syntactic relations via abductive inference is a natural consequence of the current tendency in linguistics to develop a theory based on optimality assumptions reflecting the fact that the human language faculty is a product of evolution. Abductive interpretation has two aspects: a specification of the hypothesis space, and the specification of the choice criteria for the best interpretation in a context. Strigin's work

is concerned with the first aspect. Maxi-consistent sets are used as a formalism to formulate the relation of interpretation. The hypothesis space is given by the structure of the concepts. This work is a formal explication of many current attempts to cope with the above problems of lexical interpretation. Apart from the work on abductive interpretation his research covers the semantics and the scope properties of adverbs of quantification, e.g. of *twice*, *always*, etc.

11.4 Morpho-syntactic issues of verb phrases

C. Piñón, working as guest researcher, conducted a detailed study of the syntax and semantics of the *existential tense* in Hungarian. The existential tense, unlike the ordinary tenses of Hungarian, has no special morphological marking. It is signalled by (1) strong stress on the verb followed by a falling prosody, (2) the obligatory appearance of the verb's preverb (PV) in postverbal position (if there is a PV), and (3) the optional appearance of the adverb *már* 'already' between the verb and the preverb. Compare (1a), a sentence in the existential past tense, with (1b), a sentence in the ordinary past tense. (Note that " before the verb indicates strong stress.)

- (1) a *Réka"ment(mâr)ki a kertbe.*
 Réka went already out (PV) the garden.into
 'Réka has gone out into the garden (before).'
- b *Réka ki ment a kertbe.*
 Réka went out into the garden.'
 (no reading in existential tense)

Piñón argues that the existential tense has two semantic properties that distinguish it from the ordinary tenses. First, it requires that the time of the event introduced be anchored to a novel discourse marker. Second, it requires that it be possible for an event of the type described to take place in the future. Piñón shows how these two properties predict a range of facts about the existential tense, including the absence of an existential *present* tense, the lack of an anaphoric use, the lack of a bound variable interpretation, the presence of (what he calls) the "extended-now effect",

and the presence of (what he calls) the "singularity effect". To illustrate the last of these, observe that if a sentence in the existential tense describes a type of event that is not repeatable, then the sentence is unacceptable, as in (2a).

- (2) a * *Réka "szu letett {már} Budapesten.*
 Réka was.born already Budapest.on (PV)
 'Réka has been born in Budapest (before). ' [unacceptable]
- b *Réka Budapesten szu "letett.*
 'Réka was born in Budapest.'

(2a) contrasts with (2b), a sentence in the ordinary past tense, which is perfectly acceptable.

M. Steinbach continued work on his dissertation, the focus of which is the so called middle construction:

- (1) a. This bread cuts easily
 b. Dieses Brot schneidet sich leicht

In recent literature, two ways to derive middles can be found: a) middles are derived like passives by means of syntactic A-movement, or b) middle formation is a lexical process of argument suppression. Both theories have various empirical and conceptual problems and make wrong predictions, specifically for middles in German. Furthermore, this restriction to a lexical or syntactic perspective prevents insight into the (discourse) semantics of middle sentences.

Steinbach offers a post-syntactic derivation of middles as an alternative. A lot of different languages "use" reflexive sentences to indicate some kind of valency reduction. Transitive reflexive sentences in German can be interpreted in several ways, depending on the verb and context, - reflexive, inchoative, middle and inherent reflexives - as can be seen in (2).

- (2) a. *Die Kinder waschen sich jetzt schneller* (reflexive or middle)
 'The children wash *REFL* now faster'
- b. *Die Türe öffnet sich leicht* (inchoative or middle)
 'This door opens *REFL* easily/a little bit'

German middles are analysed syntactically as common transitive reflexive sentences. The reflexive anaphor in the position of the direct object is semantically ambiguous between an argument and a non-referential "functional" interpretation indicating valence-reduction. The second, non-argument interpretation leads to the inchoative, inherent reflexive and middle interpretation. In contrast to inchoatives that do not imply the reduced argument, middles have an implicit semantic argument. Additional restrictions on middles can be explained in conceptual and discourse semantics - especially their preference for generic interpretation.

Continuing research on his dissertation project, R. Vogel has been working on topics related to the problem of polyvalent verbs. Such verbs constitute a notorious difficulty for most current conceptions of grammar, where lexical items are treated as the head of phrases and verbs are treated as the head of sentences. Which complements a verb appears with is assumed to result from its subcategorization frame. Polyvalent verbs can appear with a dramatic multitude of different complement sets. Simply listing an extra subcategorization frame for each of these in a lexical entry would not be very helpful and does not provide any explanatory insights. The solution to the polyvalence problem which Vogel is working on is to give up subcategorization in these cases (at least) and to elaborate conditions licensing the appearance of the diverse complement types independent of the phrasal head, i.e. the verb. Within this perspective, Vogel was concerned in the last year with the German case system in general, and the properties of the German dative object case in particular.

12. Other Research

12.1 Aphasia

12.1.1 Conversation analysis of aphasic talk-in-interaction

C. Heeschen focused on the analysis of episodes from video-recorded ordinary conversations of non-fluent aphasics with a close confidant. These investigations were motivated by the question of the interactional function of telegraphic style as used from time to time by agrammatic patients. The investigations were carried out within the methodological framework of Conversation Analysis (CA). Most of the analyses were done together with E. Schegloff (Department of Sociology, UCLA). The CA-method brings about certain consequences for the course and progress of research which need a brief comment. Firstly, the emphasis on details and the postulate not to disregard any detail as *a priori* irrelevant makes it impossible to arrive at generalizations in the early phases of the data analysis. The best that can be achieved are some focused questions or very cautious hypotheses. Secondly, one has to remain aware that the gradual accumulation of conversation-analyzed data can lead to the necessity to differentiate or even completely revise some generalizing hypotheses even if they had been put forward in a very cautious way. Thirdly, the analysis might provide certain observations leading to new focused questions which were originally not of central interest.

In 1996, episodes from conversations of a patient A. were given detailed attention. Patient A. (female) could be recorded once in conversation with her husband and the other time in conversation with her closest (female) friend B. Patient A. has a fairly mild agrammatism and she has never used telegraphic style in informal exchanges with an aphasiologist (mostly Heeschen) or in conversation with her husband or her friend B., with one notable exception.

In one episode, A. suddenly changes her usual way of speaking and produces telegrams or fragments which are not even turn constructional units because they lack a recognizable completion point. Her expressions consist mainly of isolated NP's and PP's. In this episode, A. launches a story about a robbery having taken place recently in the neighborhood of her own and B.'s homes. The sudden use of fragmentary/telegraphic style prompts B. immediately into very active co-construction which goes so far that parts of the story are told by B. on A.'s behalf. The fact that A. changes over here to telegraphic style might have to do with the fact that story telling is a particularly difficult task for agrammatics because it requires one to construct temporal and logical order - a task for which A. needs extensive co-constructive support from the co-participant. And indeed she gets this support, but in a way which makes use of quite ordinary interactional practices, thus avoiding embarrassment to the patient since such practices do not underscore her deficiencies.

In fact, B. never constitutes A. as "disordered", or at least minimally so. This is quite different in the conversation of A. with her husband who behaves like a therapist, underscores A.'s problems and thus constitutes her openly as "disordered"

To give a cautious summarizing hypothesis (or focused question): telegraphic style might have the advantageous interactional function of prompting the co-participant into very active co-construction. This makes us understand why this style is used by A. only when the task is especially difficult. However, she avoids telegraphic style, even in a difficult task, when she has good reasons to expect that her co-participant(s) would support her in a way which would institutionalize her as aphasic.

Analyses of the conversations of two further Broca-patients give support to this hypothesis, but also show the need for further differentiation.

12.1.2 Elliptical strategies and grammatical errors in aphasia

Although agrammatism manifests itself differently across languages, syntactic simplification is considered a key symptom. J. Christiansen, in collaboration with Heeschen, analyzed speech obtained in informal exchanges between aphasiologists and English- and German-speaking patients with agrammatic Broca's and paragrammatic Wernicke's aphasia to determine: (1) whether the agrammatic patients produce simplified utterances which obey the rules of simplification offered in their various languages, i.e., rules for situational ellipsis, and (2) whether differences in rules governing normal ellipsis across languages can account for much of the differences seen in agrammatism (see Annual Report 1995). Preliminary results indicate that agrammatic patients do tend to simplify their utterances using rules for normal ellipsis, however, such simplification cannot account for other errors, such as improper marking of aspect in English. Christiansen proposes that agrammatic Broca's aphasics are limited in formulating micro-propositions at the level of message generation. Such limitations cause micro-propositions to lack higher level information, such as tense, aspect, assertion, and topicalization. In grammatical formulation, omitted propositional information would either not be processed or would be filled in by applying a default rule. This hypothesis would account not only for the elliptical simplifications and grammatical errors seen in Broca's patients, but also for their limited flexibility in using a variety of grammatical constructions.

12.2 Child Language Acquisition

12.2.1 Acquisition of irregular past participle forms in German

While a visitor at the Institute, K. Lindner completed a study on overgeneralizations. The study examined variation among children's productions of irregular past participle forms in German which recent studies had said did not exist. The findings speak to the contrary. The study analyzed the development of past participles of particular high frequency verbs from

a longitudinal study of a child aged 1;3 - 2;5 (cf. Elsen 1991) and from cross-sectional data (experimental and natural) from 60 children aged 2;2 - 6;11 collected in a research project in München (financed by the *Deutsche Forschungsgemeinschaft*). Four factors were identified as influencing children's productions. First, past participles of high frequency verbs are over-generalized if the verb stem of the past participle is homophonous with that of the present tense or infinitive stem. A second factor is "gang effects" leading to analogical formations. A third kind of influence comes from other forms of the same paradigm, resulting in blends. Last, but not least, there is evidence that children's formation of the "perfect" is influenced by other syntactic patterns, here the modal verb construction. These findings are in line with the current connectionist view that children's productions are due to internal reorganizational processes.

12.2.2 Acquisition of Russian aspect

S. Stoll continued her dissertation research on the acquisition of Russian aspect. The underlying question of this research is whether, and to what extent, semantic, morphological or conceptual predispositions play a role in the acquisition of aspect. The project is designed as two independent studies, an experimental part and an observational part. Five children have been studied on a longitudinal basis (with weekly to bi-weekly video-taping over almost 2 years by now). The dissertation starts from the assumption that in order to get an adequate picture of the aspect acquisition process, one needs to distinguish several levels of event complexity on which aspect plays a role. Stoll distinguishes three levels:

- Level 1: The use and the comprehension of aspect markers in the description of a single event, independent of other events.
- Level 2: The use of aspect in the description of a more elaborated event, where the same action is repeated several times until a resolution is achieved in the end.
- Level 3: The use of aspect in a text.

To investigate these three levels, Stoll designed and conducted four experiments. The results of a comprehension experiment assessing level 1 (see Annual Report 1995) show that aspect marking is not generally understood by children from the very beginning and hence aspect is not a primitive or innate category. Rather, it could be shown that *Aktionsart* (temporal classes of verbs) plays a major role in the understanding of aspect. In order to test level 1 further, a production experiment with similar materials to the comprehension experiment (little puppets acting out different scenes on video) was conducted. Level 2 was investigated with a production experiment, in which the children retell short video cartoons. Level 3 was studied with two picture books which proved useful for the investigation of aspect.

12.2.3 The CLPF corpus of Dutch infants' utterances

With help from B. MacWhinney (Carnegie Mellon U.), C. Levelt has made available, through CHILDES, the data which she and P. Fikkert (U. Konstanz) collected for their dissertations. The CLPF corpus, as it is called, is the first phonetically transcribed corpus to be entered into CHILDES, and it is specifically intended for phonological research. It contains about 20.000 phonetically transcribed utterances of twelve children acquiring Dutch as their first language. At the start of the data-collecting period, these children were between 0;11 and 1;10 years old. A sound tier is now being added to every entry in the corpus so that for every utterance the actual acoustic information will be available.

12.2.4 Inuktitut child-directed speech

In joint work with M. Crago (McGill U.), S. Allen investigated vocabulary use and affixation in Inuktitut child-directed speech. Analysis involved 911 utterances from 4 mothers directed to children aged 1;9 - 2;1, and 112 utterances from the same mothers directed to adults, in naturalistic communication situations.

Inuktitut has a small but frequent vocabulary of "baby words" (distinct from adult equivalents) used by and to children under the age of 3 years, including words which may use simple phonemes (*maa* 'kiss'), reduplication (*uu-uu* 'be hot'), onomatopoeia (*vuvu* 'vehicle'), and free use across grammatical categories (*apaapa* 'food, eat'). Some 30% of mothers' verb and noun roots in child-directed speech are baby words, while no baby words are found in adult-directed speech. Inuktitut also relies heavily on affixation for both morphological and syntactic purposes. Mothers tend to use an average of one less affix per noun and verb root in child-directed speech than in adult-directed speech. Additionally, mothers produce bare verb or noun roots in 20% of cases in child-directed speech compared with only 4% of cases in adult-directed speech.

Results indicate that Inuit mothers speak differently to very young children than to adults by using more baby words, less affixes per root, and more bare roots. The vocabulary difference does not necessarily indicate simplification since less than two thirds of the baby words used represent phonological simplification, and since the child must eventually learn the adult equivalents for the baby words. The morphological difference does suggest simplification, but not of the most extreme degree possible. Thus, Inuit mothers are certainly distinguishing their language to children as special, though not masking the morphological complexity that is an integral part of Inuktitut.

12.2.5 Inuktitut monolingual and bilingual acquisition

During her visit to the Institute, Crago's research centered on her continuing work on monolingual Inuktitut and bilingual English/Inuktitut acquisition by very young Inuit children of Northern Quebec. This acquisitional work, done in collaboration with Allen, is based on longitudinal speech samples and focuses on morphosyntactic development. Additional aspects of the research include interviews and videotaped data concerning language socialization issues in homes of bilingual families as well as "Frog Story" narratives produced by school-aged children.

F. Genesee spent four weeks at MPI and worked on two projects: simultaneous acquisition of Inuktitut and English or French by infants, and language acquisition and maintenance in language/culture contact situations involving indigenous and non-indigenous groups. The first project included collaboration with Allen and Crago and is part of a multi-year longitudinal study on interdependence and autonomy in syntactic development of infants learning two languages simultaneously. This project is an extension of Genesee's research on French-English bilinguals and of Crago and Allen's work on acquisition of Inuktitut by monolinguals. The second project was done in collaboration with Crago and entailed the integration of data and the preparation of a book chapter on language development in communities where there is contact between indigenous and non-indigenous language groups.

12.3 Language shift and bilingualism

While a visitor at the Institute, M. Fortescue continued his work on the normal versus non-normal transmission of Eskimo and Chukotkan languages. This is part of a long-term project, nearing completion, in which the nature of the spread of these and other Arctic languages from Siberia towards Alaska has been investigated in terms of both historical and typological relations. The disjunction between the linguistic picture and the ethnic populations speaking these languages in the Bering Strait region today is stressed. The mechanisms of language switch and bilingualism play a central role here, and the latter topic in particular meshes with Allen's on-going concern with bilingualism in the Canadian Arctic. Some of the reasons why language shift should be so prevalent in the Arctic and why stable bilingualism has only been attained in Greenland are considered. Several scenarios for normal types of language transmission in the Arctic - perfect transmission, gradual normal shift, and abrupt normal shift - are compared with a rare case of actual "abnormal" transmission (Copper Island Aleut Creole), and the types of interference effects relatable to each scenario are distinguished. The situation reconstructed for the past in the Bering Strait region is compared to the modern, post-

colonial situation. Emphasis is placed on the perspective of the individual child learner involved in these various processes.

12.4 Factors determining the use of epistemic expressions

J. Nuyts (U.Antwerp) and W.Vonk have concluded their experimental investigation of the role of information structure (saliency of parts of information) in the use of epistemic expressions (EEs: adverbs, predicative adjectives, mental state predicates, auxiliaries). Speakers turn out to rarely focalize an EE. They even avoid doing this in conditions in which the evaluation of a state of affairs is central. In the rare instances in which they do focalize the EE, however, they use predicative adjectives. Adverbs and auxiliaries typically occur when the state of affairs itself is focal; mental state predicates are the preferred form when positive or negative polarity is focal.

Nuyts and Vonk have also started an investigation of the role of evidentiality in the use of EEs. A first experiment investigates the nature of the dimension of "objectivity vs. subjectivity" determining a speaker's selection of specific EEs. Does this involve (1) the quality of the evidence for an epistemic evaluation (good vs. weak evidence) or (2) the question of whether the speaker assumes strictly personal responsibility for the evaluation as opposed to sharing this responsibility with others (intersubjectivity of the evaluation)? Or both? This experiment is in the stage of data gathering.

12.5 Morphology

12.5.1 Corpus-based study of the Dutch suffix *-heid*

In collaboration with A. Neijt (U. Nijmegen), H. Baayen carried out a corpus-based study on how morphologically complex words with the Dutch suffix *-heid* are used in context. The Dutch suffix *-heid*, like *-ness* in English, forms abstract nouns from adjectives. Baayen and Neijt explored the hypothesis that *-heid* gives rise to two kinds of abstract nouns: nouns describing concepts, and nouns referring to states of affairs. An examination of a corpus of newspaper Dutch reveals that the referential function of *-heid* is typical for the lowest-frequency words, most of which are neologisms. Conversely, its conceptual function is found predominantly among the highest-frequency words. Detailed investigations of the use of these two sorts of words in context showed that the high-frequency words tend to be less well anchored in their context than the low-frequency words, and that they pattern more as independent units. These data argue against the view that productive word formation goes hand in hand with the absence of any storage of full forms in the mental lexicon. Instead, Baayen and Neijt claim that high-frequency formations with the productive suffix *-heid* are available in the lexicon, whereas low-frequency words and neologisms are produced and understood by rule.

12.5.2 Lexical innovation in English

A. Renouf (U. Liverpool) and Baayen continued their research on lexical innovation in English. In their previous work (reported in *Language* 72, 1996) they focused on five well-established English affixes (*-ness*, *-ity*, *-ly*, *un-*, and *in-*). Currently, they are investigating the productivity of vogue morphemes in British English. One of their findings is the emergence of a new suffix, *-type*, which attaches both to nouns and adjectives to form adjectives (*permanent-type*, *endowment-type*). This suffix, which has thus far escaped the notice of the lexicographers of the

Collins and Cobuild dictionaries, gives rise to longer series of hapax legomena than the well-established suffix *-ish*, which suggests it is more productive. Another affix that clearly emerges from their data is *mock-*. The dictionaries mention *mock* in the context of phrases (*mock Tudor* or *mock battle*). Its use as a prefixed form that attaches to nouns (*mock-denials*) but also to adjectives (*mock-diffident*) has gone unnoticed. Finally, their data illustrate ongoing grammaticalization for *-shaped*, which attaches to nouns to form adjectives, but which also occurs without *-ed* as in *hipster-shape*. Here, *-shape* is emerging as a category-changing suffix, following the same route as the (unproductive) suffix *-ship*, from Old English *scipe* 'shape'.

12.5.3 Calculus of features in Lexical Conceptual Structure

R. Lieber (U. New Hampshire) and Baayen continued their investigation of lexical conceptual structure. They investigated auxiliary selection in Dutch, claiming that a key role is played by a semantic feature, IEPS (an acronym for "Inferable Eventual Position or State"). Lieber and Baayen argue that only verbs which are [+IEPS] select the auxiliary *zijn*. They are currently developing a calculus of features to characterize those aspects of lexical semantics that are relevant to syntax and morphology. An important desideratum of such a system is that it should capture generalizations across lexical categories. Lieber and Baayen have developed a prototype system in which a semantic feature such as [+/-dynamic] generalizes to both nouns and verbs, and in which a feature like [+/-IEPS] similarly plays a role in the lexical conceptual structures of both verbs and prepositions.

12.5.4 Cross Domain Allomorphy in Tzeltal

L. Walsh Dickey carried out morpho-phonological work on the Mayan language Tzeltal (Slocum 1948, *UAL*; Kaufman 1971, *Tzeltal Phonology and Morphology*; Brown 1996, field notes) as part of an examination of the typology of allomorphic relations between stems and affixes. Tzeltal was

analyzed to show that stem prosody can determine the segmental structure of an affix (Cross Domain Allomorphy). Phonologically conditional allomorphy is when the shape of an affix depends on the shape of what it attaches to. An affix's segmental shape can be determined by the segmental shape of the stem (e.g. Georgian, Dutch) or its prosodic shape can be determined by the prosody of the stem (e.g. Dyirbal, Tagalog). What has not been discussed in the literature are cases of allomorphy being determined across the segmental and prosodic domains. With help from the fieldwork of P. Brown, Walsh Dickey demonstrated that Tzeltal provides just such a case of Cross Domain Allomorphy.

Transitive verbs in Tzeltal can take the perfective suffix /-Vh/. When the stem is monosyllabic, the suffix vowel is [o].

| | |
|----------|------------------------|
| ja s-mah | 'he hits something' |
| s-mah-oh | 'he has hit something' |

When the stem has more than one syllable, the suffix vowel is [ɛ].

| | |
|-------------|-----------------------------|
| ja s-majlij | 'he waits for someone' |
| s-majlij-Eh | 'he has waited for someone' |

Walsh Dickey demonstrated that this alternation is due to the syllable count of the stem determining the vowel quality of the suffix. She showed that this alternation is not a question of morpheme count, nor is the vowel change triggered by the stem consonant; the allomorphs do not have any distinct semantic connotations, nor is there in Mayan any sound symbolism associated with this morpheme. The vowel change also cannot be accounted for with stress or footing. The vowel alternation seen in this Tzeltal suffix is due to syllable count. Tzeltal -oh/-Sh allomorphy demonstrates four things. First, the possibility of segment-prosody interaction in allomorphy (Cross Domain Allomorphy). Second, the need for phonological rules and constraints to be able to refer to both prosodic and segmental domains at once. Third, that models of speech production must allow prosodic and segmental information to interact in morphological

and phonological encoding. And finally, the reality of the unit of the syllable in morpho-phonological processes.

12.6 Formal semantics

12.6.1 Procedural semantics

Dynamic approaches to semantics have in common that they presuppose the notion of a state. This holds of, e.g., Context-fixing semantics and the different varieties of Dynamic Semantics. However, Dynamic approaches to semantics differ with respect to what is identified as a state. In Dynamic Semantics, a state is identified as an assignment to variables, but it is the change of constants that is essential for the success of actions.

In state transition semantics (STS), developed in Bottner (1992), the states of an agent's internal registers were used to characterize natural language meanings. In the standard application, this works for expressions referring to internal actions like, e.g., perceiving or remembering, but does not work for actions effecting a change of the environment like, e.g., writing. STS was modified such that input and output states can refer both to internal registers and to external entities.

12.6.2 A constraint-based account of logical connectives.

E. Pederson conducted an initial survey of truth-functional connectives using informant data from Japanese, Tamil, and Dutch, and grammatical descriptions from Diyari, Yucatecan, and Navajo. Certain connectives commonly recur cross-linguistically, others occur only occasionally, and still others may never occur. To account for this apparent distribution, Pederson hypothesizes a set of four violable universal constraints governing the (apparent) distribution of connectives in natural language: *Avoid truth-functional irrelevance* (*TTTT, *FFFF, *TTFF, *FFTT, *FTFT, *TFTF), *avoid segregation* (*FTFF, *FFTF), *avoid implicit negatives* (*-T--, *--T-), and *consequent dependence* (*-TF-). Here, "-"

represents a variable value. The degree of constraint violation for a connective determines its probability of occurrence.

Even a simple additive sum of these constraints makes clear predictions. For example, three forms of disjunction (defined here as -TT-) should be found: *exclusive* (FTTF), *inclusive* (TTTT), and what Pederson terms *dubitative* (FTTT). Despite a wide literature on disjunction, there is essentially no discussion of dubitative connectives. In contrast, the current model predicts that dubitative disjunction should actually be fairly common. Western logical traditions place a prominence on exclusive and especially inclusive disjunction such that dubitative constructions could be easily misdiagnosed. This certainly has been done for the Tamil affix -*oo* (an n-place disjunction), and perhaps in several Australian languages as well.

A final semantic typology of truth-functional connectives requires more cross-linguistic data. In the meantime, this model makes clear predictions about the distribution of TFCs which can help guide more systematic exploration of language samples.

12.7 Parafoveal preview and the saliency of word beginnings.

When readers parafoveally preview the next word, the processing time needed for that word is shorter than when there is no preview. A preview benefit is also observed for the movement of the eyes (e.g., for landing position within a word), but only with respect to low-level parafoveal cues, such as word length. Most models state that there is no role for higher-level information in eye guidance. Recently some results indicated that the information distribution in a word partly determines the landing position, but these results are highly controversial. W. Vonk, R. Radach (RWTH Aachen) and H. van Rijn (U. Nijmegen) collaborated in investigating whether the saliency of the beginning of a word (initial trigram token frequency) affects the landing position in that word. The target

words were short nouns (5-6 characters) or long nouns (10-12 characters), embedded in the second line of two to three lines texts. Because pattern and type of fixations influence the perceptual span, the nouns were preceded by the same determiner and adjective (4-8 characters) in within-item conditions. Context was another factor in the design (target plausible, but not predictable from sentence context vs target plausible and moderately predictable from sentence context). Preliminary analyses show a small effect of initial trigram frequency on landing position, over a range of launch positions. There was no effect of sentence context on the landing position in the word, but context affected first fixation duration, and number of fixations and gaze duration. Further experiments are being carried out to check the reliability of the observed effect of the saliency of the word beginning.

OTHER ACTIVITIES

Activities of the Technical Group

General

In 1996, the general service with respect to technical facilities was further improved. The integration of more state-of-the-art network printers removed sources of frustration for users. For guests, a quick and small starter guide was made available to help them easily find their way around the systems. As well as improving support, time was also spent on developing new methods, software, and hardware. A new structure for an administration database was designed to even better administer the increasing amount of equipment and parts.

The Technical Group was also heavily involved in planning the local area networking and experimental/observational facilities in the new building and the temporary container building.

MEID/WWW

The MEID system developed at the institute was one of the first examples of a well designed (and well accepted) Intranet. The WWW-technology was adopted to present internal information of various sorts. It still is heavily accessed (about 500 requests per day). The success of MEID can be attributed to two aspects: (1) The user-interface of WWW-browsers was immediately understood by everyone due to its motivated and transparent (iconic) design and (2) the user-interface is available on all platforms in almost the same design format.

The electronic guide about technical facilities within MEED was completely checked and revised to keep the information up-to-date. Further, the MEID system was expanded such that it now covers the following information:

- electronic guide of the TG
- quick starter guide for guests (also available as hardcopy)
- update bulletins of the TG
- electronic guide of the library
- actual notes and general information
about the Neurocognition Research Group
- agenda facility with meetings, lectures and other events

The first home-page of the institute was designed and implemented and is now available to the outside world on the WWW. It is intended to give basic scientific and administrative information about the institute to those on the internet who are interested. It is installed on a separate UNIX computer to achieve a convenient and secure separation from the MEID Intranet system.

Systems

The pressure to buy new more powerful computers is currently especially high. This has to do with new operating systems such as W NT and W95, but also with more demanding application programs. Therefore, the institute bought new PCs, PowerMACs, Unix Workstations (standardized to HP and SGI), and Novell- and UNIX-servers. Due to some redundancy with respect to the servers, the down-times were significantly reduced.

The network printing facilities were extended by new fast b/w laser printers and a color laser printer. Besides improving the printing services by providing more redundancy and more reliable printers, further functionality was provided by the introduction of DINA3, 1200 dpi resolution, and color laser printing. A direct comparison between several color laser printers resulted in the selection of the new Tektronix Phaser

550 as the most optimal solution for our applications, which are mainly brain images, photo-style pictures, computer-created animations, and color plots. However, for real photos, the quality is less than with dye sublimation printers, but is still satisfactory.

PCs were equipped with W95 and W NT. W95 is the only operating system offered on new Notebooks and was required by a number of applications. W NT is seen as the successor of MS Windows. PCs with both operating systems were hooked up to the Novell-based PC-network without problems. A CD-ROM-Writer was bought and installed.

Local Area Network (LAN)

In preparation for the move of the institute in December, and due to increased bandwidth requirements, the institute designed a new local area network. Although we believe that ATM will be the optimal choice for multi-media or other constant bit-rate traffic, the institute voted for a Fast-Ethernet-based installation which can be smoothly upgraded to ATM if necessary. We opted for providing over-capacity for constant bit-rate applications (multi-media and speech traffic) by providing dedicated Ethernet or FastEthernet lines. The center of the future LAN will be a fast Cellplex switch (3Com) which will be managed by the Open View software from HP. First tests with this switch were carried out.

An IP-number problem, caused by a dramatic increase in IP-nodes, was solved using the IPX-to-IP Gateway software from Novell. Furthermore, a new communications server offering analog and digital (ISDN) modem lines was installed to improve access to institute facilities from outside the institute.

Eye tracking labs

Here again, much preliminary development work was carried out. For the first eye tracking lab (see Annual Report 95), the definitive versions of the

text editor/generator and the stimulus presentation program were finished. The text editor/generator can also be used for NESU-controlled experiments. It now accepts tagged texts and can convert them to displayable images and analysis objects, and has become a flexible tool to create textual stimuli of all sorts.

Two new eye trackers were bought and installed, because the first eye tracker (AMTECH) cannot be used for some of the new projects, and also because it is almost continuously booked. From broad market research, it turned out that there was no one unit which could fulfill all requirements, except for units that were very expensive and difficult to handle.

One of the new eye trackers will be used to register eye movements during reading and object recognition tasks. The stimuli are presented via computer display. In the end, the institute decided to buy a newly developed eye tracker from SMI (Berlin-Teltow) which uses 4 markers to do direct on-line head movement compensation. This tracker has a high spatial and temporal (250 Hz) resolution and creates a stream of calibrated data. The TG integrated this tracker to the general experimental setup (NESU).

The second of the new eye trackers will be used by the Cognitive Anthropology Research Group to observe subject behavior in various tasks where real objects have to be named and selected. Here, a helmet-mounted eye tracker was chosen (SMI) which creates an overlay from the scene camera image and the eye movement pattern. Therefore, with the help of video analysis tools (see TED and MT), it will be possible to determine which objects the subject fixates on when carrying out a task.

Experiment labs

The powerful and flexible NESU experiment specification and execution software which was developed in the institute was expanded to support more types of experiments. It was connected to the ERP-labs, the child lab, an fMRI lab, and the new eye tracker (see above). That is, with the exception of the gesture lab, NESU is now used to control all

experimental setups at the institute. In the ET-Lab, ERP-lab and child lab, NESU is used to display the stimuli, measure reaction times and behavior, and control various experimental devices.

The integration of one of the new hard-disc video recorders (Digital Graffiti) now allows for carrying out experiments which require the presentation of video scenes in random order. This integration to NESU was carried out by adding a driver which transfers function commands generated by NESU to the standard RS422 commands (Sony protocol).

A new speech server to allow random presentations of acoustic material was tested and is being integrated. In contrast to the existing speech server, the new speech servers completely rely on off-the-shelf technology, i.e. laptops and standard sound cards. From several candidates, a sound card was selected which offers an acceptable level of crosstalk noise and a high signal-to-noise ratio (>70 dB). Two SpeechServer configurations are possible: (1) A sound card is added to the NESU host. In this case, the bus will be claimed for short moments when speech buffers are transferred. These effects are dependent on a number of parameters, but the integration can be done in such a way that the influence on experimental timing is negligible. So, for most experiments, this solution will not cause trouble. (2) A sound card is hooked up to a separate PC/Laptop which is controlled by the NESU host via a standard serial line connection (currently there is no PCMCIA card or direct circuitry on the motherboards which meets with our quality requirements, therefore we can't use notebooks). This second solution is the best one for experiments where very precise timing is required.

In parallel to expanding and supporting the current DOS-based NESU program, the TG is preparing a port of the NESU software to Windows NT which we see as the "standard" for the coming decade. The structure of W NT has been investigated in detail, first reaction time measurements with prototype drivers have been carried out, and the driver construction was studied. The measured delays were so small (far below 1 msec) that we felt encouraged to go ahead. This work is seen as very important for conserving the time investments in NESU for the next decade. NESU is

currently being used by approximately 30 other scientific sites world-wide.

Computer-Assisted Video Analysis (CAVA)

The CAVA project of the TG, which already started two years ago now, came to a point where highly integrated tools are available for the scientific users. For fieldwork and quick data entry, the notebook-based Transcription Editor (TED) program is available. It allows the user to control video devices by mouse operations and to enter pre-defined codes describing, for example, gestures and speech acts. TED was ported to Windows and W 95 and it can also control the new hard-disc video recorders, enabling random access to video frames. TED can export its code to a central database which was implemented using the relational database Oracle. Several coding projects have already been carried out using TED. Although TED and the database were developed for coding gestures and speech acts, their design is so flexible that it can be easily adapted by the user for other types of codings as well.

The central database currently incorporating codings of gesture and speech acts has got a user friendly interface enabling the user to generate queries such as "give me all instances where the subject utters a verb and makes an up-down hand movement". The result of this query is a list which can either be analyzed with the help of statistical packages or which can be passed through to the MediaTagger program running on Power-MACs. The database is programmed in client-server style, i.e. the database runs on central UNIX servers and the user interface is running on all platforms (MACs, PCs, and UNIX).

MediaTagger (MT) is a multi-media system which allows the user to look at video scenes in random order and at the corresponding code tracks in a synchronized manner. This only holds for video scenes which were digitized and compressed beforehand and are available from the video archive either on the MAC itself (limited amount of video data) or on the network servers. MT's design allows the user to implement an incremental

coding strategy, since he/she always has access to the original video material. When expanding or correcting the codes, MT can either work only locally or in synchronization with the database. In the latter case, all modifications will be directly input to the database if wanted. Of course, MT can read in existing codes from the database and, therefore, code which originally was created with the help of TED. MT was debugged and extended considerably in 1996 so that it can now be called a very flexible and mature research tool. Currently, 50 movies with a mean duration of 10 minutes and some gesture databases have already been examined using MT. A time-line viewer was added which allows the user to get an overview of all coded events and their corresponding codings. The user can zoom in for a more detailed analysis and can always switch back to MT or the database for analysis or query generation.

Two main problems are currently being dealt with in the CAVA project. First, the total amount of digitized video data will increase dramatically. Therefore, an archiving system is under development which includes Hierarchical Storage Management systems, including either tape or MOD storage media with large capacities. The second problem concerns video resolution of compressed material. Currently Cinepak data compression is used which yields about 500 kB/s. The corresponding resolution on the MAC-screen is not high enough for detailed studies, i.e. it is difficult to accurately identify finger movements or gestures. A new board was bought which does real-time MJPEG decompression. MJPEG compression yields about 2 MB/s and results in a much better video quality. However, MPEG coding with about 300 kB/s transfer rate is also a serious alternative.

Video equipment

A new hard-disc video recorder was tested. It will influence the way video material will be analyzed, since it allows random access to frames. The FAST Video-Machine (FAST Electronics, see Annual Report 1995) was finally ready for use in scientific research. It turned out that the users prefer to work with such a PC-based editing suite instead of the old ones based on special hardware designs.

Software

With the help of the TCL/TK toolkit, the first platform-independent version of the originally complex and buggy Childes editor (CED) was created. A final version, including the Spoken Childes feature (access to sound), will be developed in 1997.

The data generated by the Articulograph (Carstens) can now be analyzed with the help of the standard speech analysis tool XWaves. A data conversion program and some functional additions to XWaves had to be programmed.

The MEG data produced at the MEG center in Helsinki was converted to an internal format and a plot and analysis program was developed in DDL.

A new version of the library database BISLOK (V 3.0) was installed.

For field usage, text randomization and presentation programs were created and a new Shoebox version was installed.

Automatic speech recognition

The TG also worked on preparations to develop a real-time word spotter by at first using hybrid speech technology developed at the university in Mons (Belgium). The software was ported to HP-Unix and different models (discrete HMM, continuous HMM, hybrid ANN/HMM) were successfully tested with the TIMIT database. Currently, two tasks have the highest priority: (1) organizing the Dutch SpeechStyle-Corpus (about 20 h speech) so that it can be used for training purposes, and (2) assembling a domain-specific training corpus (about 10 h speech) which can be used for domain-specific training. An analysis of the orthographic transcription of the SpeechStyle-Corpus resulted in a first lexicon. This was both cross-checked with CELEX and checked manually. The CELEX phonetic transcriptions of words together with an initially linear segmentation will be

used to train the speech recognizer. Attempts to port already existing acoustic models have failed until now. This was mainly due to the different recording characteristics.

Under the wing of the TG, two Master's thesis projects were finished in the area of speech recognition using artificial neural networks: (1) M. Zander (U. Kiel), "Optimization of the representation of spoken words in a model of spoken word recognition", and (2) M. Dashorst (U. Twente, Enschede), "Designing a fine-tuning algorithm for the RAW speech recognition model".

CELEX: The Center for Lexical Information

At CELEX, the Dutch Expertise Center for Lexical Information, work continued on the German database, thanks to a one-year grant awarded by the Dutch Organization for Scientific Research (NWO). With R. Piepenbrock acting as CELEX project manager, the further elaboration of the German lexicon was carried out by A. Krott, who after graduation from the University of Trier was appointed as a full-time collaborator in December 1995. Krott started out by thoroughly examining version 2.5 of the German database, especially concentrating on safeguarding consistency in the morphological derivation and decomposition procedures. She also generated all possible inflected participial forms for the verbs in version 2.5. After that, 2000 high-frequency words (from corpora supplied by the *Institut für Deutsche Sprache (IDS)* in Mannheim) were added for the projected version 3.0, and these were subsequently enriched with full orthographic, phonological, morphological and syntactic features.

Meanwhile, a number of software modules were either written from scratch or expanded to assist in the process of deriving German lexical features, such as a syllabifier, a grapheme-phoneme converter, a morphological parser and a syntactic tagger. Additional text corpora were again generously supplied by the IDS, amounting to a total of 28 million tokens,

which will further help us to make the lexicon a more representative and up-to-date reflection of everyday German language usage.

In 1996, the CELEX resources were available in two formats: interactive access to the databases through an Internet connection with our local host computer, or stand-alone usage of the CD-ROM version distributed by the US-based Linguistic Data Consortium. At the time of writing, 120 academic users, mainly in the Netherlands, had an interactive account on the CELEX server, while the CD-ROM was used by 185 academic researchers at home and abroad, and also by 68, mostly multi-national, companies. Commercial access for companies remained restricted to internal research. CELEX was also involved in a number of projects with participants from outside the MPI. In the MULTEXT Project of the European Union, the Dutch lexicon was used both in the enrichment of a sample corpus and in the development of more generally applicable textual annotation tools.

Within the framework of linguistic engineering projects sponsored by the government of Flanders, the University of Leuven provided standard Flemish pronunciations for all Dutch CELEX entries in the FONILEX project. Furthermore, the ANNO project yielded a corpus of written-to-spoken Flemish radio broadcasts, annotated with features from the CELEX database.

Finally, in September 1996, a joint project proposal by CELEX and the Dutch Speech Expertise Center, SPEX, was accepted by the Dutch Ministry of Education. This project aims at compiling a 10 million token corpus of modern standard spoken Dutch in its full range of social, regional and situational varieties. In collaboration with other Dutch and Flemish institutes, the process of recording, processing and annotating the data is scheduled to start in 1997.

Nijmegen Lectures

It was decided not to hold the Nijmegen Lectures in 1996. In December 1996, when the Nijmegen Lectures are normally held, the staff of the Institute had to move into temporary buildings to allow for major construction work. The Institute will be housed in temporary buildings until September 1997. It is intended that this important lecture series will resume in 1997.

The F.C. Donders Lectures on Cognitive Neuroscience

This lecture series is organized by C. Brown and P. Hagoort in collaboration with the Nijmegen Institute of Cognition and Information (NICI). Speakers in the 1996 series were: Richard S. J. Frackowiak (Wellcome Department of Cognitive Neurology, London), Giacomo Rizzolatti (U. Parma), John O'Keefe (UCL), Patricia S. Goldman-Rakic (Yale U.), and Susan D. Iversen (U. Oxford).

Award

W. Levelt received the 2-yearly Heymans Award of the Dutch Psychologists Association (NIP) for his complete scientific oeuvre.

Internal lectures and colloquia

Colloquia organized by the Institute's Colloquium Committee (A. Roelofs and S. Allen) included lectures by G. Chierchia (U. Milan), C. Clifton (U. Massachusetts at Amherst), F. Heynick (U. Eindhoven), P. van Geert (U. Groningen), F. Genesee (McGill U., Montreal), B. Dodd (U. Newcastle

upon Tyne), S. Crain (U. Maryland), R. van Hout (U. Tilburg), and H. Kamp (U. Stuttgart). Many informal lectures were also given by long-term and occasional visitors to the Institute.

Teaching

The staff of the Institute, the Cognitive Anthropology Research Group, and the Research Group on Structural Grammar (marked by an *) taught courses at the following summer schools and universities:

Bierwisch (Humboldt-U.); Blutner (Humboldt U.); Bowerman (Netherlands Graduate School of Linguistics [LOT], Utrecht); Dölling (Humboldt U., TU Berlin, U. Leipzig); Flores d'Arcais (U. Padova); Hagoort (U. Nijmegen; U. Geneva), Indefrey (Heinrich-Heine-U. Düsseldorf); Klein (U. Heidelberg; U. Paris VIE); Strigin (Humboldt-U.); Ter Keurs (U. Nijmegen); Senft (U. Köln); Vonk (U. Nijmegen, U. Turku); Wilder (Humboldt U., U. Potsdam, Palacky U.)

Colloquia Presented

The following members of the Institute, the Cognitive Anthropology Research Group, the Research Group on Structural Grammar (marked by an *), and visitors (during their time at the Institute) presented colloquia at various institutions:

*Bierwisch (HU. Berlin; U. Leipzig; U. Potsdam; Stanford U.; U. Vienna; MIT; MPI Nijmegen); Böttner (Osnabrück); Bohnemeyer (U. Köln; U. Autonoma de Yucatan); Bowerman (U. of California at Santa Barbara; U. of Bristol), Brown, C. (MPI for Brain Research, Frankfurt; U. Leiden), Dietrich, R. (HU Berlin); Flores d'Arcais (U. Rome; C.N.R); Gärtner, H.-M. (U. Frankfurt; U.Tübingen); Hagoort, P. (Schmieder Kliniken, Allensbach; U. Konstanz; MPI für Neuropsychologie, Leipzig; U. Jena), Indefrey (Heinrich-Heine-U. Düsseldorf), Keating (Bryn Mawr College. U. of Texas. Austin; U. of Arizona); Kita (Japan Women's U.; Keio U.); Levinson (U. of PNG); Meyer, A. (U. Leipzig); Nuyts, J. (U. Leipzig;

Leopold-Franzens-U. Innsbruck); Pederson, E. (U. Oslo; U. New Mexico); * Pinon, C. (HU Berlin; U. Maryland; U. Paris 7); Senft, G. (U. Nijmegen); Steinbach, M (HU Berlin; U. Tübingen); Stolz, C. (U. Hamburg; U. Kiel; U. Köln; U. Mainz; Iberoamerikanisches Institut Berlin; U. Bielefeld); Van Turenout (Westfälische Wilhelms-U., Münster; MPI for Brain Research, Frankfurt); Vogel, R. (HU Berlin); Vonk, W. (U. of Amsterdam); Walsh Dickey, L. (U. Tilburg; U. of Bielefeld); Wilder, C. (MPI, Berlin); Wilkins, D. (VAMC, Martinez; Christian-Albrechts-U., Kiel).

Workshops, Symposia, and Summer Schools Organized

W. Levelt, H. Behrens, H. Hendriks and M. Jonas organized a colloquium and party to celebrate the occasion of W. Klein's 50th birthday. The colloquium, entitled "On Time", was held at the Kasteel Heyendael, Nijmegen, in February. Papers were presented by C. von Stutterheim, M. Bierwisch, C. Fabricius-Hansen, D. Wunderlich, M. Starren, A. von Stechow, and M. Hickmann.

*M. Steinbach, *R. Vogel and *C. Wilder, together with A. Alexiadou and U. Kleinhenz (Zentrum für Allgemeine Sprachwissenschaft, Berlin), organized the GGS-Conference in Syntax, Semantics and Phonology, Berlin, May.

In June, a symposium mainly dedicated to the work of the neurocognition project, and entitled "Neurocognition of Language: PET and ERP evidence", was organized at the 8th world congress of the International Organization of Psychophysiology, in Tampere, Finland. This symposium was chaired by P. Hagoort. Presenters were: M. Cheour Luhtanen (U. Helsinki), C. Brown, P. Indefrey, and M. van Turenout.

Ray Jackendoff and Willem Levelt organized a meeting on "Future developments in linguistic theory", which took place in the Institute during June. Regrettably, illnesses caused some last-minute cancellations by

major participants. Still, an exciting meeting resulted with presentations by J. Bresnan, B. Comrie, R. Jackendoff, G. Gazdar, R. Hudson, H. Kamp, W. Klein, C. Pollard, J. Saddock, I. Sag, A. von Stechow, M. Tanenhaus and R. Van Valin.

M. Bowerman organized a workshop entitled "Learning to Structure Space for Language: A Crosslinguistic Perspective" at the 7th International Congress for the Study of Child Language, Istanbul, Turkey, July. Papers were presented by M. Bowerman, S. Choi (San Diego, State U.), L. de Léon (Reed College), and D. Gentner (Northwestern U.).

H. Hendriks organized the first European research conference on 'The Structure of Learner Language: Utterance and discourse structure in language acquisition' in Espinho, Portugal in September. The workshop was co-sponsored by the European Science Foundation, the Euroconferences Activity of the European Union and the Max Planck Society. The chair of the conference was W. Klein and the vice-chair was A. Giacalone Ramat. Nearly 30 scholars presented their research, and one of the specific aims of this conference was to encourage discussion between researchers in first language acquisition and second language acquisition, and also between researchers using a functional-pragmatic approach and those using more formal theoretical models.

In the Research Group on Structural Grammar, * R. Blutner and * M. Bierwisch organized a workshop on 'Semantic Underspecification' in October-November. This workshop explored different aspects of underspecified semantic representations and the various mechanisms which supply necessary amendments to them.

*C. Wilder, together with A. Alexiadou, and A. Meinunger (Zentrum für Allgemeine Sprachwissenschaft, Berlin), organized a workshop 'Relative Clauses' in Berlin, in November. In addition to the main topic, which was the syntax and semantics of relative clause constructions, it also included subsections on correlatives and internally headed relative clauses. Speakers included V. Bianchi (U. Pisa), V. Dayal (Rutgers U.), R. Kayne (CUNY), J. Koster (U. Groningen), A. Mahajan (UCLA), K. Murasugi

(U. Tokyo), C. Platzack (U. Lund), C. Schmitt (U. Michigan State), J. Uriagereka (U. Maryland), and J. Zwart (U. Groningen).

Presentations at Conferences, Congresses, and Workshops

- Allen, S.E.M. "Possibilities for investigation in simultaneous bilingual acquisition of Inuktitut and English". NIAS, Workshop on Bilingual Acquisition. Wassenaar, May.
- Allen, S.E.M. "The development of morphological and lexical causatives in Inuktitut". Workshop on Developing a Verb Category. 7th International Congress for the Study of Child Language. Istanbul, July.
- Allen, S.E.M. "Assessing productivity in acquisition data from polysynthetic languages". 7th International Congress for the Study of Child Language. Istanbul, July.
- Allen, S.E.M. "Causatives as imperatives in early Inuktitut". 10th Inuit Studies Conference. St. John's, Newfoundland, August.
- Allen, S.E.M., & Schröder, H. "Discourse effects on argument representation in early Inuktitut spontaneous speech". Workshop on Structure and Constituency in Native American Languages. Winnipeg, Manitoba, March.
- Allen, S.E.M., & Schröder, H. "Complementary contributions of functionalism and formalism to an analysis of argument representation in early Inuktitut". UWM Linguistics Symposium on Functionalism and Formalism in Linguistics. Milwaukee, Wisconsin, April.
- Allen, S.E.M., & Schröder, H. "Preferred Argument Structure in early Inuktitut spontaneous speech data". Conceptual Structure, Discourse & Language II. SUNY, Buffalo, April.
- Allen, S.E.M., & Schröder, H. "Null subjects and null objects in early Inuktitut". Workshop on Functional Constraints on Ellipsis. 7th International Congress for the Study of Child Language. Istanbul, July.

- Baayen, R. H. "Consequences of affixal homonymy for the processing of inflections in language comprehension: evidence from Dutch". Workshop on Inflection. 7th International Morphology Meeting. Vienna, February.
- Baayen, R. H. "How singular can plural be? Understanding and producing number inflection on nouns: Evidence from Dutch and Italian". 7th International Morphology Meeting. Vienna, February.
- Baayen, R. H. "Productivity in Context: A case study of a Dutch suffix". Trierer Kolloquium zur quantitativen Linguistik. Trier, October.
- Baayen, R. H., Tweedie, F., & Van Halteren, H. "Outside the cave of shadows: Using syntactic annotation to enhance authorship attribution". Joint Conference of the Association for Computers and the Humanities and the Association for Literary and Linguistic Computing. Bergen, June.
- Becker, A., & Dietrich, R. "The expression of scope in German L2: *nur*, *nicht/kein*, and *auch*". International Conference on the Structure of Learner Language. Espinho, September.
- *Bierwisch, M. "Scope and Modification". 18. Jahrestagung der DGfS. Freiburg, February.
- *Bierwisch, M. "How to get into language: Approaches to bootstrapping in early language development". Conference BBAW, AG RULE, Repertoires of Basic Elements Prerequisite or Result of Acquisition? Berlin, September.
- *Bierwisch, M., Budde, E., Mickel, K., & Rihm, K. Akademie-Debatte DC. Musik - Sprache - Sprachlosigkeit. Akademie der Künste in Cooperation with Sender Freies Berlin. Berlin, December.
- *Blutner, R. "Conversational Implicature and lexical pragmatics". AAAI Spring Symposium on Conversational Implicature. Stanford, March.
- *Blutner, R. "Normalität und dynamische Semantik". München, June.
- *Blutner, R. "Unterspezifizierung und die Pragmatik von Adjektiven". 1. Jahrestagung der Gesellschaft für Semantik - Sinn und Bedeutung. Tübingen, December.
- Bohnemeyer, J. "Temporale Relatoren im hispano-yukatekischen Sprachkontakt". Konvergenz und Individualität - die Mayasprachen zwischen Hispanisierung und Individualismus. Bremen, July.

- Bowerman, M. "Argument structure and learnability: Is a solution in sight?". 22nd Annual Meeting of the Berkeley Linguistics Society. Berkeley, February.
- Bowerman, M. "Shaping meanings to language: Universal and language specific in the acquisition of semantic categories". Conceptual Structure, Discourse, and Language II. SUNY Buffalo, April.
- Bowerman, M. "Discussion of the first language acquisition position papers". Functionalism and Formalism in Linguistics. 23rd University of Wisconsin-Milwaukee Symposium. Milwaukee, April.
- Bowerman, M. "Ellipsis of prepositional objects in early English and Dutch: Functional and formal constraints". Workshop on Functional Constraints on Ellipsis, 7th International Congress for the study of Child Language. Istanbul, July.
- Bowerman, M. "Discussion of papers". Workshop on Turkish in Typological Perspective. 7th International Congress for the study of Child Language. Istanbul, July.
- Bowerman, M. "Introduction: Learning to structure space for language: A crosslinguistic perspective". Workshop on Learning to Structure Space for Language: A Crosslinguistic Perspective. 7th International Congress for the study of Child Language. Istanbul, July.
- Bowerman, M., Choi, S., & de León, L. "Learning to talk about space: A crosslinguistic perspective". Workshop on Cross-cultural Perspectives on Development. Conference on The Growing Mind. University of Geneva, September.
- Brown, C. "Language and the brain". Studium Generale. Nijmegen, March.
- Brown, C., & Hagoort, P. "Structure and meaning during language comprehension: Distinct electrophysiological signatures for semantic versus syntactic processes". The 8th World Congress of Psychophysiology. Tampere, June.
- Brown, P. "Isolating the CVC root in Tzeltal Mayan: a study of children's first verbs". Stanford 28th Child Language Forum. Stanford, April.
- Brown, P. "The conversational context for language acquisition: A Tzeltal (Mayan) case study". 5th International Pragmatics Conference. Mexico City, July.
- Brown, P., & Levinson, S.C. "Frames of spatial reference and their acquisition in Tenejapan Tzeltal". Conference on The Growing Mind. Geneva, September.

- Coolen, R., & Kuijpers, C. "The role of the syllable in infants' speech segmentation". 7th International Congress for the Study of Child Language, Istanbul, July.
- Crago, M.B., & Allen, S.E.M. "Linguistic and cultural aspects of simplicity and complexity in Inuktitut (Eskimo) child-directed speech". 21st Annual Boston University Conference on Language Development. Boston, November.
- Crago, M.B., Allen, S.E.M., & Genesee, F.H. "Two languages, two morphemes: Bilingual acquisition as a source of information about early language development". 10th Biennial International Conference on Infant Studies. Providence, Rhode Island, April.
- Crago, M.B., Genesee, F.H., & Allen, S.E.M. "Decision making and dilemmas in bilingual Inuit homes". 10th Inuit Studies Conference. St. John's, Newfoundland, August.
- Cutler, A. "Listening to native and foreign speech". European Second Language Association, Nijmegen, May.
- Cutler, A. "Lexical stress and the English listener". Workshop on The Use of Lexical and Metrical Stress in Automatic and Human Speech Recognition. Nijmegen, June.
- Danziger, E. "Spatial language and spatial cognition: Data from Mopan Maya". Symposium on Language and Space. 16th International Congress of Psychology. Montreal, August.
- Danziger, E. "Cross-linguistic variation in semantic and cognitive encoding of relations in space: Reflections on data from Mopan Maya". *Diversité des Langues et Représentations Cognitives / Language Diversity and Cognitive Representations*. Ecole Normale Supérieure. Paris, November.
- Danziger, E. "The communicative creation of language: A Mayan case study. Between Anthropology and Cognitive Science: A Re-emerging Dialogue". Session to the 95th Annual Meeting of the American Anthropological Association, San Francisco, November.
- *Dölling, J. "Zur 'simplen' Semantik von Kopula-Prädikativ-Konstruktionen". ZAS, Berlin, March.
- *Dölling, J. "Ist ist mehrdeutig? Anmerkungen zu einem Vorurteil". Workshop on Complex Logic. Berlin, September.
- *Dölling, J. "Semantische Unterspezifikation und abduktive Interpretation". Leipzig, November.

- *Dölling, J. "Semantik und Interpretation von Kopulasätzen". Workshop on Predicative Constructions. ZAS, Berlin, November.
- Donselaar, W. van, & Kuijpers, C. "How do Dutch listeners process words with epenthetic schwa". 4th International Conference on Spoken Language Processing. Philadelphia, October.
- Essegbey, J. "The Syntax and Semantics of Double Object Constructions in Ewe". 26th Colloquium on African Languages and Linguistics. Leiden, September.
- Essegbey, J. "The Semantics of One-Place Predicates in Ewe". Workshop on Verb Construction Typology. Trondheim, September.
- Flores d'Arcais, G.B. AmLaP 96. International Conference on Architecture and Mechanisms for Language Processing. Torino, September.
- Geenhoven, V. van. "Partitive NPs are not necessarily strong". 1st Conference of the Gesellschaft für Semantik. Tübingen, December.
- Hagoort, P. "Taal en denken in ons brein". Studium Generale. Maastricht, January.
- Hagoort, P. "The neurophysiology of the human language faculty". BCN Lecture Series on Language and Brain. Groningen, April.
- Hagoort, P. "The neurophysiology of speaking: Possibilities of event-related potential research on speech production". 3rd International Conference on Speech Motor Production and Fluency Disorders. Nijmegen, June.
- Heeschen, C. "Interactional roots of adaptive strategies in adult aphasies". 5th International Pragmatics Conference. Mexico City, July.
- Hendriks, H. "Reference to time in narrative discourse: A comparison of adult second language and child first language acquisition". EUROSILA. Nijmegen, June.
- Hendriks, H. "La référence temporelle dans la narration: une comparaison entre l'acquisition de L2 chez l'adulte et L1 chez l'enfant". Colloque Récit et Temporalité, Paris, June.
- Hendriks, H. "Reference to person and space in narrative discourse: A comparison of child first language and adult second language acquisition". 7th International Congress for the Study of Child Language. Bogaçi University, Istanbul, July.

- Hendriks, H. "Reference to person and space in narrative discourse: A comparison of adult L2 and child LI acquisition". International Conference on the Structure of Learner Language. Espinho, September.
- Hickmann, M. "Organisation temporo-aspectuelle dans la phrase et dans le discours: perspective développementale inter-langues". Conference Espace, temps et langage. Université Paul Sabatier, Toulouse, March.
- Hickmann, M. "Children's marking of information status: A crosslinguistic analysis of referent introductions". 7th International Congress for the Study of Child Language. Bogazi University, Istanbul, July.
- Hickmann, M. "Person and space in children's narratives: A crosslinguistic analysis of discourse cohesion". International Conference on The Structure of Learner Language. Espinho, September.
- Indefrey, P. "PET research in language production". 3rd International Conference on Speech Motor Production and Fluency Disorders. Nijmegen, June.
- Indefrey, P. "PET research in language production". 8th World Congress of the International Organisation for Psychophysiology. Tampere, June.
- Indefrey, P., Hagoort, P., Brown, C., Herzog, H., & Seitz, R. J. "Cortical Activation Induced by Syntactic Processing: A [15O]-Butanol PET Study". 2nd International Conference on Functional Mapping of the Human Brain. Boston, June.
- Keating, E. "Gender, Language, and Spatial Cognition in Pohnpei, Micronesia". American Association for Applied Linguistics. Chicago, March.
- Keating, E. "An Analysis of Social Deixis in Pohnpei, Micronesia". 2nd Colloquium on Deixis. Nancy, March.
- Keusen, A. "Word order in Saliba negative clauses". European Meeting on Oceanic Linguistics. Oslo, September.
- Kita, S. "Linguistic effects on spatial thinking as probed by spontaneous speech-accompanying gestures". Symposium language, culture, and communication: towards a new paradigm. Center for Asian and African languages and cultures. U. Foreign Languages, Tokyo, May.
- Kita, S. "Information up-take from gesture in conversation", "Gesture during route direction". Gesture workshop. Kyoto, June.

- Kita, S. "Linguistic effects on spatial thinking as probed by spontaneous speech-accompanying gestures". 5th International Pragmatics Conference. Mexico City, July.
- Kita, S. "Body movements during route direction". International Congress on Semiotics. Amsterdam, August.
- Klein, W. "The Basic Variety". AAAL Conference. Chicago, March.
- Klein, W. "What can second language acquisition tell us about the human language faculty?". Workshop on Future Developments in Linguistic Theory. Nijmegen, June.
- Klein, W. "Tense and aspect: a strictly time-relational alternative to traditional formulations", "Tense and aspect in English, Chinese, and Russian", "The expression of temporality in learner languages: The Basic Variety", "Development beyond the Basic Variety". Nordic Summer School on Tense and Aspect. Vatnahalsen, June.
- Klein, W. "The Basic Variety". International Conference on the Structure of Learner Language. Espinho, September.
- Kleinschmidt, A., Indefrey, P., Brown, C., Hagoort, P., Merboldt, K.-D., Krüger, G., & Frahm, J. "The Visual Cortical Response to Lexical Activation: Seeing or Reading? A Magnetic Resonance Functional Neuroimaging Study". 2nd International Conference on Functional Mapping of the Human Brain. Boston, June.
- Köster, O., & Schiller, N.O. "Does the relatedness between the native language of a listener and the native language of a speaker play a role in speaker recognition?". 8th Annual Congress of the International Society for Forensic Phonetics. Wiesbaden, July.
- Krott, A. "Die CELEX-Datenbank: Struktur und Verwendung eines elektronischen Lexikons für quantitative linguistische Forschung". Trierer Kolloquium zur quantitativen Linguistik. Trier, October.
- Kuijk, D. van. "Does lexical stress or metrical stress better predict word boundaries in Dutch?". International Conference on Spoken Language Processing '96. Philadelphia, October.
- Kuijk, D. van. "RAW: A real-speech model for human word recognition". International Conference on Spoken Language Processing '96. Philadelphia, October.
- Kuijpers, C, Coolen, R., & Houston, D. "Early word recognition in the pre-linguistic child". 7th International Congress for the Study of Child Language. Istanbul, July.

- Kuijpers, C., Coolen, R., Houston, D., & Cutler, A. "The segmentation of fluent speech by Dutch-acquiring infants". Workshop on Evaluation of Head Turn and Intermodal Preferential Looking Procedures for testing Infant's Knowledge of Language. Melbourne, December.
- Levelt, W.J.M. "Kunnen lezen is ongewoon voor horenden en doven", Symposium Totale Communicatie en Lezen. Amsterdam, January.
- Levelt, W.J.M. "Processing stages in picture naming: The cortical localization of word form access". Cognitive Neuroscience Society 3rd Annual Meeting. San Francisco, April.
- Levelt, W.J.M. "A theory of lexical access in speech production". Opening lecture COLING-96. Copenhagen, August.
- Levelt, W.J.M. "Waar komen gesproken woorden vandaan?". Heymans Award Lecture, NIP Congress. Maastricht, October.
- Levelt, W.J.M., Praamstra, P., Meyer, A.S., Salmelin, R., & Kiesila, P., "A MEG study of picture naming". Convention of the Cognitive Neuroscience Society, San Francisco, March.
- Levinson, S.C. "Cultural differences in the use of body schema for spatial thinking". Fyssen Fondation Symposium, Culture and the Uses of the Body. Paris, March.
- Levinson, S.C. "Frames of reference in language and spatial thinking". Workshop Mental Representations in Navigation. Cambridge Basic Research, Cambridge, MA, June.
- Levinson, S.C. "Diversity in mind". 95th AAA meeting. San Francisco, November.
- Levinson, S.C., & Brown, P. "Frames of spatial reference and their acquisition in Tenejapan Tzeltal". Conference on The Growing Mind. Geneva, September.
- McQueen, J.M., & Pitt, M.A. "Transitional probability and phoneme monitoring". 4th International Conference on Spoken Language Processing. Philadelphia, October.
- Meyer, A.S. "Towards a theory of phonetic encoding in language production". 3rd International Conference on Speech Motor Production and Fluency Disorders. Nijmegen, July.
- Meyer, A.S., Bock, K., & Wissink, M. "Noun-pronoun agreement in Dutch". 9th Conference of the European Society for Cognitive Psychology. Würzburg, September.

- Meyer, A.S., & Roelofs, A. "Metrisches und segmentales Kodieren in der Wortproduktion". 38. Tagung experimentell arbeitender Psychologen. Eichstätt, March.
- Meyer, A.S., & Roelofs, A. "Segmentale und metrische Spezifikation in der Wortproduktion". 38. Tagung experimentell arbeitender Psychologen. Eichstätt, April.
- Meyer, A.S., & Roelofs, A. "Metrical encoding in word production". 37th Annual Meeting of the Psychonomic Society. Chicago, November.
- Mooshammer, C., & Schiller, N.O. "Coarticulatory Effects on Kinematic Parameters of Rhotics in German". 1st ESCA Tutorial and Research Workshop on Speech Production Modeling: From Control Strategies to Acoustics & 4th Speech Production Seminar: Models and Data. Autrans, May.
- Noordman, L.G.M., & Vonk, W. "Inference as a process of activating knowledge". Workshop on Inference during Reading: Minimalism versus Constructionism. Montpellier, March.
- Nüse, R. "Präpositionslesarten und die Salienz von Objektregionen". 2. Fachtagung der Gesellschaft für Kognitionswissenschaft. Hamburg, March.
- Nuyts, J., & De Roeck, A. "The development of metarepresentational capacities in autism: Deviance or delay?". 5th International Congress Autism-Europe, Barcelona, May.
- Pederson, E. "Frames of reference in Tamil culture, language and thought". Symposium Versprachlichungsprozesse: die Integration nicht-sprachlicher und sprachlicher Kognition. Hamburg, June.
- Pederson, E. "Spatial language, reasoning, and variation within Tamil communities". Workshop Language and Orientation in Space and Society. Charles University, Prague, November.
- Perdue, C. "Orders of acquisition in second language acquisition". EUROSILA 6. Nijmegen, June.
- *Piñón, C. "Aspectual composition and event semantics". Ereignisworkshop, Seminar für Allgemeine Sprachwissenschaft. Düsseldorf, November.
- *Piñón, C. "Reicher werden und reich werden". Workshop Prädikativ-Konstruktionen. ZAS, Berlin, November.
- *Piñón, C. "Achievements in einer Ereignissemantik". Sinn und Bedeutung, 1. Jahrestagung der Gesellschaft für Semantik. Tübingen, December.

- Praamstra, P., Levelt, W.J.M., Meyer, A.S., Salmelin, R., & Kiesila, P. "A MEG study of picture naming". International EEG Conference. München, September.
- Roelofs, A. "Semantic memory in language production". Euro-conference on Cognitive processes underlying semantic memory and its disorders. Trieste, June.
- Roelofs, A. "Accessing the terminal elements of syntactic structures in production: Model and data". NIAS workshop on Computational models of human syntactic processing. Wassenaar, June.
- Roelofs, A. "Lemmas in language production". Workshop on The lemma in neurolinguistics or: the dilemma of the lemma. Potsdam, September.
- Roelofs, A., Baayen, H., & Meyer, A.S. "Testing the WEAVER model of speech production: Role of semantic transparency and metrical structure". 9th Conference of the European Society for Cognitive Psychology. Würzburg, September.
- Schiller, N.O. "Variation bei der Produktion von /r/-Lauten: Eine Beschreibung im Rahmen der Artikulatorischen Phonologie". 27. Jahrestagung der Gesellschaft für Angewandte Linguistik. Erfurt, September.
- Schiller, N.O. "Die Rolle der Psycholinguistik für die phonologische Theoriebildung: Evidenz aus der Silbifizierung zweisilbiger Substantive". 27. Jahrestagung der Gesellschaft für Angewandte Linguistik. Erfurt, September.
- Schiller, N.O., Köster, O., & Duckworth, M. "What effect does removing linguistic information have upon identifying speakers of a foreign language?". 8th Annual Congress of the International Society for Forensic Phonetics. Wiesbaden, July.
- Schiller, N.O., Meyer, A.S., & Levelt, W.J.M. "What psycholinguistics reveals about phonology: Evidence from the syllabification of bisyllabic nouns". 9th Conference of the European Society for Cognitive Psychology. Würzburg, September.
- Schiller, N.O., Meyer, A.S., Baayen, H., & Levelt, W.J.M. "Sind die Unterschiede zwischen phonetischen und phonologischen Silben wichtig für die Psycholinguistik?". 27. Jahrestagung der Gesellschaft für Angewandte Linguistik. Erfurt, September.

- Schultze-Berndt, E. "Generic verbs, specific uses: Towards a semantic representation of simple and complex verbs in Jaminjung". Annual Meeting of the Australian Linguistics Society. Canberra, July.
- Senft, G. "Conceptions of space and spatial reference in natural languages". Symposium Rules of Spatial Memory Organisation. Akademie der Wissenschaften, Berlin, February.
- Senft, G. "Magical Conversation on the Trobriand Islands". 5th International Pragmatics Conference. Mexico City, July.
- Senft, G. "Weird papalagis and a fake Samoan Chief. 11th Conference of the Pacific History Association. U. Hawaii at Hilo, July.
- Senft, G. "The Presentation of Self in Touristic Encounters: A Case Study from the Trobriand Islands". Conference of the European Society of Oceanists Pacific Peoples in the Pacific Century: Society, Culture, Nature. Copenhagen, December.
- Sorace, A. "Permanent optionality as divergence in non-native grammars". European Second Language Association Meeting. Nijmegen, June.
- *Steinbach, M., & Erb, M.C. "Middles: A View from German". ConSOLE 5 1996. London, December.
- Stoll, S. "The Role of Aktionsart in the Acquisition of Russian Aspect". 7th International Congress for the Study of Child Language. Istanbul, July.
- Stolz, C. "Yucatec dimension terms: language-particular and comparative perspectives". Workshop on Siouian and Mayan, Conference on American Indian Languages. Annual Meeting of the Linguistic Society of America. San Diego, January.
- Stolz, C. "Hispanicisation in Yucatec Maya: the borrowing of function words". Tagung Konvergenz und Individualität - Die Mayasprachen zwischen Hispanisierung und Indigenismus. Bremen, July.
- *Strigin, A. "Situations and Adverbs". 18th DGfS Annual Meeting. Freiburg, March.
- *Strigin, A. "Interpretation as abduction to concepts: The case of sense-extension rules". Workshop From underspecification to interpretation. Berlin, October/November.
- Swaab, T., Brown, C., & Hagoort, P. "Event-related potential evidence for impaired lexical integration in aphasia". Cognitive Neuroscience Society. San Francisco, March.

- Swaab, T., Brown, C., & Hagoort, P. "Understanding ambiguous words in sentence contexts: Electrophysiological evidence for a delay in contextual selection in Broca's aphasia". 8th World Congress of Psychophysiology. Tampere, June.
- Turenhout, M. van. "The temporal order of semantic, syntactic and phonological processes in speaking: Evidence from event-related brain potentials". Euro-Conference on Cognitive processes underlying semantic memory and its disorders. Trieste, June.
- Turenhout, M. van. "Electrophysiological studies of speaking". Wellcome Department of Cognitive Neurology. London, December.
- Turenhout, M. van, Hagoort, P., & Brown, CM. "Speaking words: Electrophysiological evidence on the time course of semantic and phonological processes in speech production". 8th International Congress of the International Organization of Psychophysiology. Tampere, June.
- Vonk, W. "Inferential processes in demonstrative noun phrases". Workshop on Inference during Reading: Minimalism versus Constructionism. Montpellier, March.
- Vonk, W. "The role of readers' knowledge in controlling on-line inferences in reading". Psychology Laboratory, Data City, U. of Turku, April.
- Vonk, W. "Referential expressions as discourse structuring devices". Psychology Laboratory, Data City, U. of Turku, May.
- Vonk, W. "Demonstrative noun phrases and class-membership inferences". 9. European Society for Cognitive Psychology Conference. Würzburg, September.
- Walsh Dickey, L. "Segmental-Prosodic Interactions in Allomorphy". 8th International Phonology Meeting. Vienna, November.
- Watorek, M. "Le traitement prototypique: définition et implications". Eurosla 6. Nijmegen, June.
- Watorek, M., & Perdue, C. "Topique/focus, portée et mouvement référentiel: quelques observations empiriques". European Conference on the Structure of Learner Language . Espinho, September.
- Weeber, M., & Vonk, W. "Over het construction-integrationmodel van Kintsch". 19. Minisymposium over Lezen. Nijmegen, April.
- *Wilder, C. "English Auxiliaries". Workshop Phonology, Morphology and Syntax of Clitics. ZAS, Berlin, May.

- *Wilder, C. "Long QR: ACDs, Scope and Binding". 21th GGS-Tagung. Berlin, May.
- *Wilder, C. "Phrasal Movement in LF: De Re Readings, Binding and VP-Ellipsis". NELS 27. McGill U., Montreal, October.
- Wilkins, D.P. "Even with the best of intentions ... : Some Pitfalls in the Fight for Linguistic and Cultural Survival (One view of the Australian Experience)". Colloquium on Indian Languages of Amazonia in Science and Societies. Belem, March.
- Wilkins, D.P. "The Verbalisation of Motion Events in Arrernte (Aranda)". 28th Child Language Research Forum. Stanford, April.
- Wilkins, D.P. "The semantics of artefacts: Why field-linguists have to take gesture seriously (Part II)". Meeting of Central Australian Linguistic Circle. Alice Springs, August.
- Wilkins, D.P., & Higginbotham, J. "The Social Construction of Language competence: Augmentative Communication Technologies". American Association for Applied Linguistics. Chicago, March.
- Zavala, R. "Inverse in Oluta Popoluca". SSILA Winter Meeting in conjunction with the 70th Meeting of the Linguistic Society of America. San Diego, January.

Publications

- Allen, S.E.M. (1996). *Aspects of argument structure acquisition in Inuktitut*. Amsterdam: John Benjamins.
- Allen, S.E.M., & Crago, M.B. (1996). Early passive acquisition in Inuktitut. *Journal of Child Language*, 23, 129-155.
- Ameka, F., & Wilkins, D.P. (1996). Semantics. In P. Neide et al. (Eds.), *International Handbook Contact Linguistics* (pp. 130-138). Berlin: Walter de Gruyter.
- Baayen, R.H. (1996). The effect of lexical specialization on the growth curve of the vocabulary. *Computational Linguistics*, 22 A, 155-166.
- Baayen, R.H. (1996). The randomness assumption in word frequency statistics. In G. Perisintono (Ed.), *Research in Humanities Computing* 6 (pp. 17-31). Oxford: Oxford University Press.
- Baayen, R.H., & Renouf, A. (1996). Chronicling The Times: Productive lexical innovations in an English newspaper. *Language*, 72, 69-96.
- Baayen, R.H., & Schreuder, R. (1996). Morphology: why, how, when, when not, and why not? In G. E. Booij & J. van Marie (Eds.), *Yearbook of Morphology 1996*. Dordrecht: Kluwer Academic Publishers.
- Baayen, R.H., & Schreuder, R. (1996). Modeling the processing of morphologically complex words. In T. Dijkstra & K. de Smedt (Eds.), *Computational Psycholinguistics: AI and Connectionist Models of Human Language Processing* (pp. 166-191). London: Taylor & Francis.
- Baayen, R.H., & Sproat, R. (1996). Estimating lexical priors for low-frequency morphologically ambiguous forms. *Computational Linguistics*, 22, 155-166.
- Baayen, R.H., Burani, C., & Schreuder, R. (1996). Effects of semantic markedness in the processing of regular nominal singulars and plurals in Italian. In G. E. Booij & J. van Marie (Eds.), *Yearbook of Morphology 1996*. Dordrecht: Kluwer Academic Publishers.
- Baayen, R.H., Tweedie, F., & Van Halteren, H. (1996). Outside the cave of shadows: Using syntactic annotation to enhance authorship attribution. *Literary and Linguistic Computing*, 11, 121-131.
- Bard, E.G., Robertson, D., & Sorace, A. (1996). Magnitude estimation of linguistic acceptability. *Language*, 72, 32-68.
- Becker, A., & Dietrich, R. (1996). The expression of scope in German L2: *nur, nicht/kein* and *auch*. *LiLi, Literaturwissenschaft und Linguistik*, 704, 115-140.

- Berkum, J.J.A. van (1996). De taalpsychologie van genus. *NEDER-L, Electronisch Tijdschrift voor de Neerlandistiek*, nr. 9601.a, article 9601.04.
- Berkum, J.J.A. van (1996). *The psycholinguistics of grammatical gender: Studies in language comprehension and production*. Doctoral Dissertation. Nijmegen: Nijmegen University Press.
- *Bierwisch, M. (1996). Lexikon und Universalgrammatik. In N. Weber (Ed.), *Semantik, Lexikographie und Computeranwendungen* (pp. 129-164). Tübingen: Niemeyer Verlag.
- *Bierwisch, M. (1996). How much space gets into language? In P. Bloom et al. (Eds.), *Language and Space* (pp. 31-76). Cambridge, MA: MIT Press.
- *Bierwisch, M. (1996). Rätselhafte Größe: Gottfried Wilhelm Leibniz. In *Die großen Leipziger* (pp. 20-38). Frankfurt am Main: Insel-Verlag.
- *Bierwisch, M. (1996). Lexical Information from a Minimalist Point of View. In Wilder et al. (Eds.), *The Role of Economy Principles in Linguistic Theory* (pp. 227-266). Berlin: Akademie-Verlag.
- *Bierwisch, M. (1996). Avant Propos. In G. Haïras & M. Bierwisch (Eds.), *Wenn die Semantik arbeitet* (pp. 1-7). Tübingen: Niemeyer Verlag.
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