

# **AMLaP 2004**

**The 10<sup>th</sup> Annual Conference on  
Architectures and Mechanisms of  
Language Processing**

**September, 16-18, 2004**

**Laboratoire Parole et Langage, CNRS  
Université d'Aix en Provence**

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THURSDAY, September 16th

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9:45: On the lack of storage and integration cost effects

*Lars Konieczny*

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10:15: Conjoined NPs and syntactic complexity

*Tessa Warren and Edward Gibson*

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10:45: Processing High Level Syntactic Constraints in Chinese and English

*S. Chi, C. Skoutelakis, S. Seegmiller, & D. Townsend*

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11:15 - 11:40 Coffee break

11:40 - 12:40 Invited Talk: Brian McElree

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12:45 - 14:00 Lunch

14:00 - 16:00 Session II: Sentence comprehension

14:00: The role of the visual world in the visual-world paradigm

*Yuki Kamide & Ruth Ashby*

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14:30: Sentence wrap-up: Investigating the effects of syntactic reanalysis and lexical access

*Roger P.G. van Gompel, Robin L. Hill*

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15:00: The role of conflict resolution in parsing: Measuring individual differences in syntactic ambiguity resolution and executive-control.

*Jared M. Novick, John C. Trueswell, David January, & Sharon L. Thompson-Schill*

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15:30: The Processing of Mass & Count: Why 3 beers is different from too much banana

*Steven Frisson and Lyn Frazier*

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16:15 - 16:30 Coffee break

16:30 - 17:30 Session III: Prosody

16:30: Syntactic Predictions on the Basis of Contrastive Accent Placement: An ERP Study

*Britta Stolterfoht, Angela D. Friederici, Kai Alter, & Anita Steube*

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17:00: Sound Advice in Language Comprehension:

The Influence of Phonological Typicality on On-line Sentence Processing

*Thomas A. Farmer, Morten H. Christiansen, & Padraic Monaghan*

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*Sven Van Lommel & Géry van Outryve d'Ydewalle*

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19:30 The bus will be leaving for the conference dinner

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## Enriched composition: Behavioral and neural evidence

Brian McElree, New York University

How is the meaning of a sentence composed? A traditional view holds that sentence meaning is determined by the meaning of its constituents. However, some meanings do not appear to be strictly compositional: Often, constructing a suitable interpretation requires modifying the default interpretation of a constituent and introducing semantic content not explicitly represented in the sentence or discourse.

I will discuss studies using self-paced reading (1, 2), eye-tracking (2-5), and speed-accuracy tradeoff (6) procedures that (i) demonstrate that computing noncompositional meanings is taxing for the language processor and (ii) highlight what types of interpretative operations are costly to perform online. Finally, I will present recent work (7) using magnetoencephalography (MEG) to investigate the neural sources of semantic composition. This work demonstrates that compositional effort modulates the amplitudes of an anterior midline field (AMF) at 350-500ms. This frontal lobe source is distinct from the classic N400 effect, a left temporal source at 300-400ms (M350) that is modulated by plausibility not compositional effort.

### Reference

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## On concepts, words and syntax: the featural and unitary semantic space (FUSS) hypothesis and beyond

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In 1910, John Dewey wrote: "To grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things; to note how it operates or functions, what consequences follow from it, what causes it, what uses it can be put to". In this passage, he captures two fundamental questions in the investigation of meaning: how are meanings related? How is each meaning structured. In the talk I will address these two interrelated questions. I will start by introducing the Featural and Unitary Semantic Space (FUSS) hypothesis of the representation of the meanings of words referring to objects and events. FUSS integrates a number of previous claims and research strands encompassing psycholinguistics, cognitive psychology and neuroscience into a hypothesis which we have implemented into a statistical model. I will then turn to use FUSS as a *tool* to explore the representation and processing of other linguistic information such as grammatical class, which is correlated with meaning distinctions.

## Relevance Theory: Principles and experimental tests

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I outline the main ideas of Relevance Theory (Sperber & Wilson, *Relevance: Communication and Cognition, Second Edition*, Blackwell 1995) and in particular the cognitive principle ("human cognition is geared to the maximisation of relevance"), and the communicative principle of relevance ("every utterance conveys a presumption of its own relevance") and present a few experimental tests of these ideas.

## On the lack of storage and integration cost effects

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Two eye-tracking reading experiments will be reported that focus on reading complexity in unambiguous sentences.

In the first experiment, German subject and object-extracted relative clauses were centre-embedded either in a main clause (1-2), or in an embedded complement clause (3-4). Following the *storage cost hypothesis* in Dependency Locality Theory, DLT (Gibson, 2000), reading should slow down when more syntactic predictions have to be kept in memory, as storage and integration both draw on the same working memory resources. When the sentences in (1) and (2) are embedded into a complement clause in (3) and (4), reading times should show a considerable slow-down due to the pending prediction of the matrix verb.

While regression-path reading times revealed an advantage of SRCs over ORCs in simple sentences, there was no slow-down in embedded clauses in these measures, except for the second verb. Total reading times, however, were significantly higher on the entire sentence when it was embedded, indicating that embedding/storage affects integration during re-reading, rather than online reading.

The second experiment addresses DLT's integration cost hypothesis, ICH (Gibson, 2000). Following ICH, processing gets more costly when more, and more distant integrations have to be made. Clause-final verbs, for instance, are harder to integrate the more complements have to be retrieved from memory. ICH is contrasted with probabilistic models (Jurafsky, 1996; Hale, 2002) and Simple Recurrent Networks (Elman, 1990; MacDonald and Christiansen, 2002), which can *anticipate* verbs *better* when more dependents have been encountered beforehand (Konieczny and Döring, 2003). To test the *integration cost hypothesis* against the *anticipation hypothesis*, sentences with the same number of NPs and PPs were constructed, where one NP and a PP could either be modifying the preceding noun, or be a complement (NP) or adjunct (PP) of the verb. Case marking of the NP determined its function: Genitive (7,8) indicates that it modifies the preceding NP, whereas Dative (5,6) makes it an indirect object of the verb. The PP was disambiguated by its content, so that it was either noun-modifying (5,7) or verb-modifying (6,8).

Clause final verbs were read faster when a Dative-NP, instead of a noun-modifying Genitive-NP, was read beforehand. Adverbial PP-adjuncts, in contrast to Noun-modifying PPs, however, did not affect reading times. In general, the results support a restricted anticipation hypothesis and clearly disconfirm ICH.

I will argue that the data of both experiments support a model that integrates anticipation as a central mechanism facilitating language comprehension, but only in not too complex constructions and when sufficient resources are available.

### Experiment 1

- (1) Der Verbrecher, der den Polizist sah, floh über die Grenze. (SRC, simple)  
The criminal, who<sub>nom</sub> the cop<sub>acc</sub> saw, escaped across the border.  
"The criminal who saw the cop escaped across the border."
- (2) Der Verbrecher, den der Polizist sah, floh über die Grenze. (ORC, simple)  
The criminal, who<sub>acc</sub> the cop<sub>nom</sub> saw, escaped across the border.  
"The criminal who the cop saw escaped across the border."
- (3) Kerstins Aussage, dass der Verbrecher, der den Polizist sah, floh, erzürnte Eduard. (SRC, embedded)  
Kerstin's claim that the criminal, who<sub>nom</sub> the cop<sub>acc</sub> saw, escaped, angered Eduard.  
"Kerstin's claim that the criminal who saw the cop escaped angered Eduard."
- (4) Kerstins Aussage, dass der Verbrecher, den der Polizist sah, floh, erzürnte Eduard. (ORC, embedded)  
Kerstin's claim that the criminal, who<sub>acc</sub> the cop<sub>nom</sub> saw, escaped, angered Eduard.  
"Kerstin's claim that the criminal who the cop saw escaped angered Eduard."

### Experiment 2

- (5) 2<sup>nd</sup> NP: Dative      PP: Noun-modifying  
Die Einsicht, dass / der Freund / dem Kunden / das Auto / aus Plastik / verkaufte, / erheiterte / die Anderen.  
The insight, that / the friend / the client / the car / (made) from plastic / sold, / amused /the others.  
"The insight that the friend sold the car made from plastic to the client amused the others."
- (6) 2<sup>nd</sup> NP: Dative      PP: Verb-modifying  
Die Einsicht, dass / der Freund / dem Kunden / das Auto / aus Freude / verkaufte, / erheiterte / die Anderen.  
The insight, that / the friend / the client / the car just for fun / sold, / amused / the others.  
"The insight that the friend sold the car to the client just for fun amused the others."
- (7) 2<sup>nd</sup> NP: Genitive      PP: Noun-modifying  
Die Einsicht, dass / der Freund / des Kunden / das Auto / aus Plastik / verkaufte, / erheiterte / die Anderen.  
The insight, that / the friend / (of) the client / the car / (made) from plastic / sold, / amused / the others.  
"The insight that the friend of the client sold the car made from plastic amused the others."
- (8) 2<sup>nd</sup> NP: Genitive      PP: Verb-modifying  
Die Einsicht, dass / der Freund / des Kunden / das Auto / aus Freude / verkaufte, / erheiterte / die Anderen.  
The insight, that / the friend / (of) the client / the car / just for fun / sold, / amused / the others.  
"The insight that the friend of the client sold the car just for fun amused the others."



## Conjoined NPs and syntactic complexity

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Word-order strongly influences sentence comprehensibility, as the greater difficulty of object-extractions than subject-extractions shows. Word-order complexity is hypothesized to result from memory limitations upon the retrieval of previous material during the process of linking a new word into a sentence (Gibson, 1998; Lewis, 1996; Gordon, Hendrick & Johnson, 2001). Recent hypotheses attribute the cause of this retrieval difficulty to: (1) syntactic retrieval cue interference (SRCI, VanDyke & Lewis, 2003), (2) NP type similarity-based interference (NP-SBI, Gordon et al., 2001), or (3) decay or interference resulting from the diversion of memory resources to referential processing (RPD, Warren & Gibson, 2002). This paper presents three self-paced reading experiments investigating the effects of conjoined definite descriptions on retrieval difficulty during parsing and their ramifications for the three theories above.

In these experiments, a conjoined definite description was inserted into RC structures. SRCI predicts increased processing difficulty when the extra description matches the retrieval cues of the verbs. NP-SBI predicts that difficulty increases as more descriptions are held in memory prior to the verbs. RPD predicts increased difficulty when the extra description intervenes between the endpoints of dependencies terminating at the verbs.

Example items for each experiment are included below. Reading times on the RC-final word and matrix verb were analyzed. Experiment 1 (N=48) showed a reliable effect of subject- vs. object-extraction ( $ps < .001$ ). In object-extracted conditions, a conjoined description caused no increase in reading times when it appeared in matrix subject position or RC-internal NP position as compared with its control. In Experiment 2 (N=60) conjunctions again didn't increase complexity over baseline ( $ps > .2$ ), but predicated descriptions (e.g. the doctor of the lawyer) in matrix or RC subject position led to reliably slower reading than conjunctions on the verbs ( $ps < .005$ ), and than their controls on the embedded verb ( $F1=8.5, p=.005; F2=3.7, p=.07$ ). Consistent with these findings, Experiment 3 (N=48) showed increased difficulty when the two descriptions were verbal arguments rather than a conjunction.

### Experiment 1

- a/b) The fireman and the baker, both of whom {the lawyer greeted/greeted the lawyer}, went to the store. *Matrix Conjunction {obj/subj}*  
 c/d) The fireman, who {both the lawyer and the baker greeted/greeted both the lawyer and the baker}, went to the store. *RC-internal Conjunction {obj/subj}*  
 e/f) The fireman, who {the lawyer at the charity event greeted/greeted the lawyer at the charity event}, went to the store with the baker. *Control {obj/subj}*

### Experiment 2

- a/b) The accountant {of/and} the actress, who the manager disliked, falsified some financial reports. *Matrix PP/conjunction*  
 c/d) The accountant, who the manager {of/and} the actress disliked, falsified some financial reports. *RC-internal PP/conjunction*  
 e) The accountant, who the manager very strongly disliked, falsified some financial reports. *Control*

### Experiment 3

- a) The teacher who brought the student to the principal attended the meeting. *2 objects, subject-extraction*  
 b) The principal who brought the teacher and the student attended the meeting. *1 object, subject-extraction*  
 c) The principal who the teacher brought the student to attended the meeting. *2 objects, object-extraction*  
 d) The student who the principal and the teacher brought attended the meeting. *1 object, object-extraction*

These results suggest that: (1) the internal structure of an NP affects its contribution to processing load, (2) predication contributes to processing load, and (3) conjunctions may be processed as one plural entity (e.g. Carreiras, 1997). These conjunction findings are consistent with RPD if conjunctions are processed as one entity and predicated NPs as two. They follow from SRCI if the conjoined NP, but not its components, has retrieval cues. NP-SBI incorrectly predicts conjunctions should increase complexity if processed as two NPs or lower if processed as one. Ramifications of the predicated description findings will also be discussed.

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## Processing High Level Syntactic Constraints in Chinese and English

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The specified-subject constraint (SSC, technically subsumed under binding theory in Chomsky, 1981) prevents movement of a noun out of an NP with a possessive determiner (1) even though movement out of indefinite NPs is permitted (2). Using a task in which participants judge whether two lines of print match physically, Freedman & Forster (1985) demonstrated that violations of the SSC do not influence English matching decisions. However, basic phrase structure violations do influence sentence matching decisions, suggesting that participants treat the matching task as linguistic rather than simply visual. The pattern of results suggests that participants access basic phrase structure but not the SSC prior to the matching decision.

Chinese has no overt *wh*-movement, but it obeys the SSC at the level of logical form (Huang & Li, 1996). That is, the Chinese equivalents of (1)-(2) shown in (3)-(4) display the same pattern of acceptability as English. If Chinese participants access the SSC prior to the sentence matching decision, SSC violations will increase Chinese matching times.

Examples:

1. \*What did Anne resent Tom's comments about?
2. What did Anne resent comments about?
3. \*Anne resent Tom about what PRT comment? [Chinese gloss]
4. Anne resent about what PRT comment? [Chinese gloss]

We tested Chinese and English speakers in sentence matching and off-line acceptability tasks. The participants were 161 native Mandarin-speaking students at National Kaohsiung First University of Science Technology, and 113 native English-speaking students at Montclair State University. We examined sentence matching times for correct identity matches.

SSC violations decreased off-line judgments of "acceptable" in both languages. However, violations of the SSC increased matching times in Chinese but not in English. We discuss the following interpretations of these results:

- The fact that Chinese SSC violations influence off-line acceptability judgments justifies the notion of covert movement (Huang & Li, 1996).
- The fact that these violations influence Chinese but not English sentence matching times suggests that questions require re-analysis later in Chinese than in English. The location of the *wh*-word in English provides a cue that enables early detection that movement has occurred. The fact that the *wh*-word in Chinese occurs in its original location requires later reanalysis of the sentence and therefore increases response times on the matching task.

We are now conducting single word self-paced reading experiments in the two languages. If our interpretations are correct, then SSC violations should increase word reading times earlier in English than in Chinese.

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### The role of the visual worlds in the visual-world paradigm

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In recent years, the so-called 'visual-world' paradigm (Cooper, 1974) has attracted an extensive volume of research in numerous topics in psycholinguistics. Amongst those topics is the issue of 'anticipation' of a forthcoming referent in auditory sentence comprehension. For example, Kamide, Scheepers, & Altmann (2003; KSA hereafter) found that, presented with a picture containing a hare, a cabbage, a fox and a tree, more saccadic eye movements were obtained towards the 'appropriate' objects (cabbage in (1a); fox in (1b)) than towards the 'inappropriate' objects (fox in (1a); cabbage in (1b)) during 'eat the'/'be eaten by' in (1a) & (1b):

(1a) Active: The hare will eat the cabbage.

(1b) Passive: The hare will be eaten by the fox.

The present study explores the 'origin' of the plausibility used as a manipulation in KSA. Some of their sentences consisted of relatively robust real-world knowledge (as in the examples above), whilst others consisted of plausibility seemingly mainly based on the particular accompanying pictures (e.g., 'The painter will capture the young woman.' 'The painter will be captured by the photographer.'). We modified KSA's original pictures (e.g., 2a) in such a way that the visual configuration could somewhat conflict with the real-world knowledge (e.g., 2b). For instance, in the original picture, the hare and fox were facing the cabbage and hare, respectively. However, in the new version, the hare and fox were made to face away from their respective appropriate objects. Similar modifications were made on all but one pictures. The present study, therefore, aims to see whether the 'discouraging' manipulation of visual configuration may be strong enough to affect the time course of the anticipatory eye movements reported in KAS.

(2a)

(2b)

In Experiments 1a and 1b (questionnaire studies), the original (Expt 1a) and new (Expt 1b) sets of the pictures were presented with sentence fragments such as 'The hare will eat the \_\_\_\_' or 'The hare will be eaten by the \_\_\_\_', in order to test whether the appropriate objects were the most preferred objects in the new set of pictures off-line. In both experiments, the appropriate objects were chosen in above 90% instances, and crucially, there was no statistical difference in the rates in both sets of the pictures. However, Experiment 2 (eye-tracking study), using the new set of pictures, found the appropriate objects were looked at no more often than the inappropriate ones during 'eat the'/'be eaten by'. Further analyses, however, revealed that the appropriate objects were correctly looked at more often than the inappropriate ones while they were being referred, confirming that language was being mapped onto the visual objects during the experiment. Overall, it was suggested that the visual configuration of the visual world in the experimental paradigm could affect the time-course of auditory sentence processing (as shown as anticipatory eye movements) even when they have no influence on eventual preferred interpretations of language and the visual world. The results will be discussed with respect to other relevant studies (e.g., Knöferle et al., 2004) as well as potential limitations of the experimental paradigm.

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## Sentence wrap-up: Investigating the effects of syntactic reanalysis and lexical access

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Although the sentence wrap-up effect is well-established in reading (Just & Carpenter, 1980; Mitchell & Green, 1978; Rayner et al., 1989; 2000), it is still very unclear what processes occur during sentence wrap-up. Furthermore, it is unclear whether readers complete all processing of a sentence during sentence wrap-up, or whether some processing of the sentence continues during the reading of the initial parts of the next sentence. We conducted two eye-movement reading experiments to answer these questions.

Experiment 1 investigated whether processes that occur during sentence wrap-up include syntactic processing, in particular syntactic reanalysis. We also investigated whether reanalysis is completed at the end of the sentence, or whether syntactic reanalysis spills over to the next sentence.

We tested syntactic ambiguities such as (1).

- 1a. When the woman cleaned the bucket that was filthy broke. All of a sudden the handle came off.
- 1b. When the woman cleaned, the bucket that was filthy broke. All of a sudden the handle came off.
- 1c. When the woman cleaned the bucket that was filthy broke all of a sudden. The handle came off.
- 1d. When the woman cleaned, the bucket that was filthy broke all of a sudden. The handle came off.

If sentence wrap-up processes include syntactic reanalysis, the reanalysis effect at the point of disambiguation (*broke*) should be larger when the disambiguation is at the end of the sentence (1a/b) than when it is not (1c/d). In contrast, if sentence wrap-up does not include syntactic reanalysis, the reanalysis effect should be the same, regardless of whether the disambiguation is at the end of the sentence.

Regression-path times showed an interaction between ambiguity and position of the full stop at *broke*, indicating that sentence wrap-up includes syntactic reanalysis processes. Regression-path times for temporarily ambiguous sentences (1a/c) were longer than for unambiguous sentences (1b/d), but the effect was much larger when the disambiguation occurred at the end of the sentence.

First-pass and regression-path times for the region following the disambiguation (*all of a*) were longer for temporarily ambiguous sentences than for unambiguous sentences, regardless of the position of the full stop. We conclude that the sentence wrap-up effect spilled over to the next sentence and readers continued syntactic processing during the reading of the next sentence.

Experiment 2 investigated whether sentence wrap-up processes include lexical access by manipulating lexical frequency (*soldier* vs. *samurai*):

- 2a. The enemy cruelly killed the soldier. With surprising force the sword penetrated his whole body.
- 2b. The enemy cruelly killed the samurai. With surprising force the sword penetrated his whole body.
- 2c. The enemy cruelly killed the soldier with surprising force. The sword penetrated his whole body.
- 2d. The enemy cruelly killed the samurai with surprising force. The sword penetrated his whole body.

Although we observed main effects of frequency and position of the full stop at the critical word, there was no interaction. This indicates that sentence wrap-up does not include lexical access. Taken together, the results from our experiments show that high level processes such as syntactic reanalysis affect sentence wrap-up in a different way from low level processes such as lexical access. Sentence wrap-up processes include syntactic reanalysis but do not include lexical access.

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## The role of conflict resolution in parsing: Individual differences in syntactic ambiguity resolution and executive control

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Most research on individual differences in sentence processing has focused on the role of working memory capacity in syntactic ambiguity resolution. We explore here whether individual differences in cognitive control, specifically general conflict resolution abilities, may account for differences in garden-path recovery. This is motivated by eye-gaze during listening research showing that young children have trouble revising parsing commitments [1], as do patients with damage to Broca's area [2]. Both groups also demonstrate difficulty resolving competing representations during non-syntactic, executive-control/working-memory tasks [3,4]. We hypothesize from these extreme cases that variation should exist among normal adults in garden-path recovery, tied to general conflict resolution abilities. Consistent with this, we show that individual differences in garden-path recovery correlate between tasks differing in modality and ambiguity-type, and that these differences correlate with cognitive control in working-memory tasks.

30 healthy adults participated in a battery of (syntactic) parsing and non-syntactic tasks, including: the 'Put' eye-gaze task previously administered to children and patients but now under time constraints (see 1 below); a whole-sentence reading task using direct object/sentence complement ambiguities (see 2); and a delayed letter verification (DLV) task. In the DLV, participants verified whether a probe letter ("g") was among a prior memory set ("t k g a"). Cognitive control was measured in trials for which the correct response was NO: characteristically, RTs are slower when the probe recently appeared (on the previous trial) compared to non-recent trials.

Averaging across subjects, we replicated previously findings: garden-pathing in the 'Put' task (i.e., looks to empty napkin) increased for only 1-Referent Ambiguous trials ( $p < .05$ ); sentence RTs increased for only DO-biased Ambiguous ( $p < .05$ ); and 'Recent-NOs' were slower than 'Non-recent NOs' ( $p < .05$ ). Assessments of individual differences showed that garden-path magnitude in the 'Put' task correlated with reading garden-path effects ( $r = .5$ ,  $p < .01$ ), whereas other measures (e.g., overall reading rate) did not, implicating a general ambiguity resolution ability differing among individuals but behaving similarly across modalities and ambiguity types. Both garden-path measures correlated with individual DLV interference scores ( $p < .05$ ), suggesting common processes among all tasks. (Reading-span, our 'capacity' measure, was also collected and crucially did not correlate with any of the other measures). Interestingly, half the subjects showed at least one child-like action error on 'Put' instructions, typically on the first 1-Ref Ambiguous trial. These subjects behaved differently from others, showing larger reading garden-path effects ( $p = .07$ ), reduced RT interference in DLV ( $p < .05$ ) but increased errors – i.e., they had trouble recovering from conflicting evidence.

Alongside the child and patient research, our findings demonstrate individual differences in normal garden-path recovery and cognitive control, perhaps arising from frontal lobe systems responsible for conflict resolution. Finally, given our evidence for a common process, we should expect better agreement between the observed contextual effects in reading and listening studies; yet, 2-Ref contexts appear to eliminate garden-path effects in listening studies [5] but not reading [6]. Indeed, we conclude by showing measurable difficulty exists for 2-Ref 'Put' instructions in all individuals, which went undetected in prior studies.

### Materials

- (1) Put the frog on the napkin into the box. (Ambiguous)  
Put the frog that's on the napkin into the box. (Unambiguous)

Referential Scenes contained, e.g., a frog on a napkin, an empty napkin, a box, and a horse or a frog in a bowl, corresponding to 1-frog or 2-frog scenes.

- (2) The talented photographer accepted (that) the money could not be spent yet. (DO-bias)  
The ticket agent admitted (that) the mistake had nothing to do with the price of the fare. (SC-bias)

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## The Processing of Mass & Count: Why *3 beers* is different from *too much banana*

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While the distinction between mass and count nouns is an important issue in linguistics, philosophy, and language development, it has hardly received any attention in psycholinguistics. We use this distinction as a test case to discriminate between the lexical and conceptual properties of a word. Concretely, we propose that lexical properties are activated immediately, while conceptual properties require more time to become available. Hence, if the mass-count distinction lies at the conceptual level (e.g., Krifka, 1995; Middleton *et al.*, 2004), one would not expect to find immediate processing effects. Alternatively, if the distinction is lexical or grammatical (e.g., Gillon, 1992; Steinhauer *et al.*, 2001; Vigliocco *et al.*, 1999; Wiese & Piñango, 2002), overwriting these features should lead to immediate processing difficulties. Two eye-tracking experiments explored this issue.

Experiment 1 employed sentences like (1-4):

- (1) Yesterday, John bought imported beers at the counter of the local supermarket.
- (2) Yesterday, John bought three imported beers at the counter of the local supermarket.
- (3) Yesterday, John bought imported pears at the counter of the local supermarket.
- (4) Yesterday, John bought three imported pears at the counter of the local supermarket.

In (1), a mass noun needs to be interpreted as a count noun (*portioning* due to being used as a plural) and there is no prior evidence (e.g., "three") that it will be used as a count noun. Results showed a very early disruption in the eye movement record for (1), without additional difficulty in the later measures.

Experiment 2 tested whether *grinding*, in which a count noun is interpreted as a mass noun, exhibited the same pattern of effects and employed sentences like (5-8):

- (5) Yesterday, John wanted imported beer after the rich main course.
- (6) Yesterday, John wanted a small amount of imported beer after the rich main course.
- (7) Yesterday, John wanted imported pear after the rich main course.
- (8) Yesterday, John wanted a small amount of imported pear after the rich main course.

Results indicated that (2c) required more processing effort, but this effect was mainly apparent during later stages of processing (re-reading).

Together, these results suggest that portioning involves extra effort, but can be achieved very quickly, while the mass interpretation of a count noun might involve more conceptual processing. We conclude that, at least, the feature <mass> needs to be part of a word's lexical entry. We relate these results to the processing and representation of polysemous words.

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## Syntactic Predictions on the Basis of Contrastive Accent Placement: An ERP Study

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A series of experiments has shown that prosodic phrasing influences syntactic processing in hearing (e.g., Marslen-Wilson et al., 1992; Warren et al., 1995; Steinhauer et al., 1999) and reading (e.g., Fodor, 1998, 2002; Steinhauer & Friederici, 2001). Fewer studies looked at the interaction of syntactic processes and accent placement (Grabe & Warren, 1995; Schafer et al., 1996, 2000; Bader, 1998). In a behavioral study, Carlson (2001) investigated the processing of elliptic constructions and was able to show that pitch accents bias the interpretation of ambiguous ellipses. We used *replacives* (Drubig, 1994; see examples in (1) and (2)) to find out whether the position of a contrastive pitch accent leads to predictions about the ellipsis site.

	<i>Subject contrast, correct (SK)</i>
(1a)	Am Freitag hat [der VAter] <sub>CF</sub> den Neffen beleidigt, und nicht [der ONkel] <sub>CF</sub> On Friday has the father <sub>nom</sub> the nephew <sub>acc</sub> insulted, and not the uncle <sub>nom</sub>
	<i>Subject contrast, incorrect (SI)</i>
(1b)	Am Freitag hat [der VAter] <sub>CF</sub> den Neffen beleidigt, und nicht [den ONkel] <sub>CF</sub> On Friday has the father <sub>nom</sub> the nephew <sub>acc</sub> insulted, and not the uncle <sub>acc</sub>
	<i>Object contrast, correct (OK)</i>
(2a)	Am Freitag hat der Vater [den NEffen] <sub>CF</sub> beleidigt, und nicht [den ONkel] <sub>CF</sub> On Friday has the father <sub>nom</sub> the nephew <sub>acc</sub> insulted, and not the uncle <sub>acc</sub>
	<i>Object contrast, incorrect (OI)</i>
(2b)	Am Freitag hat der Vater [den NEffen] <sub>CF</sub> beleidigt, und nicht [der ONkel] <sub>CF</sub> On Friday has the father <sub>nom</sub> the nephew <sub>acc</sub> insulted, and not the uncle <sub>nom</sub> 'On Friday, the father insulted the uncle, and not the nephew.'

Replacives only leave one narrowly focused element behind, the contrastive remnant. In the correct sentences (1a) and (2a), the remnant constitutes a correction or replacement of a constituent that bears a contrastive pitch accent in the related clause (focus structure is indicated by brackets and pitch accent by capitals). In the related sentences of the incorrect conditions (1b) and (2b), the constituent that bears a contrastive pitch accent does not contrast with the remnant. Using the method of event-related brain potentials (ERPs), we tried to answer the following question: Does the position of the pitch accent in the related sentence lead to different expectations with regard to the ellipsis site?

Our results show clear differences with regard to the position of the contrastive pitch accents. A contrastive accent on the subject in the related clause showed an early fronto-central positivity on the last DP whereas a contrastive accent on the object resulted in a late posterior positivity. Our explanation of this difference refers to the number of possible structural predictions depending on the accent positions: if the subject bears the contrastive accent, there exists only one possible structure for the correction by the ellipsis. The ellipsis site has to be a subject remnant. If the object bears the contrastive accent, more than one possible syntactic structure for a continuation exist: Not only the contrastive object remnant is a possible continuation, but the correction could also contrast other parts of the related clause, the VP or the whole CP. The reason for these multiple possibilities is the ambiguity of an focus accent on the object. To summarize, we found clearly different ERP effects for the processing of elliptic constructions dependent on the position of contrastive accents in the related clause.

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## Sound Advice in Language Comprehension: The Influence of Phonological Typicality on On-line Sentence Processing

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Some words have a phonological form that is more typical of its lexical category than others, and this may provide useful cues for language acquisition. We suggest that the phonological typicality of a word, relative to its lexical category, may influence both lexical category assignment and sentence processing in adulthood.

Focusing on nouns and verbs, we measured phonological typicality (PT) by transforming words into a slot-based phonological representation in which each syllable was encoded in terms of three slots for onset, two slots for nucleus, and three slots for the coda (e.g., /k . . e . l p . /, /h . . e . l p . / and /s t r i i t . . /). Each phoneme was represented in terms of 11 phonemic features. We then computed the Euclidean distance between the resulting phonological representations and all other nouns and verbs. We found that nouns tend to be significantly closer to other nouns and verbs significantly closer to other verbs in terms of their phonology (Monaghan, Chater, & Christiansen, *under revision*).

- (9) The office secretary was instructed to arrange all of the files in alphabetical order.  
 (10) The office secretary was instructed to manage the office while her boss was out of town.

Ten sentence frames were constructed with verbs ('was instructed') that strongly bias participants to expect infinitival complements. In one resolution, the infinitival complement was a verb with high verb typicality ("verby" verb, 'arrange' in 1), and the other resolution contained a verb low in verb typicality ("nouny" verb, 'manage' in 2). These target verbs were controlled for frequency, number of syllables/phonemes, number of nearest neighbors, orthographic length, as well as the overall sentence plausibility. Sentences were presented using a word-by-word self-paced reading task. Participants took significantly longer to read the "nouny" verb targets compared to the "verby" verb targets ( $t_1(21)=3.145, p=.005; t_2(18)=1.77, p=.093$ ).

Given that verb PT affected on-line sentence processing on unambiguous verb-biased structures, Study 2 investigated the influence of phonological typicality on sentence processing in the context of syntactic ambiguities arising from the lexical category ambiguity associated with noun/verb homonyms. A set of sentences was created in which the phonological typicality of the homonyms was manipulated in such a way that 10 words were phonologically typical nouns and 10 were phonologically typical verbs. Half of the sentences for both nouns and verbs were resolved with a noun interpretation of the ambiguity and the other half with the verb interpretation. Consider the following example:

- (11) Chris and Ben are glad that the bird perches *seem easy* to install.  
 (12) Chris and Ben are glad that the bird perches *easily in* the cage.

The N/V homonym, 'perches', is a phonologically typical noun. Accordingly, it was predicted that participants would consider the noun resolution (3) over the verb interpretation (4). In other words, they should be slower ("garden-pathed") when encountering a verb resolution compared to encountering a noun resolution. A 2 (typical V vs. typical N) X 2 (N-resolved vs. V-resolved) X 2 (point of ambiguity (N/V homonym) vs. disambiguation (two words following N/V homonym)) repeated measures ANOVA was conducted. Plausibility (both of overall sentence and noun compound), frequency of usage, and degree of typicality were all controlled for in such a way that no significant differences existed between nouny and verby homonyms. A significant three-way interaction ( $F_1(1, 29) = 11.15, p = .002, F_2(1, 18) = 5.28, p = .034$ ), revealed that phonological typicality did influence the manner in which participants preferred to resolve the sentences. Specifically, for the "verby" N/V homonym sentences, RTs increased from the point of ambiguity to disambiguation for the noun-resolved sentences much more so than they did for the verb-resolved sentences. Additionally, for the "nouny" N/V homonym sentences, RTs increased much more from the point of ambiguity to disambiguation for the verb-resolved sentences than they did for the noun-resolved sentences.

The results demonstrate that the sound properties of individual words have direct and immediate ramifications for on-line sentence comprehension, even in the visual modality. This study provides support for constraint-based theories of sentence processing in which multiple cues are integrated on-line in order to facilitate comprehension. Our results lend support to the notion that human sentence processing is a dynamic and highly interactive process influenced not only by syntactic and semantic information, but also by phonological cues in the linguistic input.

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## The role of orthographic information in speech production revisited

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Research in the field of word perception has shown that information not logically required for accomplishing a given task can have an impact on participants' performance. For example, phonological properties of words are activated early-on and do influence the orthographic processes of visual word recognition. Somewhat in parallel, orthographic knowledge has been shown to influence the perception of speech in certain experimental settings. This class of effects is generally used to argue in favour of interactivity between different linguistic modules.

A recent study by Damian and Bowers (2003) extended this type of observation to the processes involved in oral speech production, a behaviour that does not logically require the activation of orthography. These authors used a form-preparation paradigm (a.k.a., implicit priming paradigm). They examined whether the orthographic properties of the words that participants produced had an influence on the amount of preparation that was possible on the basis of phonology. Their results consistently showed that phonological preparation effects were disrupted in conditions where orthographic properties were inconsistent. More specifically, participants produced words faster in blocks where the words to be produced shared their initial phoneme and letter than in blocks where they shared the initial phoneme but not the initial letter or when they were unrelated.

We investigated this possible role of orthography in speech production using a picture naming paradigm and a design parallel to that of Damian & Bower's experiments. In our study, no orthographic effect was observed during oral word production. Form preparation was based on the phonological properties of the words alone, irrespective of their orthographic properties. We confront the two results and we discuss whether an influence of orthography can be expected in speech production.

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## Differences in morphological processing in first and second language speakers: An ERP study.

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Neurophysiological studies and studies on patient population with different site lesions have recently brought convergent evidence showing that the processing of verbal morphology is driven by different cognitive processes governed by different brain regions (Ullman et al, 1997). Regular verbs, rule-governed, may be controlled by frontal regions while irregular verbs, fully retrieved from the lexicon, may depend on more temporo-parietal sites. However most of these studies have focused on English, a morphologically simple language. More complex languages seem to show also dissociations but with a different pattern (i.e. de Diego Balaguer et al. 2004 in Spanish; Penke et al. 1999, in German). In the current ERP experiment we were interested in observing if this converse pattern found in Spanish was also reflected in the electrophysiological responses. We distinguished two type of irregularities in order to see if the brain responses would also vary along this conditions: one extended irregularity that consists always in the same alternating vowel-diphthong correspondence in the stem (*semi-regular*) (1), and more *idiosyncratic* irregularities (2). In an attempt to block semantic priming we adopted a paradigm developed in the word-reading domain by Stolz and Besner (1998) where subjects performed a dual task: a letter search in the prime word and a lexical decision on the target.

- (1) "e" becomes "ie" as in sentir (to feel) - siento (I feel) / "o" becomes "ue" as in dorm.ir (to sleep) – duerm.o (I sleep) .  
(2) vowel changes: ped.ir (to beg) - pid.o (I beg) and consonant changes: sal.ir (to exit) – salg.o (I exit)

We were also interested in observing if first and early second language learners would show differences in the way they process regular and irregular verbs. Thus, two groups of Catalan-Spanish high proficiency bilinguals were tested: subjects for whom Spanish was their L1 and subjects for whom Spanish was their L2. According to a Dual perspective of morphological processing rule-governed knowledge should differ between L1 and L2 speakers. Results showed that while both L1 and L2 subjects showed the same N400 effect for regular verbs, irregular verbs differed across groups. The L1 group showed no N400 effect for semi-regular verbs while L2 subjects showed no N400 effect for idiosyncratic verbs. These results contrast with those obtained with languages such as English or German.

The fact that both regular and irregular verbs have suffixes in both Spanish and Catalan may make regular verbs less. These differences across languages in morphological processing may imply different brain areas recruited according to the characteristics of the language as suggested by convergent data with fMRI measures (de Diego et al., submitted).

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## Interference by suprasegmental overlap in picture naming

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In the picture-word interference task, pictures are named while attempting to ignore simultaneously presented distractor words. Segmental overlap (i.e. phonological or orthographical overlap) between target and distractor word has been demonstrated to facilitate picture naming. Thus far, little attention has been paid to features extending over several segments, and such suprasegmental features are rarely controlled for in stimulus selection. Nevertheless, some suprasegmentals are (reasonably) fixed word properties, such as word stress position and vowel quality. The presented studies took up this issue and the combination of word stress and vowel quality was investigated in a picture-word task.

A series of three experiments used Dutch target and distractor words of three possible suprasegmental patterns, resulting in a varying degree of suprasegmental relatedness between target and distractor. Fully related, partly related (either in stress pattern or vowel quality pattern), and fully unrelated conditions were compared while controlling for a manifold of variables. Distractor words affected vocal latencies for picture targets of a similar suprasegmental pattern. Reaction times increased from unrelated to fully related conditions, contrary to the facilitatory effects provided by the picture-word paradigm in case of segmental overlap. However, inhibitory form priming has been observed in other picture naming paradigms and variants of the picture-word task, and an account will be extrapolated from these instances.

A fourth experiment factorially crossed segmental and suprasegmental overlap and showed the suprasegmental interference effect can be clearly distinguished from the segmental facilitation effect. A main effect of phonological facilitation was observed, but the suprasegmental effect arises only in the absence of segmental overlap. The suprasegmental effect dissipates when suprasegmental features are manipulated in the presence of segmental overlap. This observation clarifies results of Experiment 3 in which segmental overlap was an artefact of the manipulation of suprasegmental overlap.

## A differential impact of semantic and morphological distractors on picture naming

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Numerous picture-word studies have shown that distractor words interfere with picture naming when they belong to the same semantic category as the pictured object (e.g., the word *apple* with the picture of a banana; *canary* – picture of a bird) . Distractors from a different category, often from a different word class, facilitate picture naming (e.g., *yellow* – picture of a banana; cf. Alario, Segui & Ferrand, 2000). With distractors that are morphologically related to the picture name, we consistently observed facilitation, independent of semantic category (e.g., *hummingbird* – and *birdlike* – picture of a bird) and even of semantic transparency (*jailbird* – picture of a bird; Zwitserlood, Boelte, Dohmes, 2002; Dohmes, Zwitserlood, Boelte, 2004).

Interference is explained in the model by Levelt, Roelofs and Meyer (1999) by competition for selection between elements (lemmas) that can be potential responses, for example, those belonging to the same semantic category. Semantic distractors from a different category / word class provide no competition. The problem is that both the conceptual and the lemma level in the model are blind to the morphological make-up of words. Given that it is an appropriate response, *hummingbird* should compete with *bird* just as much as *canary* does.

We addressed these issues by manipulating morphological-and-semantic vs. mere semantic relatedness (*rosy* or *thorny* – picture of a rose), within-category vs. subordinate relation (*leopard* or *gorilla* – picture of an ape), and existing vs. novel combinations (*sunflower* and *glonflower* – picture of a flower). Clearly, the novel combinations have no lexical status and thus no lemmas. Next to expected competition effects, the data reveal clear facilitation for all distractors that contain the morpheme needed for picture naming. We will point out the implications for models of speech production.

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## The role of frequency information in compound production

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In a series of four experiments the authors investigated the role of frequency information in compound production. As a rule, low-frequency words are produced at longer latencies than high-frequency words (Oldfield and Wingfield, 1965) and it is word form frequency, or more precisely, the frequency of the word's phonological code that matters (Jescheniak and Levelt, 1994). See Bates et al. (2003) for further a discussion of the locus of frequency effects.

This makes the case of morphologically complex words especially interesting, because they include more than one phonological code (morpheme). For example, the Dutch compound (C) *marktvrouw* (market woman) is composed of the morphemes *markt* ( $M_1$ ) and *vrouw* ( $M_2$ ). Each morpheme has its own frequency of usage,  $F(M_1)$ ,  $F(M_2)$ , as has the compound as a whole,  $F(C)$ . Which (combination) of these three factors affects response latency? In four experiments we examined how varying these frequencies influences the compound production latencies. We used a position-response association task, in which participants learned to associate a certain compound with a visually marked position on a computer screen. In the test phase, participants produced the associated compound in response to the appearance of the position mark and we measured response latencies. In each experiment, sixteen pairs of Dutch noun-noun compounds were selected as targets, such that there was a maximal contrast for one frequency ( $F(C)$ ,  $F(M_1)$  or  $F(M_2)$ ), while the other two were matched.

In the first experiment, each pair (e.g., *marktvrouw* (market woman) - *marktkraam* (market booth)) shared the first morpheme, and therefore its frequency, and was matched on  $F(C)$ .  $F(M_2)$  was either high or low. Compounds including the higher-frequency second morphemes were produced significantly faster than their matches. In the second experiment, pairs shared the second morpheme, (*steentijd* (stone age) - *brons tijd* (bronze age)) and were matched on  $F(C)$ .  $F(M_1)$  was either high or low. The frequency contrast significantly affected the compound production latencies. In the third experiment, pairs *nachtploeg* (night shift) - *windhoos* (whirlwind)) were matched in  $F(C)$  with frequency contrasts on both  $F(M_1)$  and  $F(M_2)$ . Again, the compound naming latencies were affected by the frequency of the constituents. In the final experiment, pairs (*rechtspraak* (jurisdiction) - *nachtploeg* (night shift)) were matched in both  $F(M_1)$  and  $F(M_2)$  with a frequency contrast on  $F(C)$ . This time, there was no difference in the production latencies.

Taken together, the results suggest that the production latency of a compound is not influenced by its frequency of occurrence as a compound, but rather varies according to the frequencies of its constituting morphemes. This supports the notion that after selecting the compound's lemma, the speaker successively accesses the phonological codes of the two morphemes. Articulation is not initiated before both codes have been retrieved.

We additionally compared the predictive values of different measures of constituent frequency in a regression analysis of the joint data of the experiments 1-3. The measures positional frequency and positional entropy outperformed the lemma frequency of the constituents suggesting a structural storage. Also, the left and right constituents are affected differently by these positional frequency measures, though the total outcome is facilitation for both.

## Access and representation of open and concatenated English compounds: the role of the constituent family revisited

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What influence does orthography have on the access and representation of words? This study examines processing differences between English open compounds (compounds with separated constituents, e.g. *apple pie*) and concatenated compounds (compounds written as single words, e.g. *cheesecake*). In a post-hoc analysis of a visual lexical decision experiment, De Jong et al. (2002) found evidence for open compounds to be recognized faster when their modifiers occur in many other compounds (i.e. compounds with a higher 'modifier family size'), while concatenated compounds appeared to be recognized faster when their modifiers occur in many frequent compounds (i.e. compounds with a higher 'modifier family frequency'). High modifier family frequency may help to recognize the modifier and therefore to access the compound. Following the interpretation of morphological family size effects (De Jong et al., 2000), a modifier family size effect shows co-activation of compounds with the same modifier, due to spreading activation at a semantic level of lexical representation. De Jong et al.'s (2002) results therefore suggest that concatenated and open compounds differ in terms of central (semantic) lexical representation. However, there is no obvious reason for this difference. The use of a space in English compounds seems to be rather conventional. There is surely no semantic rule that governs its usage (see, e.g., *bookshop* vs. *coffee shop*).

We therefore tried to confirm De Jong et al.'s post-hoc results, using a factorial design. In experiment 1, we contrasted position family size of compound modifiers and heads. In experiment 2, we manipulated family frequency of modifiers and heads. Results revealed that open compounds are recognized faster than concatenated compounds, independent of family frequency and family size (see De Jong et al., 2002). We argue that the visual separation of the constituents in open compounds enhances the identification of constituent boundaries and therefore the recognition of the compounds. In contrast to De Jong et al.'s study, there were no processing differences between open and concatenated compounds with regards to differences in family size and family frequency. Both kinds of compounds were recognized faster when they contained a modifier or a head with a high family size. There was no effect of family frequency. These findings suggest that both types of compounds are equal in terms of central-level representations. We argue that orthographic conventions do have an effect on the access of words, but not on central lexical representations.

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## Investigating the Automaticity of Code-Switching Using Masked Priming: An Event-Related Potentials Study

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It is generally accepted that switching between linguistic codes incurs a cognitive cost under most circumstances. However, it is not known whether this cognitive cost occurs during automatic or controlled processes, or if it occurs at different places in the processing stream based on language competency. In this study English-native university students early in the process of learning French were exposed to word pairs, in which the first word of the pair was completely masked (duration 10ms), and event-related potentials were recorded to target words. There were four trial types per block: one in which the prime and target were identical; one in which the prime and target were the same language but different items; one in which the prime and target were from different languages; one in which target words were probe items for the semantic categorization task. These trials were blocked by language of the target—one block contained only trial types with French targets, and one only trial types with English targets. The order of these blocks was counterbalanced across subjects. The N250, known to be sensitive to automatic language processing issues, demonstrated sensitivity to language-switching, as did the N400, a well-known index to controlled language processing. The N250 showed progressively greater negative deflection between repetition trials, within-language trials, and between-language trials; this deflection was greater for the French block (the subjects' L2). The standard repetition effect was obtained for repetition trials; in English trials, increasingly greater negative deflections to the N400 to within-language and between-language trials were seen. However, in French trials, the between-language trials produced no greater deflection than the within-language trials. These results are consistent with the hypothesis that the N250 reflects automatic processes; they are also in agreement with the majority of research suggesting that the N400 represents controlled processes. (Although the N400 has been shown to be sensitive to masked priming, this is best interpreted as evidence that the N400 is dependent on the outcome of automatic processes, and not an automatic process itself.) Our results suggest that there is an automatic aspect to code-switching as well as a controlled aspect, and this controlled aspect may be mediated by competency. The implications of these results will be discussed within the framework of recent models of bilingual lexical processing.

**Masked cross-modal morphological priming:  
Unravelling morpho-orthographic and morpho-semantic influences in early word recognition**

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Already in the early days of psycholinguistics, researchers have acknowledged the importance of morphological complexity (e.g., Murrell & Morton, 1974). Since then, numerous studies have demonstrated the crucial role that morphology plays in the way words are stored and accessed in the mental lexicon. Up to today, however, there is little agreement as to precisely how morphological complexity plays that role. Within the variety of different theoretical views, a rough distinction can be made on the basis of the adopted definition of a 'morphemic processing unit'. Whereas some approaches define these units purely by their (orthographic and/or phonological) form (e.g., Taft & Forster, 1975; Longtin, et al., 2003; Rastle et al., in press), others stress the unique property of morphemes as instances capturing regularities between form and meaning (Giraud & Grainger, 2000,2001,2003). Clearly this issue has important implications for the locus of morphological effects. In the present study we addressed this issue by examining priming from semantically transparent and opaque suffix-derivations (including pseudo-derived words such as *corner*), using the masked cross-modal priming technique (Grainger et al., 2003). In this technique, a visual or an auditory target directly follows a briefly presented visual masked prime. Our first experiment showed that, in a Dutch lexical decision task, latencies to root targets were facilitated when visually presented primes were semantically transparent derivations of the target, regardless of whether targets were presented visually or auditorily. Pseudo-derivations only provided weak evidence for priming and only when targets were presented visually. In a second experiment we tested transparent and opaque priming more thoroughly in a French lexical decision task by using the incremental priming technique in combination with a psychophysical approach. The results showed that opaque as well as transparent derivations facilitated the visual and auditory processing of their (pseudo-) root. However, in the visual modality (i) transparent priming occurred earlier than opaque priming and (ii) when opaque priming appeared, transparent derivations produced a larger facilitation effect. The above pattern shows a double contribution of morphemes to lexical processing: one based on their formal properties (priming of opaque primes) and one based on their morpho-semantic properties (different time-courses for opaque and transparent items). Our findings shed new light on the issue of morphological processing by suggesting the existence of two distinct processing systems underlying early morphological processing: a *morpho-orthographic system* and a *morpho-semantic system*.

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## The locus of frequency effects in word recognition

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When people are required to respond to two stimuli presented in quick succession, response times to the second stimulus generally increase as stimulus onset asynchrony (SOA) decreases. This is often attributed to a resource bottleneck that prevents one or more stages of processing from being carried out simultaneously for both stimuli. McCann et al. (2000) have used the dual-task paradigm to argue that visual word processing is not automatic. Here we use the same paradigm to examine automaticity and bottleneck effects in spoken and visual word recognition.

In Experiment 1, participants made a binary colour discrimination response to a visually presented square (S1), quickly followed by a lexical decision response to a spoken word (S2). As SOA was reduced, response times to S2 increased. Unlike McCann et al., we found that spoken word frequency effects were underadditive with SOA: at 800ms SOA, there was a 124ms frequency effect, at 200ms SOA an 89ms effect, and at 100ms SOA an 82ms effect. Experiment 2 used a similar approach to investigate visual word processing (S1: binary pitch discrimination, S2: lexical decision to a visual word), and again found underadditive frequency effects with SOA. These underadditivity effects suggest an automatic pre-bottleneck locus for frequency effects in word recognition.

In Experiment 2, as predicted by bottleneck models, we found a direct linear relationship between response time to S2 and SOA in Experiment 2 (i.e. a slope of -1 between response times for the shortest SOAs). This theoretically important -1 slope was not evident in Experiment 1 for spoken words. Experiment 3 again investigated spoken word recognition, this time aligning S1 relative to the final phoneme of S2. Using this method, we found the predicted -1 slope. This suggests that spoken and visual word recognition systems are similarly affected by dual-task bottlenecks - the only difference is in terms of the timecourse of information availability.

Our finding that frequency effects were underadditive with SOA suggests that pre-bottleneck frequency-sensitive processing makes use of the "slack" time available during processing of S1. Rather than supporting McCann et al.'s argument for a late locus of frequency effects, our findings are consistent with an early and automatic locus of frequency effects for both visual and spoken word recognition.

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## WordGen: A Tool for Word Selection and Non-Word Generation in Dutch, English, German and French

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WordGen is an easy-to-use program that uses the CELEX and Lexique lexical databases for word selection and non-word generation in Dutch, English, German and French. Items can be generated in these four languages, specifying any combination of seven linguistic constraints: number of letters, neighborhood size, frequency, summated position-nonspecific bigram frequency, minimum position-nonspecific bigram frequency, position-specific frequency of the initial and final bigram and orthographic relatedness. The program also has a module to calculate the respective values of these variables for items that have already been constructed (either with the program or taken from earlier studies). Stimulus queries can be entered through WordGen's graphical user interface, or by means of batch files. WordGen is especially useful for (1) Dutch and German item generation, because no such stimulus selection tool exists for these languages, (2) the generation of non-words for all four languages, because our program has some important advantages over previous non-word generation approaches and (3) psycholinguistic experiments on bilingualism, because the possibility of using the same tool for different languages increases the cross-linguistic comparability of the generated item lists. WordGen can be downloaded freely from the following URL: <http://expsy.ugent.be/wordgen.htm>.

**Neural correlates of speech segmentation:  
event-related brain potentials (ERPs) and functional Magnetic Resonance Imaging (fMRI) evidences**

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Speech segmentation, or how to identify the component units in a continuous speech stream, is one of the main problems a listener faces when confronting unfamiliar spoken language. Besides, it is one of the first tasks an infant has to solve in order to acquire language (Saffran et al. 1996a). Even though, there are several regularities in speech, such as prosodic, accentual or phonotactic regularities that help the listener in solving this task. One of the key cues that listeners exploit is the statistical information contained in the speech. The aim of the project is to study the neural mechanism (time course and brain network) implied in the detection of statistical regularities for speech segmentation. In the first part of the project two behavioural experiments were conducted in order to evaluate the ability to segment words and the amount of time needed for the accomplishment of this process. As in previous behavioural studies the percentage of correct detected words was ~ 70%. Next, an ERP experiment was planned with the aim of studying the on-line evolution of this segmentation process. Finally, a block fMRI study was conducted in order to identify the brain regions implied in the present task.

During the speech segmentation task, a synthesized acoustic stream is presented (8 minutes duration), which consists in four trisyllabic nonsense words concatenated to form a speech stream with no acoustic pauses between items (i.e. pirutabagolitokudagukibo...) (Saffran et al., 1996). The grouping of syllables that have higher transitional probability are segmented from the stream and afterwards, recognized like possible word-candidates of the artificial language created. In addition, a baseline acoustic condition was created in which a stream of equal characteristics and syllables were presented with the restriction that all syllables had equal transitional probability (random presentation). In this condition, transitional probability could not be used in order to identify clear "possible words". Five streams were created for each language and random condition.

In the ERP experiment, the experimental setting created allowed us to identify time-related ERP averages associated to the process of segmentation. Averages were created for the four blocks (two minutes each) in which the five languages and five random languages were presented. Possible-words elicited a widespread negativity peaking at about 300-400 ms at fronto-central sites, coinciding with the processing of the second syllable. This N400 component identified could be considered as on-line index of speech segmentation. Importantly, the amplitude of this component was larger at the second block, approximately at the time point in which the segmentation process should take place. The mean percentage of correct detected words was 67.5%.

In the block fMRI experiment, two brain regions were observed to be active during speech segmentation process: the posterior superior temporal gyrus and the ventral premotor cortex. Time-course reconstruction of the BOLD responses showed that these areas were more activated during the first two minutes of the language streams, compared to the random streams. This auditory-premotor interface is proposed as the brain network involved in segmenting possible candidate words when learning a new language.

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## DOES PRACTICE MAKE PERFECT?

### An ERP study of morphosyntactic processing in highly proficient English-Spanish late bilinguals.

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Two of the most influential factors in determining the nature and characteristics of second-language processing are age of acquisition and level of proficiency. It is often claimed that language processing in the L2 when this is acquired late (after a critical period) will not be automatic in nature or qualitatively comparable to L1 processing. Many studies have supported this assumption (Weber-Fox and Neville 1996, Hahne and Friederici, 2001) as they have failed to find evidence of automatic syntactic processing in late bilinguals. However, many of these studies have involved late bilinguals with a relatively short history of exposure to the L2 and thus a comparatively low level of competence in this language.

Another open question is whether similarities between L1 and the L2 influence bilingual processing. In that sense, one interesting question is whether the presence of a particular syntactic feature in the L1 allows late learners to more easily acquire this in the L2 and so be able to process this feature in a similar way to that of their first language.

We examined both of these questions by selecting a group of late English-speaking bilinguals who were first exposed to their L2 (Spanish) after puberty but who have been immersed in a Spanish-speaking environment for an average of 20 years and are thus highly proficient in the L2. We investigated how these late but highly competent bilinguals process morphosyntactic features of Spanish that coincide or not with features of their L1 (English). Morphosyntactic agreement is computed for grammatical as well as for conceptual gender in Spanish, which is not the case in English, where only conceptual gender is considered. However, in both Spanish and English, number is an important feature of agreement computation.

A previous study recently carried out in our laboratory with monolingual Spanish speakers reading sentences containing grammatical gender and number violations revealed an ERP pattern of LAN and P600 in response to this type of morphosyntactic violations, with no differences between the number and gender conditions. We used these same materials to contrast the performance of the competent late bilinguals with that of the monolinguals in overlapping (number agreement) and non-overlapping (grammatical gender agreement) morphosyntactic features.

Results included a Left Anterior Negativity effect –generally taken to indicate automatic processing –for both conditions and a P600 effect for number violations.

This would seem to indicate that early agreement processes can become automatic in proficient bilinguals, even for features that are not present in the L1. However, the reanalysis and repair processes normally associated with the P600 component would seem to be engaged only for features that are present in L1.

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## Representing verb transitivity information: Evidence from syntactic priming

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We report two syntactic priming experiments that provide new evidence about how people represent verb transitivity information. Although it is generally assumed that people must represent such information and use it during sentence processing (e.g., Clifton et al., 1984; Stowe et al., 1991), it is unclear exactly how transitivity information is stored.

Arai et al., (2003) reported initial evidence from syntactic priming. Participants produced more monotransitive completions to (2) after reading monotransitive (1a) than intransitive primes (1b).

- 1a. The teenager was bullying the man. (monotransitive prime)
- 1b. The teenager was bullying. (intransitive prime)
- 2. While the prisoner was bullying/jeering ... (target to be completed)

Furthermore, after intransitive primes, participants produced more intransitives when the verb in prime and target were the same than when they were different. Most interestingly, however, for monotransitive primes, there was no verb repetition effect. Arai et al. concluded that information about intransitives is represented for each individual verb (lexically specific), whereas information about monotransitives is represented for the class of verbs as a whole (category general).

Two experiments corroborate and extend Arai et al.'s (2003) model. Experiment 1 investigated whether the absence of a verb repetition effect for transitives generalises to verbs other than mono/intransitives. We tested mono/ditransitive verbs (3).

- 3a. The performer sold the ticket. (monotransitive prime)
- 3b. The performer sold the tourist the ticket. (ditransitive prime)
- 4. The uncle sold/offered ... (target)

Participants produced more monotransitive completions to (4) after monotransitive primes (3a) than after ditransitive primes (3b). Most importantly, we observed a verb repetition effect for ditransitive but not for monotransitive primes.

We conclude that information about monotransitives is represented at the category-general level whereas information about ditransitives is represented at a lexically specific level. We argue that this is the most parsimonious representation, because almost all verbs can be monotransitive, whereas far fewer verbs can be ditransitive (Arai et al., 2003).

In Experiment 2, we investigated whether transitivity priming is thematic (number and type of thematic roles) or structural (argument order). If priming is thematic, *wh*-movement sentences (5) should prime monotransitives, because the thematic roles are the same as in (1a).

- 5. It was obvious which man the teenager was bullying. (*wh*-movement)
- 6. While the prisoner was bullying/jeering ... (target)

If priming is structural, (5) should prime intransitives, because their surface structure is more similar to intransitives: They lack a NP following the verb.

Participants produced more intransitive completions following (5) when the verb in prime and target was the same than when it was different, indicating that *wh*-movement sentences and intransitives are represented similarly. We argue that the results are inconsistent with thematic priming and conclude that the priming effect is structural. Taken together, these results support Arai et al.'s conclusion that information about monotransitives is category-general, whereas the representation of intransitives and ditransitives is lexically specific. They also suggest that the representation of transitivity information is predominantly structural.

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## Translation equivalence enhances cross-linguistic syntactic priming

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Only recently, research on bilingualism is beginning to focus on the syntactic, rather than the lexical level. For example, Hartsuiker, Pickering and Veltkamp (2004), using a dialogue version of the syntactic priming paradigm (Branigan, Pickering, & Cleland, 2000), found evidence for cross-linguistic syntactic priming in Spanish bilinguals by manipulating the use of transitive structures (passive-active). Somewhat less conclusive evidence was found in a study by Loebell and Bock (2003), using datives.

The aim of the present study was twofold. First, we planned to replicate the findings of dative priming with Dutch bilinguals. Second, our interest was to explore the role of translation equivalent verbs in cross-linguistic syntactic priming. Experimental trials consisted of a Dutch dative prime sentence produced by a confederate, followed by the English description of a dative target picture, given by the bilingual participant.

Experiment 1 showed that the use of the English prepositional dative was more common following a Dutch prepositional dative (de kok geeft een hoed aan de non [the chef gives a hat to the nun]), than following a Dutch double object dative (de kok geeft de non een hoed [the chef gives the nun a hat]). Moreover, the syntactic priming effect tended to be stronger if the verbs used in prime and target were translation equivalents, rather than unrelated verbs. Using an improved (i.e. within-items) design, these results were replicated more strongly in Experiment 2. Hence, the syntactic priming effect was increased significantly using translation equivalent verbs.

Taken together, these results strongly suggest syntactic sharing between languages. More importantly, we found that translation equivalency enhanced the dative priming effect. We believe that this enhanced effect is due to simultaneous activation of a combinatorial node, specifying the dative structure (Pickering & Branigan, 1998) and the translation equivalent's lemma (due to the connection between the semantic representation and the lemma), increasing the probability of selecting the same structure with the translation equivalent (see Cleland & Pickering, 2003, for a similar interpretation of semantic enhancement in monolingual syntactic priming). We plan to extend the results of the present study with a monolingual experiment in L2 (English), using repeated verbs. Branigan, et al. (2000) showed an enhanced syntactic priming effect with repeated verbs in English speaking monolinguals. Experiment 3 will investigate whether this effect can be replicated within an L2- monolingual setting, and whether this repeated verb effect is comparable to the observed translation equivalency effect.

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## PO/DO priming in comprehension: A visual world eye-movement study

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Many language production studies have shown that people tend to reuse the same syntactic structure across consecutive sentences, a phenomenon known as syntactic priming (e.g., Bock, 1986). It is often assumed that comprehension and production share the same grammatical representation and that priming occurs in comprehension as well as production (e.g., Pickering & Garrod, in press). Priming studies in comprehension (Pickering & Traxler, 2004; Scheepers & Crocker, 2004) have so far mainly focussed on syntactic ambiguities that are very different from the structures used in production studies. In the current experiment, we will investigate whether priming during comprehension occurs in ditransitive sentences such as (1) and (2), which have either a prepositional object (PO) or double object (DO). Syntactic priming in language production is well-established in these structures (e.g., Bock, 1986; Pickering & Branigan, 1998).

We investigated PO/DO priming in comprehension by combining a reading paradigm with the visual world eye-movement method (Scheepers & Crocker, 2004). Participants first read prime sentences, either DO (1a) or PO ditransitives (1b). Subsequently, they saw target pictures and at the same time listened to auditorily presented sentences, which either contained a DO (2a) or PO structure (2b). The target pictures always contained three entities (the agent, recipient and theme).

- 1a. The assassin will send the dictator the parcel. (DO prime)
- 1b. The assassin will send the parcel to the dictator. (PO prime)

- 2a. The pirate will send the princess the necklace. (DO target)
- 2b. The pirate will send the necklace to the princess. (PO target)

We analysed gaze durations that started between the onset of the verb and the onset of the post-verbal noun in the target sentence. The result showed an effect of prime condition on fixated object (theme or recipient): After DO prime sentences, there were longer gazes at recipient objects, whereas after PO primes there were longer gazes at the theme objects.

In conclusion, the experiment shows that syntactic priming occurs in the same structures in both production and comprehension. Furthermore, the results show that people anticipate the next constituent (recipient or theme) at the verb. We propose that in addition to projecting thematic argument structure (which is underspecified for argument order), language users also project the order of the arguments upon encountering the verb. Thus, the results extend findings by Altmann and Kamide (1999), who showed that listeners predict the type of argument that follows a monotransitive verb.

## The processing of object relative clauses in young Hebrew speakers

Inbal Arnon

It has long been noted, in a variety of languages (French, English, Hebrew) and tasks (act-out, picture-selection) that children have difficulty in comprehending object relative clauses. Two studies examining the production and comprehension of both resumptive and non-resumptive object relatives report (i) a novel error pattern and (ii) a correlation between the novel error and production of object relatives with resumptive pronouns.

One prominent explanation attributes the difficulty to children's syntactic inability to resolve filler-gap dependencies [The Movement hypothesis 1,2]. Findings that adults also have difficulty with object relatives [3,4] and that children do not experience difficulties with comprehending WH-questions, which involve similar dependencies [5,6] suggest, however, that children's difficulty may not be due only to underdeveloped structural operations but rather to processing limitations. This proposal was examined in two studies that investigated error patterns in comprehension and production of object relatives and comprehension of resumptive relatives using a picture-selection task.

Findings of Reversal errors (assigning the reverse thematic role to the clausal head) and of chance performance on object relatives have been cited as support for the Movement hypothesis [1]. Study 1 examined the stipulation that methodological limitations may have hindered detection of errors that are not compatible with this hypothesis. In addition, comprehension and production were evaluated among the same children, which has not been previously done. Specifically, using a picture-selection task in which children match a relative clause like *Show me the grandmother that the girl is kissing* to one of two pictures (girl kissing grandmother vs. grandmother kissing girl[1]) only detects errors of thematic reversal. In contrast, in the present study 14 young Hebrew speakers (mean age 4;7) were asked to identify an NP rather than a picture thus enabling the detection of a full error range. Comprehension results confirmed a novel Agent error (e.g., choosing the girl that is kissing the grandmother) that occurred almost as frequently (22%) as did the Reversal error (28%). Interestingly, a significant correlation ( $r = .57, p < .05$ ) was found between the Agent error and production of object relatives with resumptive pronouns, which are grammatical in Hebrew. Study 2 then tested the seven children who showed poorest comprehension of object relatives on comprehension of resumptive relatives (*Show me the grandmother that the girl is kissing her*), which are grammatical in Hebrew. Such structures are not considered to involve movement in Hebrew[7], and hence under the Movement explanation should not cause children any difficulty. Results confirmed, in contrast, that although children performed somewhat better (52% correct vs. 34% for non-resumptive object relatives), they still performed poorly.

The identification of the novel Agent error together with children's poor comprehension of resumptive structures seems to undermine the Movement hypothesis. The correlation between the novel error and production with resumptive pronouns calls for further investigation of the role of resumptives in processing. Discussion of the results draws on the influence of referential properties of relatives on adult processing [4,9] to suggest a processing explanation that views child and adult performance as different points along the same continuum: what adults find hard, children find even harder.

### Answer types

*Show me the grandmother that the girl is kissing*

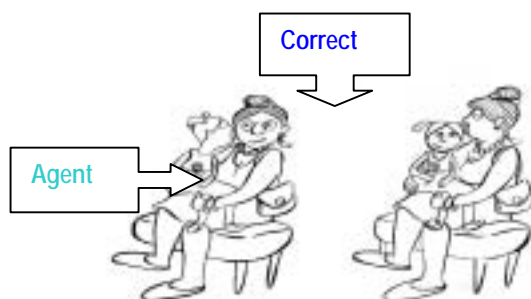
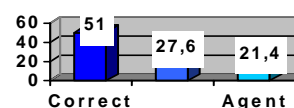


Figure 1  
Performance on object relative clauses



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## The Use of Prepositions Lowers Relative Clause Attachment Preferences in German

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While processing ambiguous sentences, prosodic phrasing might influence the preferred interpretation even in silent reading (see Fodor, 2002). We examined relative clause attachment ambiguities, where a relative clause can either modify the first or the second noun of a complex NP. While an effect of relative clause length on phrasing has been replicated in many studies (e.g. Fernández & Bradley, 1999, Fernández & Bradley, 2004; Hemforth et al., submitted), we focused on the influence of the preposition linking the two NPs – no preposition (complex Genitive NPs) vs. thematic *bei* vs non-thematic *von* (cf. Lovric, 2003, who found an impact of non-thematic preposition on phrasing in Croatian).

In visual EEG studies as well as in questionnaire studies we carried out, we observed a low attachment preference for those sentences in which NPs were linked by prepositions. This preference became manifest in a positivity in the EEG when attachment was forced high, and in a higher percentage of low attachment answers in the questionnaire. For the genitives, no such attachment preference was found. As a high-attachment preference has been repeatedly reported for German genitives (Hemforth et al., 2000a; Hemforth et al., 2000b), we carried out a self-paced reading study. This method has been standardly used for many German studies dealing with relative clause attachment.

The material of the EEG experiment was spread over lists, and unambiguous filler items were included. The factor 'preposition' was fully crossed with 'forced attachment'. Sentences were forced towards high or low attachment by number agreement of one of the NPs with the auxiliary of the relative clause. Reading times of the disambiguating verb were measured and analysed. The results are compatible with our earlier findings: when NPs were linked by prepositions, reaction times were significantly faster when attachment was forced low. For the genitives, no significant differences in reading times were found.

Taken together, the results can be interpreted as being compatible with a prosodic account, which predicts lowering of attachment when a preposition is present. The fact that there are no preferences for the genitives might be explained by several phrasing options for the genitives, while the presence of a preposition is a clear indicator for a smaller prosodic break before the relative clause, presumably an intermediate phrase boundary only. This grouping favours a low attachment interpretation. In order to obtain evidence for overt realizations of prosodic boundaries on the target items, we are presently conducting a production study with 10 German native speakers which is intended to be the basis for further ERP studies with auditorily presented stimuli.

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## Grammar and Parsing in Complex Infinitival Constructions in German

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Bach et al. (1986) have shown that Dutch infinitival constructions with crossed dependencies are easier to understand than German infinitival constructions with nested dependencies. However, Standard German has also constructions with crossed dependencies, and colloquial German shows even greater flexibility in this regard. Several experiments will be presented which investigated different types of German infinitival constructions deviating from the simple nested pattern. All experiments used the method of speeded-grammaticality judgements.

The first experiment investigated sentences with an infinitival verb, a modal verb, and a perfect auxiliary (cf. (1)). The infinitival constructions varied as to whether the verbal elements were adjacent to each other, or whether a non-verbal element intervened (AUX1 vs. AUX2 in (1)), and whether the lexical verb was used with one or two arguments ((1a) vs. (1b)). When the verbs were adjacent (Standard German pattern), the results showed no difference between the one- and two-objects condition. When a non-verbal constituent intervened (the colloquial pattern), sentences with two objects were accepted much more often than sentences with one.

- (13) Sentences contained the auxiliary "hat" ('has') either at position AUX1 or AUX2
- a. Man hat mir bestätigt, dass Maria (AUX1) die Reisenden (AUX2) warnen wollen.  
One has me confirmed that M. the travelers warn wanted
  - b. Man hat mir bestätigt, dass Maria die Reisenden (AUX1) vor der Gefahr (AUX2) warnen wollen.  
One has me confirmed that M. the travelers of the danger warn wanted

In a follow-up study, the effect of processing load in structures like (1b) was investigated in more detail. The results show a dispreference for material between the auxiliary and the remaining clause-final verbs which is counteracted by a preference for distributing material evenly before and after the auxiliary. Together with the results from the first experiment, this suggests that the distribution of non-verbal and verbal elements is governed by factors of processing-load.

The next two experiments investigated infinitival constructions with control verbs. A first study tested sentences with extraposed infinitival complement (2a), intraposed infinitival complement (2b), and sentences with one argument of the infinitival complement intraposed and the remainder extraposed (cf. 2c). As before, the infinitival verb had either one or two objects. The results show that intraposed infinitivals are more difficult than extraposed infinitivals, and that the mixed structure receives the lowest acceptability rating. However, there is a strong lexicality effect. With verbs such as "versuchen" 'to try' that allow so-called clause-union (merging of infinitival clause and matrix clause into a single clause), there is basically no difference between intraposed and mixed construction. Furthermore, there is a tendency for intraposition to get worse with two objects and for the mixed structure to get better.

- (14) Sentences either contained a PP-object (von der Hausarbeit "of the house-work") or not.
- a. Mir wurde berichtet, dass Maria versucht hat, ihren alten Vater (PP-OBJECT) zu entlasten.  
Me was reported that M. tried has her old father to disburden
  - b. Mir wurde berichtet dass Maria ihren alten Vater (PP-OBJECT) zu entlasten versucht hat.  
Me was reported, that M. her old father to disburden tried has
  - c. Mir wurde berichtet, dass Maria ihren alten Vater versucht hat (PP-OBJECT) zu entlasten.  
Me was reported, that M. her old father tried has to disburden

In summary, our results suggest that colloquial non-nested structures are judged the better the more they help to reduce complexity in German infinitival constructions.

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## Processing difficulties found as a delayed garden path effect: Evidence from reading Finnish clauses

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The existing evidence concerning the processing of syntactically locally ambiguous structures is contradictory. Some studies imply that the ambiguity resolution is purely syntactic in nature (e.g. Frazier & Rayner, 1982; Pickering & Traxler, 1998), whereas other studies suggest that the resolution is also lexical (e.g. MacDonald, Pearlmutter, & Seidenberg, 1994) or probabilistic (e.g. Jurafsky, 1996).

In the present study, we examined whether transparent and productive morphological transitivity cues attached to the main verb affect syntactic analysis. We used noun or adjective roots, of which both derived transitive and intransitive verbs can be naturally constructed. In the transitive verbs, the causative morpheme (bold in the example below) expresses transitivity (i.e. the subject causes something to the object), and the anticausative morpheme expresses intransitivity, respectively:

'rapa' = small fragile stone >> 'rappeUTTAa' = to ruin > 'rappeUTUa' > to be ruined.

The frequencies of the verbs were matched.

### Materials

Below an example target sentence pair is given:

The transitive verb condition, in which the bold target noun is the direct object of 'rappeuttaa':

- (15) Monien mielestä armeija rappeuttaa KANSANTALOUTTA sitomalla pääomia tuottavasta toiminnasta.

Many (Genitive)/ mind (Elative)/ army/ ruin/ national economy (Partitive) to engage (3rd infinitive, Adessive) capital (Partitive) productive (Elative) activity (Elative).

According to many, the army ruins THE NATIONAL ECONOMY by engaging capital away from productive activity.

The intransitive verb condition, in which the bold target noun appears in the same case as in (1), but it functions as a modifier of the following noun phrase:

- (2) Monien mielestä armeija rappeutuu KANSANTALOUTTA sitovien säästötoimien vuoksi.

Many(Gen)/ mind (Elative)/ army/ is ruined/ national economy (Part) to constrain (1st participle, Gen) retrenchment (Gen)/ because of.

According to many, the army is ruined because THE NATIONAL ECONOMY is constrained by retrenchment.

### Experiment

Twenty-two sentence pairs were created. They were identical till the critical verb, and the target noun after the verb was identical. The plausibility of the target sentences was judged by 20 university students. Another 20 students participated in the experiment proper. Participants' eye fixations were recorded, while they read the sentences for comprehension.

### Results

No effect of verb transitivity was observed in the first fixation duration (FFD), gaze duration, or in the regression duration (RD) either on the verb or on the target noun, suggesting that a morphologically transparent transitivity cue on the verb cannot immediately affect the syntactic analysis. We also calculated first pass fixation time (FPF) and RD for the clause endings (fixation time/character). The mean length of the transitive and intransitive clause endings was 25.5 and 24.8 letters, respectively. Even though the lengths were comparable at the condition level, there was considerable variation between items, which led us to do the analyses on the length-adjusted fixation times. The FPF on clause endings was significantly shorter for causative than in anticausative clauses ( $p < .05$ ), but there was no difference in RD. This result suggests a late processing cost for anticausative structures.

In conclusion, the present study suggests that readers do not use lexical or thematic role information in the initial syntactic analysis. However, the processing cost appears much later in reading, thus implying that readers favour an object analysis for all verb types, despite the availability of transparent morphological cues that unambiguously signal transitivity or intransitivity.

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## Self center embeddings revisited

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Similarity-based interference is known to affect sentence processing difficulty from several perspectives. For example, Lewis and Nakayama (2001) have proposed pro- and retroactive interference, Gordon et al. (2002) point to semantic similarity of noun phrases, and Lee and Nakayama (2003) present evidence showing that morphophonemic identity of case markers adversely affects processing.

Interestingly, one of the early claims in this direction, based on linguistic intuitions, was from Miller and Chomsky (1963), who argued for clausal self embedding as a determinant of processing difficulty. An instance of self embedding would occur if some feature values of one clause are identical with those of a clause embedded within it. Seen in this way, the self embedding claim can be reformulated as the assertion that if some features of an embedded clause within another embedded clause are identical, processing should be adversely affected. We present a study showing that this is not true.

In a 2x2 German self-paced reading experiment (n=36) involving subject and object relatives (hereafter: SR, OR), stimulus sentences had the property that either an SR was embedded inside another SR (1), an SR inside another OR (2), an OR embedded within an SR (3), or an OR embedded within an OR (4). German is particularly interesting in this context, because subject and object relative pronouns are overtly case marked for these grammatical roles.

- (16) Der Vater, / DER / den Sohn, / DER / den Bruder / aergert, / beschimpft, / ist / normalerweise / ein ausgesprochen geduldiger Mann.  
The father, who the son, who the brother annoys, scolds, is normally an extremely patient man  
'The father who scolds the son who annoys the brother, is normally an extremely patient man.'
- (17) Der Vater, DEN der Sohn, DER den Bruder aergert,...  
(18) Der Vater, DER der Sohn, DEN den Bruder aergert,...  
(19) Der Vater, DEN der Sohn, DEN den Bruder aergert,...

If clause-similarity is responsible for increased processing difficulty, then object-within-object relatives and subject-within-subject relatives should be equally hard to process, and the other conditions should be easier. The reading time at the most embedded verb was taken as a measure of processing difficulty since (assuming incremental parsing) at this point the verb must be integrated with the incomplete syntactic representation of one of the two predicted relative clause subtrees: the more similar the relative clause subtrees, the harder should processing be.

However, the results show that OR-within-OR is the hardest to process, OR-within-SR is harder than both SR-within-SR and SR-within-OR. This is interesting because the dominant constraint appears to be that object relative-ness determines processing difficulty: ORs are harder than SRs, and increasing the total number of ORs makes processing additively harder.

Thus, in surprising contradiction to the Miller and Chomsky claim, the similarity per se of self-embedded clauses does not in general appear to be a dominant criterion in determining their complexity. Other factors, such as relative frequency of object vs. subject relatives, can play a more important role. The broader significance of this result is that feature-identity of similar linguistic entities does not affect processing adversely across the board; recall that semantic similarity of noun phrases (Gordon et al, 2002) and morphophonemic identity of case markers (Lee et al. 2003) do seem to affect processing adversely. Any non ad-hoc theory of sentence parsing that recognizes similarity-based interference as a factor determining processing ease would need to provide a principled explanation for why clause-level units are immune to interference effects.

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## Parsing NPs: Fixing case

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Research on German and related languages has firmly established that case ambiguities lead to garden-path effects of varying strengths. While this shows that the HSPM assigns case to case-ambiguous NPs in advance of disambiguating information, it is still an open question at which point during parsing the case of an ambiguous NP is fixed. We addressed this question in several self-paced reading studies by looking at NPs with an ambiguous determiner and disambiguation by the head of the NP or an adjective preceding the head.

We looked first at the ambiguous determiner *der* (nominative-masculine in (1a), dative-feminine in (1b)). Disambiguation occurred either at the adjective (*lebende/lebenden*) or the noun (*Autor/Autorin*). Given the general nominative-preference in German, case fixing immediately after reading the determiner should cause a garden-path for (1b), especially in the 'long'-condition (with an adjective phrase intervening between determiner and noun). Reading times for (1b) thus should be longer than reading times for the preferred (1a) and the unambiguous (1c).

- (20) a. dass der (schon seit Jahren in Frankreich lebende) Autor ein Interview gegeben hat.  
that the already for years in France living author a interview given has  
'that the author (who is living in France for years now) gave an interview'
- b. dass der (schon seit Jahren in Frankreich lebenden) Autorin ein Interview verweigert wurde.  
that the already for years in France living author-fem a interview refused was  
'that an interview was refused to the author (who is living in France for years now)'
- c. dass dem (schon seit Jahren in Frankreich lebenden) Autor ein Interview verweigert wurde.  
that the.DAT already for years in France living author a interview refused was  
'that an interview was refused to the author (who is living in France for years now)'

A self-paced reading experiment revealed no substantial garden-path effect for (1b) at the head noun - reading times for (1b) were substantially longer than for (1a) but did not differ from the unambiguous (1c). At the second NP (*ein Interview*) a small garden-path effect for (1b) occurred in the 'short'-condition. We take this as a hint that the parser fixes case at the head noun of the NP. A second experiment with sentences like (1b) and different control sentences confirmed these findings.

Two further experiments investigated the ambiguous determiner *den* (either accusative-singular or dative-plural), as shown in (2). All sentences had unambiguous counterparts. Again, if case were fixed immediately after reading the determiner a garden-path effect should occur for the 'dative'-condition (2b), i.e. we would expect a substantial interaction of ambiguity and case. We expect the dative to be more difficult since it requires additional structure (KP) and an additional feature (plural).

- (21) a. dass Werner den (an dieser Universität nicht sehr beliebten) Dekan schon mehrfach unterstützt hat.  
that Werner the at this university not very popular dean already manifold supported has  
'that Werner supported the dean (who is not very popular at this university) several times'
- b. dass Werner den (an dieser Universität nicht sehr beliebten) Dekanen schon mehrfach geholfen hat  
that Werner the at this university not very popular deans already manifold helped has  
'that Werner helped the deans (who are not very popular at this university) several times'

At the disambiguating noun, main effects of case, length and ambiguity occurred, but no interactions. In the following regions the effect of case remained, and a marginal interaction between status and length was observed. These results again indicate that case is fixed only after reading the noun.

In sum our results indicate that the HSPM waits until the head noun before fixing the case of a locally ambiguous NP. This conclusion is compatible with findings concerning grammatical number, insofar as number marking at the noun is given more weight than number marking at the determiner (Eberhard, 1997).

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## Word order does not account for the advantage of subject-extracted over object-extracted relative clauses

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What causes object-extracted relative clauses (ORCs) to be more difficult to process than subject-extracted relative clauses (SRCs)? MacDonald and Christiansen (MC 2002), providing evidence from simple recurrent network (SRNs, Elman 1990) simulations, proposed that English ORCs suffer from irregular word order (O-S-V), whereas SRCs benefit from a transfer from main clauses, which exhibit the same regular word order (S-V-O). However, this explanation cannot straightforwardly be mapped onto German, as both SRCs and ORCs have a different, clause-final, verb placement, when compared to main clauses. Nevertheless, SRCs might still benefit from a more regular S-...-O order, where the gap can either be empty or a verb.

We will present a series of SRN simulations of German SRCs and ORCs, to test this prediction. In the first step, we kept the grammar as close as possible to MC's with necessary modifications for German. It turned out that ORCs exhibit less output error than SRCs at the embedded verb due to the locally coherent ...-subject-verb sequence in ORCs. This prediction is in strong opposition to reading time data (Konieczny, 2004). Moreover, the networks failed to acquire matrix verb agreement at all. We therefore ran a further series of simulations, where the grammar of the training corpora was reduced to contain transitive verbs as the only verb class, plus commas, which are obligatory before and after German RCs. Now, the networks did learn long-distance matrix-verb agreement. Moreover, at the comma position after the RC, the prediction error was higher for ORCs than for SRCs, as predicted by the reading time data. A detailed output activation analysis revealed that the effect is due to the locally coherent, but globally false prediction of an accusative determiner, continuing a local subject-verb-... object sequence. While this result is mildly compatible with reading time data, the networks fail to predict an SRC over ORC advantage before the comma, as obtained by Konieczny (2004). We conclude that SRNs' inherent word-order driven mechanism is not sufficient to explain parsing complexity differences.

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## The effect of animacy on the time course of filler-gap resolution in wh-questions

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Successful resolution of filler-gap dependencies requires evaluating the fit and gap on different syntactic and semantic dimensions. One possibility is that the processor uses narrowly defined linguistic information such as the selectional restrictions of the verb, specifically its animacy requirements (e.g., Caplan et al., 1994). Using a speed accuracy trade-off variant of a grammaticality judgment task (McElree, 1993; McElree & Griffith, 1995; 1998), we measured whether the animacy constraints of the verb affected not only the likelihood of resolving the dependency but also the time it takes to do so. Wh-dependencies with animate and inanimate fillers were used with both simple and complex constructions. The inanimate example is shown in (1) and the animate in (2), with unacceptable interpretations asterisked.

(1) Which case<sub>i</sub> [investigated by the seasoned policeman] did the young detective solve/ \*dishearten \_\_\_<sub>i</sub> ?

(2) Which criminal<sub>i</sub> [investigated by the seasoned policeman] did the young detective dishearten/\*solve \_\_\_<sub>i</sub> ?

We predicted that inanimate fillers would be resolved sooner than animate ones because they are more strongly correlated with syntactic object position (e.g., Comrie, 1989). Asymptotic differences in accuracy (d') showed that inanimate filler questions had a higher probability of being interpreted successfully. For both simple and complex constructions, the time-course data showed that pairs of sentences with inanimate fillers (1) were interpreted sooner than sentences with animate fillers (2). This result is consistent with the parser considering fewer possible syntactic roles or interpretations of the filler NP. Although these findings are compatible with an account based on the coarse-grained notion of animacy, it is also possible that richer semantic constraints are responsible for the time-course differences (Boland et al., 1995).

To begin to distinguish between these accounts, we will report on sentence completion norms in which we assess the predictability of the filler given the verb (e.g., how likely is a noun like *case* given the verb *solve*) as well as the predictability of the verb given the filler (e.g., how likely is *solve* given *case*).

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## The time course of processing difficulties with non-WH extraction in Danish

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Danish, a V2-language, allows liberal extraction of non-WH elements from a variety of clause types to sentence-initial position, e.g. from relative clauses. Extractions from complement clauses, see (1), are more frequent (Jensen 2001) than extractions from adverbial clauses as in (2).

- (22) De sokker tror jeg at han køber [gap] på udsalget i morgen.  
Those socks think I that he buy [gap] at sale-DET in tomorrow.  
"I think that he will buy those socks at the sale tomorrow".
- (23) De sokker besvimer jeg hvis han køber [gap] på udsalget i morgen.  
Those socks faint I if he buy [gap] at sale-DET in tomorrow.  
"I will faint if he buys those socks at the sale tomorrow".

Theories of this phenomenon hold that constraints on extraction in Danish are dependent on coherence (Jensen, 2001) or pragmatic dominance (Erteschik-Shir, 1982) between the main and the dependent clause, both presupposing processing of the dependent clause for judgment of the acceptability of the extraction. Thus assuming that detection of unacceptability causes processing difficulties, these theories predict reading time increases for unacceptable extractions at the earliest late within the dependent clause when evaluation of the pragmatic/semantic status is possible.

I outline an alternative account based on valency expectations associated with the main-clause verb. Since extraction from complement clauses is frequent, when processing sentences with verbs taking clauses as objects (comp-verbs), the parser doesn't expect to have linked all mentioned arguments with the main verb at the clause boundary. For clauses with intransitive verbs, on the other hand, the parser expects to be able to find a role for all constituents within the clause, i.e. the parser should experience difficulties if unintegrated constituents are present at a clause boundary. Thus this theory predicts longer reading times at 'if' in (2) compared to 'that' in (1). Thus with regard to time course, this account is similar in spirit to work on island constraints in English indicating that extraction constraints work immediately at island boundaries (e.g. McKinnon & Osterhout, 1996; Traxler & Pickering, 1996).

Self-paced reading experiments were conducted to test these alternative accounts. Type of verb (comp vs. intransitive) was fully crossed with an extraction/no-extraction control factor (3-4). An anova revealed a significant interaction between verb type and extraction at the position of 'if/'that', with longer RTs in the intransitive condition (2) compared to the complement (1) and control conditions (3-4).

- (24) Jeg tror at han køber de sokker på udsalget i morgen.  
I think he buy those socks at sale-DET in tomorrow.  
"I think that he will buy those socks at the sale tomorrow".
- (25) Jeg besvimer hvis han køber de sokker på udsalget i morgen.  
I faint if he buy those socks at sale-DET in tomorrow.  
"I will faint if he buys those socks at the sale tomorrow".

The relevance of the experimental manipulations to theories about acceptability of extraction in Danish was confirmed in a separate acceptability judgment experiment with the same stimuli. The intransitive extraction condition was rated significantly lower than the other conditions.

Together, the results of the two experiments are interpreted as supporting the verb expectation theory over theories based on semantic/pragmatic evaluation of the content of the dependent clause, because difficulties arise before evaluation of this content is possible.

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## Filler-gap dependency violations in wh-questions: An auditory ERP investigation

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Numerous investigations in the processing of sentences involving movement reveal that with wh-movement, the antecedent of the wh-word is reactivated in the vicinity of the gap: the parser reconstitutes the features of the filler/wh-word at a silent syntactic element [*t<sub>i</sub>*] and sets up the dependency between the wh-word and the gap (Garnsey, Tanenhaus, Chapman, 1989). "*t<sub>i</sub>*" is typically located after the first predicate. This study aims to determine the neural correlates of the filler-gap relation in wh-questions. We hypothesise that one specific property, the animacy of the wh-word, is reactivated at the gap position and that the parser analyses it during structure-building processing. If we filled the gap with a specific Noun Phrase (NP) that presents similar animacy properties to the wh-word (What did Jack race the boat with the woman?), it would then constitute a syntactic filler-gap violation.

We recorded EEG (128 channels) from 19 adults (mean age 24 years old, 18-38, 8 males) as they listened to wh-object questions (what/who), which were either correct (N=80, what did Jack race the nurse with [*t<sub>i</sub>*]?) or introducing a filler-gap violation (N=80, what did Jack race the boat with the woman?). Participants had to judge the grammaticality of the questions (motor delayed response). All words were controlled for frequency, length, imageability and age of acquisition. Acoustic analysis showed no differences in pitch (Hz), intensity (dB) or duration (ms) between our two experimental conditions before the preposition position. ERPs are re-averaged offline with the average reference. We analysed ERPs from the critical noun in the object position (nurse, boat).

Results show two different effects. First, between 150 and 300 ms, the syntactic filler-gap violation elicited an Early Negativity, distributed on the Anterior sites (EAN), whereas on the posterior electrodes more positivity was recorded compared to the ERPs of the control questions. Second, two different positivities were recorded between 800 and 1000 ms. The syntactic filler-gap violation elicited more positivity in anterior and central regions compared to the ERPs from the control questions (P600), whereas control questions elicited more positivity in posterior sites.

The late positivity, P600, indicates a re-analysis (Friederici, 2002) of the question in the syntactic filler-gap violation. The positivity in the control questions is likely to reflect acoustic differences at the preposition (Steinhauer, 2003). Because the early EAN appeared during noun processing, this result provides converging evidence for an active online resolution of syntactic dependencies in adults.

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## Relative clause attachment in Russian: The role of constituent length

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Sentences with a Relative Clause (RC) following a complex NP, (1), are ambiguous between two readings, one in which the servant is on the balcony (high attachment) and the other in which the actress is (low attachment). This ambiguity tends to be resolved differently in different languages: e.g., English speakers show a preference for low attachment, while Spanish speakers – for high attachment. However, in all languages tested to date (Brazilian Portuguese, Croatian, Dutch, English, German, Japanese, Spanish, Arabic and French) the effect of the Constituent Length (CL) was observed: Short RCs are more likely to attach low than long RCs.

- (1) Someone shot the servant of the actress that was on the balcony.
- (2) Prestupnik      zastrelil      služanku      aktrisy, ...  
criminal.Masc    shot            maid.Fem      of actress.Fem
- a. ... kotoraja      ego      prjatala.  
    who.Fem        him      was hiding.Fem  
'The criminal shot the maid of the actress who was hiding him'
- b. ... kotoraja      ego      prjatala              v kamorke      na čerdake      osobnjaka.  
    who.Fem        him      was hiding.Fem    in closet        at attic            of mansion  
'The criminal shot the maid of the actress who was hiding him in the closet of the mansion's attic'
- c. ... kotoraja      ego      prjatala,              potomu što      ljubila      brjunetov.  
    who.Fem        him      was hiding.Fem    because        liked.Fem      brown-haired guys  
'The criminal shot the maid of the actress who was hiding him because she liked guys with brown hair'
- (3) ('{...}' marks prosodic phrasing)
- a. {... N<sub>1</sub> - N<sub>2</sub> - RC<sub>short</sub>}
- b. {... N<sub>1</sub> - N<sub>2</sub>} {RC<sub>long</sub>}
- c. {... N<sub>1</sub> - N<sub>2</sub> - Clause<sub>1</sub>} {Clause<sub>2</sub>}
- d. {... N<sub>1</sub> - N<sub>2</sub>} {Clause<sub>1</sub> - Clause<sub>2</sub>}

The present paper examines the effect of CL on RC attachment in Russian. The results of the experiment in which CL was not manipulated demonstrated a preference for high attachment (Sekerina 2003). However, in our first questionnaire study (N=42 subjects, N=16x2 targets) manipulating CL (2a, 2b), we found the main effect by subjects ( $F(1,40) = 5.90$ ,  $p = 0.0198$ ): Short RCs tend to attach lower (41,9% high attachment) than long RCs (51,2% high attachment). Thus in Russian the length of RC affects attachment preference as well.

An attempt to explain the cross-linguistic effect of CL is the Implicit Prosody Hypothesis (IPH) of Fodor (1998): A prosodically heavier RC constitutes a better sister for the complex NP. To test whether it is the prosodic weight that influences the sentence interpretation we conducted the second questionnaire study (N=63 subjects, N=18x3 targets) in which there were three types of RCs: short, long and broken (2a-c). Broken RCs had the same length as long RCs but allowed for two different intonation phrase readings – with no prosodic break after N<sub>2</sub> and a break inside the RC (3c) or with a prosodic break after N<sub>2</sub> and no break inside the RC (3d), while (simple) long RCs allow for only one reading, with a break after N<sub>2</sub> (3b). If IPH is correct, we would expect significant differences in attachment preference for the three RC types.

The results showed the significant main effect of RC-length ( $F(2,120) = 36.79$ ,  $p < 0.001$ ;  $F(2,34) = 61.59$ ,  $p < 0.001$ ) – long RCs strongly preferred to attach high (69% high attachment), short RCs – to attach low (31% high attachment), and broken RCs did not show any preference (51,3% high attachment). IPH would explain this arbitrary attachment of broken RCs as caused by the possibility to read the RC with two different prosodic patterns. The first one, (3c), is similar to the pattern of sentences with short RCs, (3a), and the second one, (3d), is similar to the pattern of long RCs, (3b). However, whether speakers really produce these two patterns with broken RCs should be confirmed for overt prosody in spoken reading.

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## Early preferences in RC attachment in Spanish: Two methods, and disambiguation by number agreement

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In unspedeed questionnaire tasks probing the preferred interpretation of the relative clause (RC) in ambiguous strings like (1), high attachments are more frequent than low attachments, in Spanish (Cuetos & Mitchell, 1988, among others). The robustness of this finding contrasts with the discrepancies between experiments employing speeded measures (self-paced reading, eye-tracking). Some studies report faster reading times for forced-high (2a-b) over forced-low (2c-d) attachments (Cuetos & Mitchell, 1988; Carreiras & Clifton, 1993, 1999). But others observe the reverse pattern (Carreiras, Betancort & Meseguer, 2001; Fernández, 2000/2003), evidence that calls into question the assumption that Spanish attaches high at all phases of processing: Spanish might obey Late Closure in the initial parse, revising a low attachment if extra-syntactic information prompts it to do so.

Evidence of an early preference for forced-low in Spanish comes from studies where number agreement disambiguates attachment; one could argue that such a finding is artefactual and due to particular combinations of marked and unmarked number features interfering with "normal" processing. Within a clause, a plural intervening between a singular subject and the verb it must agree with (e.g., *the key to the cabinets was...*) disrupts processing (e.g., Bock & Miller, 1991). With RC attachment, the agreement relation is between clauses; nonetheless, a plural N2 might disrupt forcing attachment high in (2a) in ways that the singular N2 in (2b) may not.

In two experiments, Spanish monolinguals read identical target materials (N=32×4) crossing RC's attachment (low/high) and N2's number (singular/plural); see (2). In Experiment 1 (self-paced reading), targets were presented in two frames (segmentation as indicated by slashes), the critical measure coming from the second frame, where RC's attachment was disambiguated. In Experiment 2 (response-contingent same-different sentence-matching; Stevenson, 1993), having read a sentence presented by itself, participants pressed a button to make a second sentence appear directly beneath the first, at which point they made a judgment about whether the two sentences matched. (Target materials were always "same" pairs; distractors were either "same" or "different".) Experiment 2 provides two measures: an (uninteresting) whole-sentence reading time not necessarily sensitive to early processing effects, and a *matching time* that has been argued to reflect processing load associated with ungrammaticality detection in early phases of processing (Stevenson, 1993).

In both experiments, we observe a preference for forced-low attachments (2c-d) in the two measures assumed to be sensitive to early processing (RC reading times in Experiment 1; matching times in Experiment 2). This suggests that first-pass representations of the RC attachment construction are guided by Late Closure, even for a language where ultimate interpretations more frequently involve high attachments. Furthermore, in both experiments, sentences with plural N2s provoke substantially heavier processing load than those with singular N2s. The effect of N2's number does not interact with attachment in the RC reading time measure of Experiment 1. However, in the matching time measure of Experiment 2, the preference for forced-low is reliable when N2 is singular, but disappears when N2 is plural.

### Examples

(26) Andrés cenó con el sobrino del maestro que se emborrachó.

(Andrew ate with the nephew of the teacher who [refl] got-drunk[sg].)

(27) Andrés cenó con...

(Andrew ate with...)

- |    |  |                      |
|----|--|----------------------|
| a. | el sobrino de los maestros / que se emborrachó.    | [N1-sg N2-pl RCV-sg] |
| b. | los sobrinos del maestro / que se emborracharon.   | [N1-pl N2-sg RCV-pl] |
| c. | el sobrino de los maestros / que se emborracharon. | [N1-sg N2-pl RCV-pl] |
| d. | los sobrinos del maestro / que se emborrachó.      | [N1-pl N2-sg RCV-sg] |
- (... the nephew(s) of the teacher(s) / who [refl] got-drunk[sg/pl].)

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## The Contribution of Reading Prosody to Text Processing: Evidence from Eye-Tracking

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Understanding a message is harder when it is spoken monotonously than when it is spoken with natural coherent prosody. Studies of speech comprehension suggest that prosodic patterns correspond to the syntactic structure of the sentence and thereby facilitate syntactic analysis and assist in maintaining sentence information in working memory (WM). This study examined the proposition that in a similar way prosody helps text processing as well.

According to the structural approach to reading, the extraction of structure precedes the analysis of meaning and paves the way for it. Previous studies suggested that prosodic patterns produced online during reading reflect sentence structure relatively independent of semantic content (Koriat, Greenberg & Kreiner, 2002). This study examined the hypothesis that natural reading prosody assists in maintaining information organized in WM and facilitates integrative processes.

In Experiment 1 subjects read sentences applying either natural or monotonously grouped prosody, and their immediate recall was tested. The results indicated that sentence organization was better maintained when natural than when grouped prosody was applied, suggesting that because natural prosody corresponds to sentence structure it helps maintaining information organized in WM.

Previous eye-movements studies indicate that morpho-syntactic incongruity between subject and predicate results in prolonged gaze durations. This incongruity effect is assumed to reflect online syntactic integration. Experiment 2 tested the hypothesis that because natural reading prosody facilitates online syntactic integration, its destruction should reduce the incongruity effect. Subjects read sentences containing congruent or incongruent subject-predicate agreement (gender or number) while applying either natural or monotonous prosody. Gaze duration was longer for incongruent than for congruent predicates when natural reading prosody was applied, but this effect disappeared when monotonic prosody was applied, suggesting that destructing natural reading prosody disrupts syntactic integration.

Experiment 3 was similar but semantic rather than syntactic congruency was manipulated. When natural prosody was applied the spillover eye-movement measure yielded a significant incongruity effect, but again this effect was eliminated when monotonous prosody was applied. However, second-pass measure (assumed to reflect reanalysis rather than online processing) yielded a highly significant incongruity effect in both prosodic conditions. These findings suggest that natural reading prosody facilitates online semantic integration, but later processes of semantic integration can be achieved even when natural prosody is impaired.

The proposition that reading prosody produced on the basis of early structural processing assists in maintaining the sentence structure in WM thereby facilitating online integration of text is discussed in view of these results.

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## Comprehension and memorization of an oralized text: the role of the page layout properties

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A now-classic conception considers text comprehension as a result of the interaction between the text content and the reader background knowledge (see Kintsch & van Dijk, 1978; Kintsch, 1988). Indeed, several studies have shown an effect of both classes of factors (see Kintsch & Yarbrough, 1982; McNamara et al., 1996). Our study focuses on the influence of the page layout properties which refer to the physical appearance and the position of the text elements on the page. According to the model proposed by J. Virbel to represent the text structures (see Virbel, 1989), these properties correspond to discursive segments expressing speech acts concerning the text itself. When the writer assigns specific physical properties to some parts of his text, he reveals textual objects as titles, paragraphs, enumerations, ... These objects and their relations form the architecture of the text. This model and some empirical findings obtained by R. Lorch on the effect of visual signals (see Lorch & Chen, 1986; Lorch et al., 1995; Lorch et al., 2001) led us hypothesize that the layout properties contribute to the meaning of the text and thus participate to the construction of a coherent text representation.

To test this hypothesis, we led an experimental study in which subjects listened to a restaurant menu oralized by a Text-To-Speech synthesis (TTS). The layout properties of the original written text submitted to the TTS helped to identify the number of dishes offered by the menu because they signal the disjunction relations between the dishes (each dish was distinguished from the following with a blank) and the conjunction relations between the main constituent of a dish and its accompaniment (each main constituent was described with its accompaniment on the same line, the first being separated from the second with a comma). The oral version presented to the subjects of the text varied. In the restricted version, the layout properties did not give rise to a specific conversion by the TTS. In the discursive version, discursive segments aimed to restore the semantic scope of the properties: the conjunction relations between the main constituent and its accompaniment and the disjunction relations between dishes were made explicit. In the prosodic version, prosodic cues were supposed to give them back (e.g. pause durations longer between disjunctive elements than between conjunctive ones). A second factor was the presentation format: the oralized text was either presented alone, or its listening was coupled together with the presentation of a picture representing exclusively the physical characteristics of the text. The picture was presented either during or before the listening. We aimed to test whether the picture of the text helped the subjects to detect the logic relations between the segments of the text. The tasks assessed the subject's memorization and comprehension: subjects were instructed to recall aloud all they could (free recall task), to estimate the number of dishes offered by the menu (comprehension task) and to fill in gaps in the original written text (cued recall task).

The results related to memorization showed no effect of the factors on the performances at the free recall task but revealed that the discursive version involved better performances than the prosodic and restricted versions at the cued recall task. The fact that effects on memorization were obtained at the cued recall task but not at the free recall task can be explained by a floor effect affecting the performances at the free recall task. The superiority of the discursive version at the cued recall task may be due to the fact that the logic relations are explicit and thus, subjects can allocate more processing resources to the memorization of the information. As expected, the results related to comprehension revealed that with the discursive and prosodic versions subjects gave a better estimation of the number of dishes offered than with the restricted version. Moreover, the discursive version showed superiority on the prosodic one. Subjects having heard the restricted version tended to overestimate the number of dishes because they took accompaniments for dishes. However, the picture presentation before or during the listening of the text did not exert any influence on the comprehension performances. These results highlight the contribution of the page layout properties to the global meaning of the text and consequently the necessity to restore their semantic scope when transposing the written text in the oral modality. The use of prosody and discursive segments seems to constitute an efficient restoration mean, whereas the presentation of a picture of the text, regardless of whether it is displayed before or during the listening, does not benefit to the subjects, maybe because of the lack of familiarity of such a presentation display.

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## Reference resolution and conjoined NPs: Plurality, coordination and grammatical role

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This paper investigates conjoined NPs in subject and object position. Although previous research has addressed related issues (e.g.[3],[4],[6],[8]), it has not tested whether the grammatical or thematic roles of conjoined NPs influence the NPs' salience and the referential forms subsequently used for the NPs. With nonconjoined NPs, effects of grammatical and thematic roles on salience and referring expression choice have been intensively researched (e.g.[1],[2],[8]). What about conjoined NPs? Is salience still determined by grammatical/thematic roles in the same way as for nonconjoined NPs? [5] found that conjoined and nonconjoined NPs pattern alike, and so it seems the answer is yes. However, what if we pit conjoined and nonconjoined arguments against each other and manipulate their grammatical/thematic roles? How do these two factors interact? The following two experiments investigate this:

Exp. 1 manipulated the conjoined arguments' grammatical position and thematic role. The critical items had conjoined subjects (*The-X-and-the-Y-verb-ed-the-Z*) or objects (*The-X-verb-ed-the-Y-and-the-Z*). The participants' (N=16) task was to write natural-sounding continuation sentences. X, Y and Z were either all masculine or all feminine characters/roles (e.g. *businessman, seamstress*). All verbs were action verbs (subject=agent, object=patient), which—when tested with singular subjects and objects—have been found to make the object/patient more salient/likely to be mentioned in the next sentence than the subject (e.g. [8]). Participants' continuations were coded for which entity the subject of the continuation referred to and what referential form was used. (Continuations where the intended referent was unclear, as well as continuations which did not refer to any of the three mentioned entities, were excluded from subsequent analyses.)

In the conjoined-subject (conj-S) condition, there was a significant preference to refer to the object ( $p < 0.05$ ). In 70% of continuations, either a pronoun (33%) or a full NP (37%) was used to refer to the object. Only 27% of continuations referred to the subject, and all did so with the pronoun *they*. This fits with the previous findings that agent-patient verbs make the object more salient than the subject. However, in the conjoined-object (conj-O) condition, this object preference disappears: We see slightly more subject continuations than object continuations: 50% of continuations refer to the subject (47% with a pronoun, 3% with a full NP), and 34% to the object (29% with a pronoun, 5% with full NPs). Thus, here the object bias of agent/patient verbs is weakened to the point of no longer being significant, which suggests that participants have a preference for nonconjoined NPs over conjoined NPs. However, since the test sentences had one singular nonconjoined argument and one plural conjoined argument, the results could actually be due to a singular > plural preference.

To test this, in Exp. 2 the nonconjoined argument was pluralized (e.g. *The-X-and-the-Y-verb-ed-the-Zs, The-Xs-verb-ed-the-Y-and-the-Z*). Again, the participants' (N=12) task was to write natural-sounding continuations. Coding was as above. In the conj-S condition, there was again a preference for the object ( $p < 0.01$ ), as expected for agent-patient verbs. 78% of continuations referred to the object (73% with a full NP, 5% with a pronoun); only 16% referred to the subject (all with *they*). The object preference is absent in the conj-O condition: 24% subject-continuations (18% with a pronoun); 15% object-continuations (6% with a pronoun). However, in the conj-O condition, the most common continuation (42%) uses a full NP for the *second* noun in the object, which may be a task-induced linear-recency effect. Abstracting away from this, we see a slight numerical nonconjoined > conjoined preference, and clearly no object preference.

In sum, with agent/patient verbs with conjoined subjects and nonconjoined objects, we see a clear preference for the object. This holds for singular and plural objects. Crucially, this preference disappears with nonconjoined subjects and conjoined objects. Then, we see a slight numerical preference for subjects. We can conclude that coordination interacts with grammatical/thematic role in influencing a referent's likelihood of being the subject of the next sentence. If this likelihood is a measure of salience, then the question arises: Why is there a nonconjoined>conjoined salience ranking? This may be due to the nature of conjunction. In the mental representation of a conjoined NP, each constituent is presumably represented individually at some level and can be referred to later with a definite NP. A conjoined NP thus contains multiple entities competing for subsequent reference: the constituent NPs and the entire conjoined NP. In a nonconjoined NP, there are no constituent entities (if singular) or they are not individuated (if plural). The competition between the constituents and the entire conjoined NP may be what 'dilutes' the salience of the entire conjoined NP and makes it less salient than a nonconjoined NP.

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## Amusing Comedians Can Be Difficult – Implicit Causality and Role Names

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Implicit causes for events are typically thought to be associated primarily with the verbs describing those events. However, Garvey and Caramazza (1975), in their original discussion of implicit causality, suggested that other factors, such as the way the protagonists in the events are described, might play a role. Implicit causality studies typically use “neutral” proper names to describe protagonists. In two experiments we investigated the influence of information carried by role names on implicit causality effects in language production and comprehension. Our choice of role names was suggested by the abnormal conditions focus model of Hilton and Slugoski (1986). According to this model, causality is attributed to context-specific abnormal conditions. Role names suggest particular properties of the person described, and hence conditions that they might normally be expected to fulfil (or not to fulfil). For example, comedians normally amuse other people, but we do not especially expect them to be amused by other people themselves. So in “the comedian amused Dennis” causality would be attributed to Dennis, because comedians are expected to amuse. But in “Dennis amused the comedian” causality would be attributed the comedian. In a production study, we found evidence supporting this view. When people completed sentence fragments of the form “the comedian amused Dennis because he...” the normal NP1 bias of “amuse” was attenuated, whereas when they completed fragments of the form “Dennis amused the comedian because he...” the bias was accentuated. We found similar effects for NP2-biased verbs. However, the most obvious prediction of this view for comprehension, that abnormal conditions should accentuate the standard congruency effect for implicit causality was not supported in our second experiment. Instead, in comprehension we found that sentences that matched prior expectations (“Dennis amused the comedian because he was very entertaining”) were always easier to understand than those that did not (“Dennis amused the comedian because he was easily entertained”). This effect is the standard congruency effect that has been reported in many studies of the comprehension of implicit causality. It was not modulated by the “abnormal conditions” manipulation. The implications of these findings are discussed.

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## Early verb acquisition in French : syntactic frames in child directed speech.

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In recent years the impact of language specific characteristics of maternal input has undergone considerable scrutiny (Sampson 1989, Goldberg 1995, Lieven et al, 1997, O'Grady 1997, Tomasello & Brooks 1999, Cartwright & Brent 1997). However, very little of this research has examined language acquisition in children acquiring languages other than English. Chenu & Jisa (2004) examined three hypotheses concerning verb usage (frequency, position, diversity) in speech directed to two French-speaking children recorded every two weeks from the age of 12 to 28 months in interaction with their mothers. This work reveals, first, a correlation between the early verbs used by children and the frequency of verbs in child-directed speech: both mothers and children use a majority of light verbs. A second finding shows that children learn verbs which they hear in a variety of syntactic frames, ie., the verbs used by mothers in a diversity of positions were the verbs that the children acquired early on. Our third finding reveals that these two mothers prefer canonical word order when speaking to children. Despite the fact that French word order is characterized as SVO, spoken French shows considerable variation with dislocations abounding. Although dislocations are typical of spoken French (Lambrecht 1994; Blanche-Benveniste 1997), the two mothers examined prefer canonical word order when speaking to children. A fourth finding was that, contrary to our expectations, the French-speaking mothers do not use verb final position more than verb medial position in transitive constructions. In French when a known referent plays a direct object role in the construction, it is placed in preverbal position, resulting in an SOV(X) construction. This finding would indicate that that mothers use lexical noun objects more than pronominalization and that deictic pronouns (ça 'that one' and là 'there'), which do not move to preverbal position, are used rather than object pronouns.

In the work proposed here we will investigate more specifically the role of these input factors on the acquisition of transitive constructions by the children. It has been argued that frequent hearings of transitive verbs enhances their semantics and entrenches their syntax (Naigles et al 1995, Braine & Brooks 1995, Tomasello & Brooks 1999). If input factors play a role in acquisition of transitive constructions and transitive verbs are overwhelmingly heard in canonical word order, one would expect that children will use transitive verbs in canonical word order. If children use object dislocation structures, this would argue that the child goes beyond the input during the acquisition of transitivity. Dislocations alter the pragmatics of constructions but do not alter the argument structure of transitive verbs.

Particular attention will be given to the pattern of errors in the children's production . We will examine the data for the omissions of objects (clitics and lexical) in transitive constructions and for the use of intransitive verbs in transitive constructions. We will also investigate components of the children's grammar where the transitive/intransitive alternation plays a role: the selection of *être* and *avoir* as auxiliaries in the *passé composé*; and the use of *se* as a marker of detransitivization.

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## Discovering word categories: Distributional regularities in German child-directed speech

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As a particular instance of the family of *Poverty of the Stimulus* arguments, it has been claimed that the distinction between the main lexical categories (such as *noun* or *verb*) must be innate because the language that children hear would be too impoverished and too unreliable for these categories to be learned (e.g., Pinker, 1984). Other researchers, however, have argued that children do find various kinds of cues in their linguistic input which together would suffice for the children to discover these categories from experience (e.g., Bates & MacWhinney, 1982). In particular, it was suggested that the words' distributional properties would help children to group them into categories (e.g., Maratsos & Chalkley, 1980). This *Distributional Bootstrapping* proposal was motivated by the observation that words which tend to co-occur with the same kinds of neighboring words are likely to be members of the same category. But it was not until recently that the relevant linguistic data and computational tools became available to test this proposal empirically. Such tests were presented by Redington, Chater, and Finch (1998) and Mintz, Newport, and Bever (2002) who successfully demonstrated that, at least for English, distributional regularities can indeed provide robust and informative cues about lexical categories.

Since the co-occurrence statistical paradigm used in these studies highly relies on surface word order, it was not clear how well it would extend to languages with fewer word order restrictions than English. We therefore applied a modified version of this paradigm to German child-directed speech which was taken from one very large high-density corpus. Beyond verifying the potential usefulness of distributional information for category acquisition in German, we investigated the following questions: Are distributional regularities more informative about some categories than others? Which categories are particularly difficult to discriminate from each other on purely distributional grounds? What are the precise regularities underlying these findings?

The most important result was that the verb category is distributionally much more complex than the noun category, and this complexity arises directly from syntactic structure and usage preferences. This finding may help to explain psycholinguistic evidence that children discover the noun category prior to the verb category (for English: Olguin & Tomasello, 1993; Tomasello & Olguin, 1993). Additional investigations further elaborate the early role of the noun category in category acquisition. If children do not initially distinguish between individual function words—as suggested by developmental evidence—distributional information becomes even more useful for discovering the noun category. And once the noun category is acquired, this knowledge would facilitate the discovery of several other categories, most of all determiners and prepositions but also verbs, adjectives, and adverbs.

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## How language-specific is language-acquisition? A cross-linguistic analysis of cues for syntactic categorisation

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Multiple cues can assist the child in developing an understanding of the relationship between words and the world. Such cues may be language-external, relating to semantic, or gestural features of communication. Or they may be language-internal, where the structure of the language provides constraints on the possibilities for symbol-grounding. One such constraint is the information provided within the language, either phonological or distributional, about the probable syntactic category of the word in question. Language-internal cues provide accurate information about syntactic categories in English (Kelly, 1992; Redington, Chater, & Finch, 1998). We assessed the extent to which these types of cue are language-specific, or whether they may provide syntactic information across languages by testing cues in English and in another Germanic language, Dutch, and also a romance language, French, which we predicted would demonstrate less similarity to English.

We extracted the 1000 most frequent words in the child-directed speech corpora from CHILDES for English, Dutch, and French. Each word was cross-referenced with CELEX for English and Dutch and LEXIQUE for French to mark syntactic category and phonological form. We generated 50 phonological cues by assessing the manner and place of articulation of phonemes in the whole word, the onset, and the first phoneme. As an example, for the word "plankton" (/pl&Nk-t@n/) the 50 cues included proportion of consonants that were voiced (0.5 in whole word, 0.5 in onset, 0.0 in first phoneme), proportion of consonants in each position (e.g., 0.17 bilabial in whole word, 0.5 bilabial in onset, 1.0 bilabial in first phoneme), proportion of consonants of each manner (e.g., 0.33 nasal in whole word, 0.0 nasal in onset, 0.0 nasal in first phoneme), and mean vowel height and position (close/open and front/back). We generated 50 distributional cues by measuring the strength of association of each word with either the preceding word or the succeeding word when the preceding/succeeding word was one of the 25 most frequent words in the corpus. For example, "plankton" occurs after "some" and before "is" frequently and so is strongly associated with these words, but does not at all after "you" so has a low association value for this cue. We tested the potential value of such cues by assessing their ability to distinguish gross distinctions in syntactic category: between open- and closed-class words, and, within the open-class category, between nouns and verbs. We chose these distinctions as phonological and distributional properties have been proposed to have a contributory role in the formation and assigning of words to categories (e.g., Kelly, 1992).

For English, 11 phonological and 6 distributional cues distinguished open-class from closed class words, and 4 phonological and 16 distributional cues distinguished nouns from verbs. For Dutch, 1 phonological cue and 8 distributional cues distinguished both open/closed-class words, and nouns/verbs. For French, 12 phonological and 12 distributional cues distinguished open/closed-class words, and 9 phonological and 12 distributional cues distinguished nouns/verbs.

The distributional cues we tested were useful for syntactic categorisation for all the languages. However, we found that the manner/place phonological cues only significantly distinguished categories in English and French, and were particularly useful for French. It may be that Dutch children exploit different phonological cues to those tested here. However, the validity of cues across the languages suggests that similar language-internal properties may be exploited by children acquiring different languages.

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## Priming Content Words Enhances Fluency and Priming Function Words Decreases Fluency for Children who Stutter

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The EXPLAN theory of Howell and Au-Yeung (2002) claims that function and content word disfluencies play different roles in speech production. The hypothesis is that while one word is executed, the following word is being planned. Function word disfluency reflect the repetition of quickly executed function words in order to stall the execution of a subsequent slowly planned content word. If the speaker advances to the execution of the content word without stalling, then only the start of the plan may be available, leading to disfluency on the content word. The current experiment tests this model by using a priming methodology, because priming has been found to increase the speed of speech production online (e.g. Smith and Wheeldon, 2001). 12 children who stutter (CWS) (aged 3;10 to 8;11, mean 6;5), and 12 fluent age and gender matched controls (aged 3;9 to 8;10, mean 6;6) described intransitive action-event cartoons by using a single Phonological Word (Selkirk, 1984) of the form 'PN is Ving' and their fluency was compared after repeating function word primes (e.g. 'He is') versus content word primes (e.g. 'swimming'). The primed trials were separated by a single animal naming filler item. It was predicted that primed words would be executed faster as responses, such that function word primes would increase the discrepancy between content word planning (slow) and function word execution time (fast), leading to more need to stall. For CWS, this was expected to prompt more disfluencies, but the control children were expected to be able to stall by using devices such as pausing and slowing down their execution of the function words. In contrast, content word primes were expected to reduce this discrepancy and lead to fewer disfluencies. As predicted, CWS produced significantly more disfluencies after function word primes than content word primes,  $Z = -3.63$ ,  $p < 0.01$ , but this difference was not significant for the control children. An ongoing analysis of pausing, voice initiation times and word duration will confirm whether the control children avoided disfluency by stalling in alternative ways. The experiment is important as it is the only study to date that directly tests how the tradeoff between planning and execution timing influences fluency in speech production.

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## Meaning acquisition of new words: event-related brain potential evidences

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The link between word form and meaning lies in the core of human language. The aim of the present investigation is to unravel the neural mechanisms implied in language acquisition and word-learning. More specifically, this project addresses the challenge that young children are facing when learning the meaning of words or similarly adults when learning a foreign language. This ability to learn words is not trivial and requires at least the ability to infer intentions of others, the ability to acquire concepts, an appreciation of syntactic structure and certain general learning and memory abilities (Bloom, 2000; Carey, 1994; Gleitman, 1990; Gomez & Gerken, 2000; MacNamara, 1972; Safran et al., 1999). In order to simulate how the learning machinery is engaged in acquiring new words, Gillette and Gleitman, (1999) has used the human simulation word-learning paradigm. It has been developed with the aim of emulating vocabulary learning when acquiring the meaning of new words. Adults or children are exposed with different sources of information (linguistic and extralinguistic), which have to be used to create the meaning of the new or hidden item.

In a similar vein, the present investigation tries to identify the brain regions that are responsible and sustain the cognitive processes involved in meaning acquisition of new words. Event-related brain potentials (ERPs) has been used with the purpose of characterizing its time-course (Münte et al., 2001). Therefore, in the experiments that will be described, adults were engaged in developing the meaning of new words presented repetitively across some sentences.

In order to study the time course activity of meaning development using the above proposed paradigm we will benefit of a well known ERP component, the N400, that indexes how the meaning of a word is integrated with the current context (Kutas & Hillyard, 1984; Van Petten, 1990, 1995). During sentence processing all words show a N400 component with an amplitude determined by how expected the word is. However, when a semantically inappropriate word is encountered (e.g., "I am go to eat a table"), the amplitude of the N400 is drastically enhanced. Subsequent work has shown that the N400 amplitude is an inverse function of the semantic relatedness between a word and its sentence context.

In concrete, subjects read sentences characterized for ending with a new word (non-word). For each new word, three sentences were built, in which increasing degree of contextual constraint was created. In this way, subjects had the opportunity to create the meaning of the non-word in a progressive way, from the lowest constraint sentence (the first one) to the highest constrained one (third sentence). Two conditions were created, one in which the new word meaning could be extracted and created, meaningful-group; and one condition in which the new word meaning could not be resolved across the sentences, non-meaningful group. In all cases the hidden-target words were concrete nouns of middle frequency. In order to control for the N400 repetition effect a control condition was presented in which real words will be used. The N400 incongruity effect was used as an index of the acquisition of the meaning across time, while the learning process is active. This effect was contrasted with the control condition in which meaning resolution was not possible. The results show differences in the N400 component depending on condition. At the beginning, first sentence, non-word meaning and non-word no meaning waves show practically no differences, whereas word condition elicits an N400. As sentences proceed, it is constructed a N400 for non-word meaning condition, resulting the third sentence in slightly the same pattern as word condition, which means that subjects have been able to extract the new word meaning, mapping the new lexical label with the preexisting one, and at the same time with the concept it represents.

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## The emergence of “intelligent” eye-movement control during reading: a computational account

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Twenty-five years of eye-tracking research has shown that many cognitive (e.g., word frequency) and non-cognitive (e.g., saccadic error) variables influence when and where the eyes move during reading (Rayner, 1998). This research suggests that moment-to-moment decisions about when and—to a lesser degree—where to move the eyes are linked to the on-going cognitive processes (e.g., lexical access) that are necessary for text comprehension. Although many formal models have been proposed to explain eye-movement control during reading (for a review, see Reichle, Rayner, & Pollatsek, 2003), these models are based on divergent a priori assumptions and have mainly been used to demonstrate that particular accounts of eye-movement control are feasible. Thus, although these models are useful existence proofs and have generated new research, they generally fail to explain how or why readers learn to move their eyes in the way that they do. The present work redresses this limitation by examining how a simple adaptive agent (i.e., a system capable of learning via a value-iteration reinforcement learning algorithm; Barto, 1995) learns to control its eye-movement behavior when faced with the goal of maximizing its overall reading rate. This agent was subject to several hard constraints (e.g., limited visual acuity, minimal times to identify words and program saccades) and was given the task of learning when and where to move its eyes so as to identify as quickly as possible and in order the words in a corpus of training sentences. The agent was then tested on a set of novel transfer sentences so that its eye-movement behavior could be evaluated. The agent exhibited many human-like behaviors; like human readers, the agent tended to: (1) direct its eyes towards the centers of words; (2) look at high-frequency and/or predictable words for a shorter amount of time than low-frequency and/or unpredictable words; and (3) start programming saccades away from a fixated word prior to full identification of the word. Each of these behaviors is adaptive in that they allow the agent to identify the words in a sentence at a maximal rate while at the same time satisfying all of the constraints that are imposed upon the system. This modeling work thus demonstrates how the relatively “intelligent” heuristics that are used to guide eye movements during reading can emerge from a fairly simple adaptive system that is faced with the task of learning to read rapidly.

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## Informativeness and Optimal Visual Word Fixation: A Computational and Psycholinguistic Investigation.

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Human readers demonstrate a preferred viewing location (PVL) in normal reading and a comparable optimal viewing position (OVP) for recognition of isolated words. The OVP is the fixation point in a word that gives the fastest, most accurate recognition of that word. The link between, and factors contributing to these effects are still under debate. The key challenge is to explain the asymmetry of these curves; the PVL and OVP fall to the left of word centre in longer words. What we propose to explore here is the possible role of informativeness.

Some models of reading behaviour suggest that identification of written words is made faster by fixating towards more informative parts of the word, where it is best distinguished from other word candidates (e.g.: Clark & O'Regan, 1998; Legge et al. 1997). Evidence of this effect in humans comes from various studies by O'Regan and others (e.g.: O'Regan et al., 1984; O'Regan and Levy-Schoen, 1987). These studies found an influence of information distribution on the OVP curve, although rarely a complete reversal in the curve for end informative words as might be predicted.

Such a role of informativeness is captured in the Split-Fovea Model of Shillcock et al. (2000). This model assumes that the parts of the words at the left and right of the fixation point are projected to the contralateral hemisphere. They define the optimal fixation point to be where both the left and right parts of the word are the most informative (i.e., shared by the smallest number of words in the lexicon). Using a computational algorithm based on these principles, correct predictions for OVPs in both English, a 'left-to-right' language, and Hebrew, a 'right-to-left' language, have been generated (Shillcock et al. 2000; McCauley, AMLaP, 2002).

However, while the simulation results resemble the nature of the OVP curve, no systematic comparison of the degree of skew in the OVP curves has been made between simulation and human data.

We propose to directly contrast the model's predictions with human data. First we investigate how OVP predictions from the algorithm actually correspond to human OVPs for particular word lengths. Various parameters of the algorithm are changed and compared, including the incorporation of word frequency.

Next we present a version of 'moving OVP' experiment in English. The algorithm is used to generate stimuli, processing words and non-words to generate beginning- and end-informative stimuli sets. The experiment uses forced fixation with a lexical decision and word identification task, in order to directly test predictions from the model of the effect of information profile on location of the OVP.

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## The skipping of words during reading

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In 1985 Balota, Pollatsek and Rayner reported an experiment examining the effects of different preview conditions on skipping behavior. An example of the 5 conditions they used and the corresponding skipping rates are reported below.

- (1) Predictable Word  
Since the wedding was today, the baker rushed the wedding *cake* to the reception. (.11)
- (2) Neutral Word  
Since the wedding was today, the baker rushed the wedding *pies* to the reception. (.02)
- (3) Semantically anomalous word  
Since the wedding was today, the baker rushed the wedding *bomb* to the reception. (.01)
- (4) Visual similar non-word  
Since the wedding was today, the baker rushed the wedding *cahc* to the reception. (.11)
- (5) Visual dissimilar non-word  
Since the wedding was today, the baker rushed the wedding *picz* to the reception. (.00)

When the readers passed an invisible boundary between the target word and the prior word, the target word was replaced by either the predictable word or the neutral word. While this experiment clearly shows that words that are highly predictable from the preceding context are skipped more often than neutral words, it also shows that this happens often on the basis of partial information, hence the high skipping rate of the visual similar non-word condition. In the experiment that we will present, we will address two shortcomings of the original study. First, no significant skipping was found in or differences reported between the conditions that presented a neutral word, a semantically anomalous word and a visual dissimilar non-word. Because the overall skipping rates were so low this failure to find effects in these conditions could be due to a floor effect. In the present study shorter stimuli will be used to avoid such a potential floor effect. The second shortcoming of the Balota et al. study concerns the fact that no distinction was made in terms of how far the launch site of the saccade that skips over the target was located from the target word. It is not inconceivable that the lack of difference between the predictable word and the visual similar non-word will not hold at a launch site close to the target word.

Results based on 24 subjects indicate that there is a difference in skipping the predictable word and the visual similar word at a closer launch site. Consequences of these results for models of eye movement control in reading will be discussed.

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## Effects of Transitional Probability and Predictability on Eye Movements

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A number of eye movement experiments have shown that words that are highly predictable from the context are read faster, and skipped more often, than words that are less predictable (e.g., Rayner & Well, 1996). Recently, McDonald and Shillcock (2003a, 2003b) found evidence for a different type of predictability, namely transitional probability (TP). TP, or word-to-word contingency statistics, is the probability that a given word N+1 follows a word N. For example, the probability of “defeat” following “accept” is higher than the probability of “losses” following “accept”. McDonald and Shillcock (2003a) showed that, with a neutral preceding context, first fixation and gaze durations on the second word were slightly though reliably shorter for high-probability words compared to low-probability ones. Importantly, they claim that this is a low-level effect independent from (high-level) contextual predictability effects. If so, then an increase in contextual predictability should not overcome the TP effect.

Two eye-tracking experiments were carried out with the aim of investigating whether TP effects can still be found in more restraining contexts. Items like the following were constructed (C=contextually restraining context, N=neutral context, H/L=High/Low-probability):

- C-H As they cannot afford to lose the game, the team won't accept defeat even when they're far behind.
- C-L Since their mission is to make money, the manager won't accept losses even when it means pay cuts.
- N-H It is silly that they simply won't accept defeat even when they're far behind.
- N-L It is silly that they simply won't accept losses even when it means pay cuts.

Experiment 1 replicated M&S's results in that high-probability words were read faster than low-probability words, both on gaze and total reading times. These effects were apparent for both the neutral and the context conditions. We also found an immediate effect of contextual predictability, with reading times on the target word faster when preceded by a constraining context. However, a cloze test indicated that the items were not closely matched for contextual predictability. The only conditions that were well matched were C-L and N-H, and no TP effects were found between these two conditions. Likewise, analyses of subsets of items that were matched for cloze showed no TP effects. Whereas M&S's pattern of data replicated, our results suggest that cloze differences rather than TP might have caused the effects.

In order to test this, Experiment 2 was carried out using a new and larger set of items which were carefully matched for cloze between high and low TP conditions. Early measures (single fixation, first fixation, gaze duration) showed a contextual predictability effect, but no effects of TP, while later measures (total time) showed both contextual predictability and TP effects.

Together, the results showed clear effects of contextual predictability, but no independent effects of TP. We conclude that TP effects might be part of “regular” predictability effects and relate these results to other findings of contextual constraints on fixation times and skipping rates.

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## The eyes are right when the mouth is wrong

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When describing visual displays, speakers typically gaze at objects while preparing their names (Griffin & Bock, 2000; Meyer, Sleiderink, & Levelt, 1998). There are several reasons why gazing at an object while preparing its name could help production. Such gazes could provide cascaded activation to linguistic representations, easing the selection of correct ones (e.g., Humphreys, Riddoch, & Price, 1997). Gazes on referents could also prevent interference from unrelated visual information as seen in environmental intrusions (Harley, 1990) and gaze aversion (e.g., Glenberg, Schroeder, & Robertson, 1998) in multiword utterances (although not in isolated word production; Bloem & La Heij, 2003; Damian & Bowers, 2003). Furthermore, if speech errors result from rushed word preparation (e.g., Dell, 1986) or failure to check prepared names by gazing at objects (Van Der Meulen, 2001), speakers should spend less time gazing at referents before errors than they do before correct names.

To further study eye movements and language production, a corpus of 41 speaker-corrected speech errors was analyzed (Griffin, in press). Two sets of correct naming trials were compared with errors. In one set, the same speakers named similar objects. In the other, different speakers named the same objects. Counter to predictions, gazes on referents before errors (e.g., looking at an axe before saying "hamm[er] axe") were very similar to (or longer than) gazes before correct names ("axe"). After speakers began saying erroneous names, they gazed at referents for significantly more time than after correct names. The 700 ms difference appeared to be associated with preparing correct names.

So, gazing at objects does not appear to facilitate production of a correct name. A similar result was been reported for anticipatory speech errors in repeatedly naming sequences of objects (Van Der Meulen, 2003). Speakers also show a tendency to gaze at blank locations where objects that they discuss were recently displayed (Richardson & Spivey, 2000). Together these results converge on the conclusion that while speakers prepare names, they tend to gaze at the objects to which they intend to refer (or the last location of the objects), even when an association between the object and word is lacking, intentionally as in a lie (Griffin & Oppenheimer, 2003) or accidentally as in a speech error. Like gesture (McNeill, 1985), gaze may accurately reflect a speaker's intentions even when the associated speech does not.

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## Verbs don't drive sentence production in English-Korean sentence translation

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An experiment used a written-to-oral sentence translation task to test the head-driven models of sentence production. According to head-driven models (e.g. Ferreira, 2000; Bock, 1987), verbs provide syntactic structure, so a verb must be selected before sentence articulation can begin. Korean and English were used because of their differences in verb position. The dominant word order in English is SVO as opposed to Korean, which is SOV. Among other variations in stimulus sentences, we varied the number of noun phrases occurring before versus after verbs in English source sentences (see examples 1-2). Stimuli composed of two short clauses were included to test if translators would stop reading at a clause boundary (3).

- (28) The sick man slept on the sofa. [Verb early, long clause]
- (29) The people in the library quietly studied [Verb late, long clause]
- (30) A bird sang. A dog barked. [Verb early, short clause]

Translators' eye movements were recorded to indicate which words they read before beginning to articulate sentences. Unlike most translation experiments, the stimuli were written and available to translators before and during their translations. Based on reading research (see Rayner, 1998), we assumed that translators would fixate on or near content words to recognize them. We also assumed that translators needed to recognize words before they could translate them. Therefore, if verbs were not fixated before speaking, they could not be translated and therefore could not be initially available to structure the sentence. Insofar as head-driven models apply to sentence construction in translation, translators should consistently fixate on verbs before the onset of sentences. If translators do not skip ahead to verbs, the onset of translated sentences should increase with the number of content words preceding a verb.

Analyses excluded disfluent sentences (e.g., when translators restarted their sentences). The results did not support head-driven models of sentence production. Translation onsets did not differ significantly for English source sentences where verbs occurred early (1) versus late (2). However, translators were more likely to fixate verbs before speaking when the verb occurred early rather than late. In contrast, they were less likely to fixate on the second noun when the first verb was early rather than late (i.e. the second noun proceeded the verb). On average, translator's read about 2.5 content words from long clauses before initiating fluent translations, regardless of the words' grammatical classes. When the stimuli consisted of short clauses, translators began speaking significantly earlier and read fewer content words before speaking. The results suggest that translators do not need verbs to begin structuring and uttering fluent and grammatical sentences.

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## How much linguistic information is extracted from ignored pictures? Further evidence for a cascade model of speech production

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An important issue in speech production is how activation flows throughout the production system. Cascade models assume that any activated representation automatically spreads a proportion of its activation to representations at subsequent levels of processing. In contrast, discrete models assume that there is a filter, either at the conceptual level (Bloem & La Heij, 2003) or at the lexical level (Levelt et al., 1999), that prevents the flow of activation to subsequent levels. These two type of models have recently been tested by investigating the effects of distractor pictures on word translation (Bloem & La Heij, 2003) and picture naming (Morsella & Miozzo, 2002 [M&M]; Damian & Bowers, 2003). The results of these studies yield contrasting conclusions. Importantly, however, only the study by M&M brought positive evidence for a cascade model. We report two experiments that: a) test the reproducibility of the M&M's results, and b) extend their observation to other naming contexts in which attended and non-attended information are easily discriminable.

In Experiment 1, participants were presented with superimposed picture-picture pairs, and were asked to name the picture depicted in green while ignoring the one in red. The names of the pictures in a given pair were either phonologically related (e.g., *L*MON [lemon] – *L*BRO [book]) or phonologically unrelated (e.g., LIMON – SILLA [chair]). Naming latencies were faster in the former condition, replicating M&M's results, and indicating that phonological information of distractors is activated.

In Experiment 2, participants were presented with a colored picture and were asked to name its color, while ignoring all other aspects of the picture. Picture names and picture colors were either phonologically related (*VELA* (candle) – *VERDE* (green) or unrelated (*VELA* – *MARRON* (brown)). Color naming latencies were faster when picture-color names were phonologically related than when they were unrelated, again indicating that the phonological properties of an irrelevant dimension were activated.

These results suggest that in the course of lexical access, activated (but not selected) conceptual representations that are semantically unrelated to the target do activate their phonology. This observation is contrary to discrete models, as according to these models, phonological activation is restricted either to the target lexical node (Levelt et al. 1999) or to the target lexical node and semantically related lexical nodes (Bloem and La Heij, 2003). In contrast, our observations are predicted by models that assume spreading activation throughout the whole system. Thus, we conclude that speakers extract phonological information from non-attended pictures, a result that supports cascade models of lexical access.

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## Does syntactic priming speed up linearization?

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Speakers tend to reuse syntactic structure in consecutive sentences. Explanations of this “syntactic priming” (SP) phenomenon revolve around reduction of processing effort (Levelt & Kelter, 1982; Bock, 1986). Reuse of recent syntactic materials during the production of a new sentence requires less effort than starting from scratch, thus facilitating fluency and reducing voice-onset RTs. Most SP experiments have focused on categorical effects: They explored how SP influences the probability (preference) of reusing particular structures. Recently, several studies also found priming effects on RTs. Smith & Wheeldon (2001) report that, with coordinated versus non-coordinated response-initial NPs, syntactically related primes speed up onset latencies to subsequent spoken target responses. In a written DO-PO sentence completion task, Corley & Scheepers (2002) also found latency differences between primed and unprimed conditions.

Many sentence production models (e.g. Garrett, 1975; Kempen & Hoenkamp, 1987; Bock & Levelt, 1994) distinguish between a functional and a positional level of syntactic processing – between assembling the hierarchical structure of a sentence and determining the linear order of constituents. This raises the question whether SP affects both these levels. The aforementioned studies cannot provide the answer because they used prime-target pairs that differ at both levels.

Word order variation in Dutch clause-final verb clusters provides a suitable testbed. Order of past participle (PastP) and auxiliary verb (Aux) is arbitrary and semantically neutral. In grammar formalisms honouring the hierarchical/positional distinction, it does not involve hierarchical differences. Furthermore, Hartsuiker & Westenberg (2000) have reported that SP indeed affects the linearization of Aux and PastP during speaking.

We conducted three experiments to test the effort reduction hypothesis at the positional level. In Experiment 1, we confirmed Hartsuiker & Westenberg’s categorical SP effect on linearization. In Experiments 2 and 3, we registered voice-onset RTs to target completions under slightly varying conditions. Filler items ascertained that residual priming from previous trials could not obscure the SP effect. Although we again found the categorical priming effect (and a main effect of target order: AuxPastP < PastPAux), no priming effect on voice-onset RT obtained.

Given these (and related) findings, we propose to split SP effects into two parts: BIASING (increased probability of selecting the primed syntactic alternative, i.e. raising its priority) and SPEED-UP (faster preparation/assembly of the selected hierarchical structure). Apparently, SP exerts both biasing and speed-up effects on the assembly of syntactic hierarchies, but only a biasing effect on the selection of a constituent order.

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## The role of animacy in Japanese sentence production

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There is a tendency for animate referents (person, animal) to come earlier than inanimate ones (objects) (e.g. McDonald et al., 1993). Bock and Warren (1985) explained that conceptually accessible items (in this case, animacy) are highly associated with higher grammatical function, as a result these tend to be in a subject position (link between animacy and subjecthood). However, some studies (Branigan & Feleki, 1996 in Greek, and Prat-Sala and Branigan 1999 in Spanish) suggest that these items are associated with early word order, then these tend to appear at the beginning of the sentence (link between Animacy and first position of the sentence). These suggest that languages which allow free word order will show the true effect of animacy in syntactic processing.

To investigate this, using Japanese is particularly useful - case-marking (e.g. *ga*/nominative, *ni*/dative, *o*/accusative) will determine the syntactic functions, in other words, as long as there is case-marking, the word order is freely changeable. In addition, order of passive voice can be also moved ('Agent - Patient+Oblique-passive' can be 'Patient+Oblique - Agent-Passive').

Using these facts, we conducted two immediate sentence recall experiments (subjects listen to 8 sentences and recall them all). In experiment 1, we investigated the relationship between Animacy and word order (plus conjunct),

1. Agent-Patient-V (animate, inanimate) The man pushed the car
2. Agent-Patient-V (inanimate, animate) The car pushed the man
3. Patient-Agent- V (animate, inanimate) The man, the car pushed
4. Patient-Agent- V (inanimate, animate) The car, the man pushed
5. Conjunct (Animate and inanimate) The man and the car were queuing.
6. Conjunct (inanimate and animate) The car and the man were queuing.

Experiment 2 was conducted to see the relationship between Animacy, word order and voice;

7. Agent-Patient-V (animate, inanimate) passive The man was pushed by the car.
8. Agent-Patient-V (inanimate, animate) passive The car was pushed by the man.
9. Patient-Agent-V (animate, inanimate) passive By the man, the car was pushed.
10. Patient-Agent-V (inanimate, animate) passive By the car, the man was pushed.

We found the effect of Animacy on OSV word order in experiment 1 and 2, indicating animacy does affect simple word order in production. Also, Animacy effects voice sentence – active (or passive) becomes passive (or active) if animate entities are not in a subject position. These indicate the effect of Animacy and word order – animate NP1 preference in experiment 1, animate NP in subject position preference in experiment 2.

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## The interaction between semantics and grammatical gender in language production revisited

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The present experiments investigated semantic priming effects and gender priming effects in a picture naming task. The question whether these effects interact has important implications for models of language production (see for a discussion: Vigliocco, Lauer, Damian, & Levelt, 2002). Native Dutch speakers named a series of pictures in Dutch. Unbeknownst to them, some of the pictures were primes and some were targets (e.g., van Berkum, 1997). The prime always directly preceded the target (lag 0). Dutch has two different grammatical gender classes, common and neuter gender. A prime could belong to the same semantic category as the target (semantically related, e.g., horse – cow) or to a different semantic category (semantically unrelated, e.g., ship – cow). Furthermore, prime and target could be of the same gender (goat\_common – cow\_common) or of opposite gender (horse\_neuter – cow\_common). These two factors were completely crossed. In a first experiment, participants named the pictures with bare nouns. There was a significant semantic priming effect; target pictures in the semantically related condition were named 21 ms faster than in the unrelated condition. No difference was found for nouns of same or opposite gender. This semantic facilitation in itself is interesting because it apparently contradicts some findings in the literature. However, most of these experiments either had primes from a different modality, e.g. words (Alario, Segui, & Ferrand, 2000) or lexicon definitions (Wheeldon & Monsell, 1994), or they used different priming paradigms, e.g. indirect priming (Vigliocco et al.) or blocked presentation of all primes before blocked presentation of all targets (Vitkovitch, Humphreys, & Lloyd-Jones, 1993). It can be argued that facilitation and competition effects arise differently in a sequential priming paradigm where primes and targets are from the same modality. Another argument often encountered in this kind of study is that it is very difficult to disentangle semantic similarity and visual similarity. Therefore, for each prime-target pair, our participants gave a subjective rating on visual similarity after the main experiment. And indeed, items from the same category were visually more similar (3.54 on a 7-point scale) than items from different categories (1.71). However, taking only a subset of the items (those with the lowest ratings in the two same category conditions and those with the highest ratings in the two different category conditions) reduced this difference to 2.32 for same category items and 2.14 for different category items. With this reduced set of items (half the number of items in each cell), the semantic facilitation effect was still significant and even larger descriptively (41 ms).

In a second experiment, participants named the same series of pictures with determiner noun phrases. The semantic priming effect was still present. More important, there was a significant interaction of semantic relatedness (same vs. different category) and “gender-relatedness” (prime and target of same or different gender). For prime-target pairs from different categories, target naming was 25 ms slower when prime and target had the same gender than when prime and target had different gender (note that no such effect was observed in Experiment 1, where bare nouns and no gender-marked noun phrases were produced). In his spreading activation model for lexical retrieval, Dell (1986) postulates that the activation level for a selected item is immediately reduced to zero to prevent repeatedly selecting the same item. However, because of activated neighbours, the activation level will not stay down for a long time but rebound quickly. In the context of our experiment, one could assume that a determiner is selected and then its activation level drops to zero. If a word of the same gender has to be produced directly afterwards, the determiner node might not have recovered enough activation yet, therefore causing longer naming latencies than a noun phrase starting with a determiner of which the activation level has not dropped.

The data pattern is clearly different when prime and target belong to the same semantic category: Target naming was 12 ms faster when prime and target had the same gender than when they had different gender. In the terms of Dell's activation levels, it could be the case that semantic category members are all highly activated and continue spreading activation to the nodes of their corresponding determiners, thereby allowing a node with reduced activity to rebound more quickly. However, this explanation is highly speculative. But our experiments show clearly that semantic and syntactic properties can interact in picture naming.

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## The introduction of postpositions - an experimental approach

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Generally, languages have a unidirectional tendency to develop from left towards right-branching structure. The tendency is unidirectional in that the opposite shift is not generally observed (Bichakjian 1991, Bauer 1995). There do appear, however, to be exceptions to the general trend. Bauer (1995) discusses two examples. First she mentions that Latin reintroduced postpositions at a time when prepositions were already dominant; and second she argues that the same happened in German. We argue that the introduction of postpositions does not have to be considered as an exception of the general trend towards right-branching. Rather, processes known in grammaticalisation are involved.

We aimed to model processes involved in grammaticalisation, which were responsible for the emergence of postpositions in the 17th century, in an experiment. The reported particles that had a development towards postpositions derived generally from adverbs, especially verb particles. The particles that developed into postpositions had the property to be able to undergo fronting, while particles that could not be fronted did not undergo such development.

Frontable particles can be contrasted in constructions where they occur. So 'along' can be contrasted with 'down', 'up' etc in a construction such as 'to go along'.

Unfrontable particles occur in more idiomatic constructions, so in 'to eat up (aufessen)', 'up' cannot be contrasted with another particle. Particles that could be fronted gave way to the development of postpositions.

The particle 'along' can be fronted such as in 'Along go I the way'. When postpositions arised, not only the particle could be fronted but as well the preceding noun. So we could get 'The way along go I'. The object noun and the particle are adjacent and it is known in grammaticalisation that this favours grammaticalisation.

In experimental work, we will show that this path of grammaticalisation is quite productive. We will show that particles that are judged to be more likely to be fronted, are also more likely to be used as postpositional adpositions.

### Conclusion

According to Lehmann (1971) Hawkins (1979), postpositions occurred in Early New High German because of increase in frequency of SOV-structures, which according to other authors is not the case. We show that the increase in postpositions is rather a process of grammaticalisation and that it is not a consequence of reintroduction of further SOV-structures.

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## The representation of verbal roots in a highly inflected language

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We investigate verb processing in the course of lexical access in French, a language with highly inflected verbs.

Research conducted in English shows a strong priming effect between regular past forms and their stem (e.g., walked/walk) versus a diminished or absent priming with irregular verbs (e.g., drove/drive) (Marslen-Wilson & Tyler, 1998). This priming difference is thought to reflect an organisation of verb access based on distinct mechanisms for regular and irregular verbs. Interestingly, various experiments conducted in French failed to observe this dichotomy (Meunier & Marslen-Wilson, 2004): the same amount of priming was observed for regular and irregular verbs. This cross-linguistic difference was attributed to the decomposability of French irregular forms.

We investigate this hypothesis by manipulating the surface and cumulative frequency of French verbs. Cumulative frequency refers to the sum of the surface frequencies of all the inflectional forms that use a given root: *buv-ait*, *buv-ez*, *buv-ons*... We reasoned that cumulative frequency effects on lexical decision times would reflect the processing of a representation of the verbal root. The frequency manipulations were applied to three types of verbs:

1/ Regular verbs have a single root in all its inflected forms (e.g., *mang-ez*, *mang-eas*, etc. for MANGER). For this class of verbs, we selected different verbs to oppose low and high cumulative frequency forms (e.g., *mange-as* vs *grimpe-ra*). Results show additive surface and cumulative frequency effects. The effect of cumulative frequency suggests the decomposability of inflectional verbs during lexical access.

2/ Irregular idiosyncratic verbs have at least two different roots (e.g., *buv-ais*, *boi-rons* for BOIRE). For this class of verbs, results show again additive effects of surface and cumulative frequencies. The latter effect was observed in spite of the fact that low and high cumulative frequencies concern the same verb. It suggests that lexical access for these class of verbs is mediated by a representation of the corresponding verbal root (e.g., either "buv-" or "boi-")

3/ Morphological verb has two related root forms that follows a variation which can be derived by rule (e.g., *sem-ais*, *sèm-érons* for SEMER). For this class of verbs a surface frequency effect was found but no cumulative frequency effect. This result suggests that, contrary of irregular verbs, lexical access for this class of verbs is mediated by a single root that is accessed by all derived forms.

In sum, surface frequency effect could reflect the early global representation of verbs forms. The result obtained with the cumulative frequency confirm that irregular French verbs are decomposed just as regulars, and this interpretation explain the presence of priming effects in Meunier & Marslen-Wilson (2004).

Additionally, the effect observed for morphological verbs support a mechanism of the lexical access which contacts different structure of representation for regular and irregular verbs.

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**The brain bases of regular, irregular and 'pseudo-regular' morphology:  
Evidence from priming and functional MRI experiments of past tense in English**

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Dual-mechanism theories of morphology hold that regular (WALKED) and irregular (TOOK) past tenses are processed by two independent processes [1]. In this work we explore the alternative account that all forms are processed within a single connectionist mechanism [2]. We focus on a key distinction between these theories: whereas dual-mechanism theories propose a strong distinction between regulars and irregulars, the connectionist approach instead predicts graded effects. For instance, irregulars that exhibit subregularities ('pseudo-regulars': SLEPT, SOLD) should behave more like regulars compared to other irregulars (TOOK.)

We first tested this in two priming experiments. English speakers (N=44 in both experiments) performed a visual lexical decision following either an auditory or visual prime, at either short (0ms) or long (500ms) ISIs. Stimuli were past tense primes and present tense targets that were either regular (WALKED-WALK), irregular (TOOK-TAKE) or pseudo-regular irregulars (SLEPT-SLEEP.) Results of the two experiments were similar, marked by significant priming for regulars in both experiments, whereas irregulars produced interference at short ISIs and small degrees of priming at long ISIs. Interestingly, pseudo-regular forms showed intermediate effects, marked by no priming at short ISIs and positive priming at long ISIs. The finding suggests that greater priming for regulars than irregulars might not reflect the influence of a morphological rule in recognizing regulars, but could instead reflect the stronger phonological relationship between present and past tenses of regulars.

We further investigated pseudo-regular past tenses using fMRI at 4 Tesla. Ten subjects heard a present tense verb and covertly generated its past tense. Stimuli included regulars, true irregulars and pseudo-regulars. No region showed an advantage for irregulars over regulars, though we did observe significantly greater activation for regulars than irregulars in left and right inferior frontal gyri (IFG). However, contrary to the theory that IFG is specialized for processing rules [3], we observed that activation for pseudo-regulars was also greater than for irregulars in this region. We thus propose that brain activation in IFG reflects phonological processing engaged in mapping present and past tenses. In contrast, regions of the posterior temporal lobe did not distinguish regulars from irregulars and instead appeared to be sensitive to lexical-semantic information such as frequency.

We propose that the similarity of pseudo-regular forms to regulars in these experiments defies a dual-mechanism explanation. Instead, our results suggest that differences between regulars and irregulars are graded and arise from the relative contribution of phonological and semantic information during past tense processing.

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Sample Materials (frequency):

Regulars	Irregulars	Pseudo-Regulars
marched (204)	swam (209)	fled (165)
needed (3294)	stood (2826)	lost (2557)

The role of gender information in spoken-word recognition in a non-native language

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Numerous eyetracking studies (e.g. Tanenhaus et al., 1995) have confirmed phonological competitor activation in spoken-word recognition: While identifying a target object, participants fixate objects with names overlapping in onset with the target more than unrelated objects. Furthermore, Dahan et al. (2000) demonstrated that preceding gender information can constrain lexical access: When competitors mismatch the gender-marking on a preceding article, early competitor activation is eliminated (e.g. after hearing "le<sub>[masc]</sub> bou...", *bouton*<sub>[masc]</sub> is activated, but not *bouteille*<sub>[fem]</sub>).

But what role does gender play in non-native spoken-word recognition? It has been shown that competitors from the mother-tongue interfere with spoken-word recognition in a non-native language (e.g. Weber & Cutler, 2004). Similarly, native gender information might also interfere with non-native processing.

In two experiments, we asked proficient second-language learners to mouseclick on pictures in displays which contained a target and a competitor overlapping in onset in French and German, plus two unrelated distractors. The target always shared gender in both languages, and was preceded by its gender-marked article in the instructions. There were two conditions, defined by the competitor's gender: In the "same-gender" pairs (1), target and competitor shared gender in both languages. Thus, neither French nor German gender constrained the initial set of lexical candidates. In the "different-gender" pairs (2), target and competitor differed in gender in French, but not in German, so that French gender excluded the competitor, but German gender did not.

Example items:

		Target	Competitor
(1) same gender pair	French	<i>perle</i> <sub>[fem]</sub>	<i>perruque</i> <sub>[fem]</sub>
	German	<i>Perle</i> <sub>[fem]</sub>	<i>Perücke</i> <sub>[fem]</sub>
		'pearl'	'wig'
(2) different gender pair	French	<i>cassette</i> <sub>[fem]</sub>	<i>canon</i> <sub>[masc]</sub>
	German	<i>Kassette</i> <sub>[fem]</sub>	<i>Kanone</i> <sub>[fem]</sub>
		'tape'	'canon'

Carrier sentences:

French: *Cliquez sur le<sub>[masc]</sub>/la<sub>[fem]</sub>...*  
('Click on the...')

German: *Wo befindet sich der<sub>[masc]</sub>/die<sub>[fem]</sub>/das<sub>[neuter]</sub>...?*  
('Where is the...?')

In Experiment 1, Germanophone listeners heard French instructions. They fixated competitors more than unrelated objects in both conditions: In the "different-gender" trials, they could not use non-native gender to eliminate competitor activation. Presented with the same materials, a French control group showed competition for same-gender but not for different-gender trials, thereby replicating Dahan et al. (2000).

In Experiment 2, the same materials were presented in German to Francophone learners. Here, gender differed in the different-gender pairs only in the underlying French translations. French listeners showed competition only in the same-gender trials, suggesting that in the different-gender trials, native French gender inappropriately eliminated early competitor activation while listening to German.

This finding allows us to contribute to the ongoing debate (see Dahan et al., 2000) about the origin of the gender effect: Given that it is very unlikely that distributional regularities from a language not spoken during the experiment will influence processing, our results rather support the notion that the gender effect originates on the grammatical level of processing, instead of being due to a superficial co-occurrence of the forms of articles and nouns.

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## The infant's brain response to words and nonsense words in meaningful contexts

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Behavioural studies have shown that during their first year of life infants acquire probabilistic knowledge about the phonetic, prosodic, and phonotactic organization of their native language sound structure. At the end of their first year of life infants have also established some conceptual representations so that they are able to comprehend their first words. Until now, however, nearly nothing is known about the neural mechanisms of semantic processing during early language acquisition.

Using event-related brain potentials (ERPs), we investigated whether adult-like mechanisms of semantic integration into the current context are already present in one-year-old-infants. In addition we examined whether the initiating of semantic processing routines depends on the regularity of phonotactic features of nonsense words. We tested 12- and 19-month-old infants as well as adults. While subjects were looking at sequentially presented pictures they were acoustically presented with

- (31) basic level words that were congruous to the picture contents,
- (32) basic level words that were incongruous to the picture contents,
- (33) nonsense words that were phonotactically legal in German, or
- (34) nonsense words that were phonotactically illegal in German.

A differentiated age- and stimulus-sensitive pattern could be observed in the infant's ERPs. We found both, early starting differences in the N200/N350 amplitude which had previously been shown to reflect familiarity in 20-month-old infants (Mills, Coffey-Corina, & Neville, 1993), and differences in the N400, a component that is associated with mechanisms of semantic integration in adults (Kutas & Hillyard, 1980).

The comparison of the infant's ERPs on congruous and incongruous words revealed a N200/N350 priming effect for both age groups, whereas an adult-like N400 semantic incongruity effect was only present in 19-month-olds. Infants of the older age group also displayed a N200/N350 familiarity effect between phonotactically legal and illegal nonsense words as well as a N400 on phonotactically legal pseudo-words. Both effects did not occur in the younger age group.

The results imply that mechanisms of lexical priming are already present in 12-month-old infants. Adult-like mechanisms of semantic integration, however, mature during the first half of the infant's second year of life. These mechanisms develop only in response to phonotactically legal, but not to phonotactically illegal nonsense words.

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## Breaking the tyranny of learning: A broad-coverage model of visual word processing

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We describe a distributed connectionist model of visual word processing that covers a large sample (of approximately 60,000 words) of the English lexicon. The model is trained to produce at its output a representation of the meaning of a word, after having been presented at its input with a representation of the orthographical form of that word. Both the orthographic forms and the word meanings are encoded by distributed vectors automatically constructed from corpora. We compared the errors in the output layers with the RT's to several published datasets, investigating the effects of the informational complexity of structured morphological paradigms, verb regularity, and Age of Acquisition (AoA).

As found for the RT's of participants in lexical decision experiments, the complexity of the morphological paradigms to which a word belongs is inversely correlated with the error produced by the model in recognising that word, even after partialling out other effects such as word frequency or word length. This indicates that, despite the fully distributed nature of the model's representations, the pseudo-regularities in the mappings between orthography and meaning have led to the development of structured, tree-like representations of morphological paradigms, as it has been shown to affect participants in behavioural experiments (Moscoso del Prado Martín, Kostić & Baayen, 2004).

Additionally, although the model did not have different 'hardwired' mechanisms for dealing with regular or irregular verbs, it showed clear effects of verb regularity, both when processing past-tense forms and, more importantly, also when processing present-tense forms. This indicates that the regularities in the orthographic and semantic properties of groups of regular and irregular verbs may be responsible for many of the differences that have been observed in their processing, in line with the results presented by Baayen & Moscoso del Prado Martín (2004).

Finally, our model showed a clear effect of AoA norms, by which words that tend to be acquired earlier, are processed more accurately than words that tend to be acquired later. Crucially this effect arose in our model, despite the training disregarding any developmental considerations on the order by which words were presented during training. This finding supports the hypothesis advanced by Anderson & Cottrell (2001) that the AoA effect reflects, at least in part, the regularities in the mappings between the form and meaning of a word, independently of developmental considerations.

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## Masked Identity Priming: Preactivation or Retrospective Retrieval of the Prime Episode?

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Masked priming has become quite popular in the study of lexical processing since Forster and Davis (1984) argued that the technique removes episodic memory effects and thus provides a pure measure of word recognition. This view has been called into question by Bodner and Masson (1997), who claim that the observed facilitation is not due to the prime preactivating the target representation, but results from the retroactive retrieval of some episodic representation of the prime during target processing.

A crucial ingredient of Bodner and Masson's retrospective view on masked priming is the way in which they account for the typical absence of identity priming for nonwords. In their view, the usual null effect for this item type results from a response conflict: the episodic trace of the prime facilitates perceptual processing of the target (just as it does for words), but at the same time it enhances target familiarity and thus generates a "yes" response bias. Since the task requires a "no" response for nonwords, the perceptual facilitation component is cancelled out by a conflict at the decision stage. This explanation formed the basis for our experiments. In these experiments we assessed the retrospective view by studying effects of masked identity priming on words and nonwords.

Bodner and Masson's account of nonword identity priming implies that facilitation in the lexical-decision task is always a composite effect, reflecting both faster perceptual processing and a "yes" response bias. In the case of words, these two processes lead to a sizeable facilitation effect. However, this account implies that identity priming for words should be smaller in a task where enhanced target familiarity is irrelevant for responding than in the lexical-decision task, where such familiarity is directly relevant for the decision-making process. However, this prediction was not confirmed by our data: the same word set produced an equally large priming effect in a gender-decision task as in a lexical-decision task. In a second set of experiments we studied nonword identity priming. The retrospective account predicts that it will be easy to establish such priming when the facilitation due to stimulus familiarity is not cancelled by a response bias. In line with this prediction, we obtained identical priming effects for nonwords as for high-frequency and low-frequency words in an experiment requiring decisions on target pronounceability. These repetition effects were accompanied by strong effects of lexicality and frequency, which indicates that this task engaged normal lexical processing. Moreover, no difference was found between nonwords with or without word neighbours (FREAM - GLOOP), indicating that the facilitation for nonwords was not lexically mediated. Interestingly, when the same materials were used in a lexical-decision task, the facilitation was restricted to nonwords with a single neighbour. Whereas a retroactive view would not predict this interaction between nonword priming and this lexical variable, a preactivation account would: the prime gives a headstart to the process of initial erroneous access and subsequent rejection of the word neighbour and thus produces facilitation.

Our overall data pattern is in line with a preactivation account of masked priming. We argue that the prime creates a pattern of activation over a set of representational units at different levels. Facilitation only emerges when the preactivated units are needed to arrive at the response that is relevant to the task.

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Is gaze direction controlled by utterance formulation?

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Do visual fixations predict the linguistic realization of specific event participants? Several different studies suggest that they might (Tomlin 1995, 1997; Griffin and Bock 2000; Holsánová 2001). Online soccer commentator data show that at least in some circumstances, they do.

While the correspondence between visual attention and grammatical subject proposed by Tomlin is probably too tight, as suggested in Diderichsen (2001), the data presented here indicate that gazes do indeed predict the realization of specific participants as would be expected from the studies of Griffin and Bock and Holsánová. In particular, Griffin and Bock (2000) suggests that gazes on some participant are indicative of grammatical encoding only after the event to be reported is known.

The linguistic output and eye movements of a single Danish national radio sports commentator were collected in the actual commentator booth at a Danish 'Superliga' soccer match. From these data, all instances of the passive construction were extracted and analyzed. The passive utterances and the eye movements associated with them were categorized into three phases:

- I. *Pre-event perception*. Fixations on participants of impending events, typically from the moment they approach the ball.
- II. *Event perception and Passive Intonation Unit (PIU)*. Fixations on participants from the moment the event occurs until the event has been explicitly mentioned (Average phase II duration = 3828ms, sd = 2101).
- III. *PIU+1*. The intonation unit after PIU containing either the agent of the action or elements from the ensuing game (typically the recipient of the ball, or simply continued commenting about the action near the ball).

Two illustrative examples can be seen in the table below:

Phase I	Passive Intonation Unit	Phase II	PIU+1 (potential agent position)
960 ms agent fixation time	Ø bliver så headet væk sidste øjeblik Ø is headed away moment	2280 ms agent fixation time	af Anders Veller by Anders Veller
			then at the last
2160 ms agent fixation time	Ø bliver så i første omgang sparket væk Ø is then the first time kicked away	760 ms agent fixation time	men-øøh Silkeborg bevarer bolden but-err Silkeborg keeps the ball

Whether or not the agent is realized in PIU+1 can be predicted from the amount of fixation time on the agent. Logistic regression analyses showed that agent fixation time in phase II was a good predictor of the occurrence of agents in PIU+1 (Model  $\chi^2 = 15.94$ ,  $p < 0.001$ ; Darlington's  $R^2$  analog = 0.36). An unexpected negative relationship between phase I agent fixation time and agents in PIU+1, although significant in its own right (Model  $\chi^2 = 8.23$ ,  $p < 0.005$ ), did not improve the model significantly ( $\chi^2$  of the improvement = 2.61,  $p > 0.1$ ). Perhaps surprisingly, the total agent fixation time from the beginning of phase I to the end of phase II was not even a near-significant predictor of the agent (Model  $\chi^2 = 1.09$ ,  $p = 0.396$ ).

These data suggest that visual fixations have a different linguistic significance after an event than before it. This supports the suggestion by Griffin and Bock (2000) that linguistic formulation (cf. Levelt 1989) controls the direction of gaze once events have been perceived.

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## Traces of cascading activation in speech errors

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Recent findings suggest the presence of cascading activation between lexical selection and phonological planning processes. Multiple lexical representations (not just the selected target word) activate their phonological representations (e.g., Peterson & Savoy, 1998). We examined whether cascading activation is also found between phonological planning and articulatory processes. When a target segment is replaced in an error, it should remain partially active. Cascading activation from this segment can then influence the realization of the error segment. For example, in the error "tab"->"dab," the partially active phonological representation /t/ may send cascading activation to articulatory processes. This cascade may cause the acoustic / articulatory properties of the [d] in "dab" to reflect a "trace" of the target [t] (e.g., [d] may be produced with a longer voice onset time).

*Method.* Eighty tongue twisters were generated using syllables made up of four initial obstruents (/k, g, t, d/), five vowels (/i, E, AU, aI, OI/), and four final fricatives (/f, v, s, z/; e.g., "keff geff geff keff"). Five English speakers read each twister aloud three times quickly to induce speech errors.

*Results.* Productions resulting in perceptible errors (e.g., "keff->geff") were paired within each speaker with correct productions matched to the error (e.g., "geff->geff"). The voice onset time (VOT) distribution of error tokens reflected a trace of the target segment. Voiced -> voiceless tokens exhibited a shorter mean VOT (68 msec) compared to correctly produced voiceless tokens (76 msec; Wilcoxon signed-rank  $p < .02$ ); voiceless -> voiced error tokens (e.g., /k/->[g]) exhibited a mean VOT (26 msec) that was significantly longer than correctly produced voiced tokens (e.g., /g/->[g]; 24 msec;  $p < .002$ ).

A post-hoc analysis found that the size of the trace was influenced by the lexical status of the error. The mean size of the trace for nonword errors (e.g., "keff -> geff") was significantly larger (6 msec) than the trace for word errors (e.g., "kess -> guess"; 1 msec;  $t(58) = 2.1, p < .04$ ).

*Conclusions.* Error tokens reflected an acoustic trace of the intended target. This suggests that partially activated target phonological representations send cascading activation to articulatory processes. The effect of lexical status on errors can be attributed to cascading activation from lexical selection processes. This cascade increases the activation of phonological representations that correspond to words; this activation advantage then cascades to articulatory processes, reducing the influence of target representations (and the size of the trace).

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## Do Speakers Avoid Ambiguities during Dialogue?

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Do speakers use ambiguity-avoidance devices to help addressees overcome comprehension difficulties associated with certain syntactic ambiguities? Previous evidence suggests that they don't; speakers show no evidence of exploiting such devices (e.g., optional disambiguating words, prosody, choice of constituent order) more often when an utterance is potentially ambiguous than when it is not. For example, Ferreira and Dell (2000) found that speakers were no more likely to use an optional "that" to disambiguate "The coach knew (that) you missed practice" (where "you" could be incorrectly interpreted as the direct object of "The coach knew") than "The coach knew (that) I missed practice" (where "I" is unambiguously the subject of the embedded clause). Given that syntactic ambiguities can make comprehension difficult (e.g., Rayner, Carlson, & Frazier, 1983), this kind of evidence (see also Arnold, Wasow, Asudeh, & Alrenga, 2004; Kraljic & Brennan, 2003) has often been used to challenge the idea that speakers spontaneously consider their addressee's "needs" during language production (the Audience Design hypothesis; e.g., Clark & Carlson, 1982).

However, our data suggest that speakers do show some sensitivity to potential syntactic ambiguities in interactive dialogue contexts. Participants played a communication game that involved giving and following instructions with a partner. One player was a confederate scripted to produce prime utterances that potentially contained a goal/modifier PP-attachment ambiguity (cf. Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). The confederate disambiguated the PP in half of his primes using "that's" (e.g., "Put the pig that's on the block on the square"). On the following turn, participants either gave an instruction for an array containing one referent (e.g., one penguin in a cup) or two referents (a penguin in a cup, a second penguin on its own, and an empty cup). Participants' utterances showed significant effects of both prime type and referential context. They were more likely to insert "that's" after hearing the confederate produce a prime containing "that's" (46%) than after a prime without "that's" (18%,  $p < .001$ ). This suggests that function word priming reported for monologue (Ferreira, 2003) extends to dialogue. Independent of the priming effect, our participants also produced more optional disambiguating words in two-referent contexts (36%) – where the addressee could potentially be garden-pathed by a structurally ambiguous PP – than in unambiguous one-referent contexts (28%,  $p < .05$ ). This finding stands in stark contrast to previous evidence which has been used to argue against audience design in ambiguity avoidance.

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## Articulatory shortening in repeated noun phrases is affected by participant role.

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When a noun is repeated twice by the same person in a discourse context, the second production tends to be faster than the first, i.e. it is articulatorily 'reduced' (Fowler, 1988). This attenuation could potentially be attributed to many factors, such as the increased predictability of a word after its first pronunciation, its given/new status and sentence-level phonetic variables.

In addition to this established 'within-partner' effect, Bard et al (2000) found 'between-partner' reductions in dialogue; that is, when one person says a word initially, and then their interlocutor repeats it, it still tends to be attenuated. Our study set out to discern if this between-partner articulatory shortening is affected by the participant's role in the experiment. We used the 'Map Task' paradigm (Brown et al, 1984) - a referential communication task in which one participant (the 'giver') has to describe to their partner (the 'receiver') how to draw a line on their map to match the line on the giver's map. The participants were allowed to talk freely, and so the names of the landmarks on the maps were repeated several times by both participants within each trial. The durations of the first two pronunciations of each landmark name were measured manually, on the condition that the names were always in clause-final position, and that there were no other intervening landmark names between repetitions.

As well as replicating the established within-partner effect, our measurements demonstrate that participants' roles in a task interact with the between-partner reduction of articulation over repetition. Overall, when a landmark name is initially said by the giver and then by the receiver, the receiver's pronunciation is reduced. However when the first pronunciation is by the receiver, and then the giver repeats it, there is no significant reduction. A second finding was that this between-partner reduction (only when first spoken by giver, then by receiver) is specific to those cases where the landmark in question is on the receiver's map. When the giver mentioned a landmark that the receiver didn't have, the receiver's pronunciation didn't reduce. Our results suggest firstly that even apparently automatic processes like articulatory reduction can be influenced by social factors such as role, and secondly, that previous mention alone is often not sufficient to confer 'givenness' upon an item; its visual presence is also required.

## Sources of variation in American English word-boundary palatalization environments

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Word pronunciation variation in spontaneous speech is a widespread, complex phenomenon. One approach to understanding variation is to model its origins during language production. Current models of production (e.g., Levelt et al. 1999) predict that variation may variously arise at lexical access, phonetic encoding, or articulation. Observed variation arising at different levels of production should be sensitive to different variables within the speech context, and variable sensitivity could thus provide evidence for how variant phenomena arise. Lexicalized pronunciations should be relatively invariant, and perhaps limited to predictable items (Bybee 2001); segmental and metrical structure may license phonetic allophony, which may also be predicted by sociolinguistic factors; and faster, more fluent speech is associated with segment shortening (including deletion) and gestural overlap during articulation (Byrd & Tan 1996). The current study uses the Buckeye corpus of spontaneous speech (Pitt et al. 2004) to examine variation in word-boundary palatalization environments (e.g., "that you", which may be pronounced as "thachu"), where palatalization commonly occurs. In a dataset consisting of over 400 tokens, comprising all /t,d#y/ word pairs in hour-long interviews with 16 speakers, four variants predominated in the following decreasing order of frequency: glottal stop, palatal affricates, alveolar stops, and (alveolar stop) deletion.

We examined the distribution of these four variants according to a variety of linguistic and extra-linguistic variables in order to determine the level of production at which they originated. While lexical access of words that are /t,d/-final commonly result in alveolar stop production, less than 20% of /t,d#y/ sequences were labelled with the alveolar stop variant. Excluded from our dataset were pairs including the very frequent word "and", which throughout the entire Buckeye database was almost always produced with /d/ deleted, suggesting that a reduced pronunciation for this word is lexicalized and not a result of deletion. Although lexical chunking of word sequences may account for some of the remaining variation in the /t,d#y/ environment, the number of variants produced per type overall increased as pair frequency increased. Glottal, palatal, and deletion variants are sensitive to different sets of variables, and arise after lexical access. The glottal variant rarely occurred in /d#y/ sequences from these Standard American speakers (although glottals are a variant of /d/ in other dialects; Kohl & Anderson 2000), and there were more glottals in women's speech than men's (cf. Byrd 1994). Even glottals in /t#y/ sequences were strongly conditioned by phonological context, as 90% occurred following vowels. These results suggest that the glottal stop is an important allophonic variant of /t/ for female speakers of this dialect when /t/ is preceded by vowels, and that the glottal variant arises during phonetic encoding. Whereas the glottal variant was conditioned by phonological context, the palatal variants were sensitive to fluency factors. Rates of palatal production and deletion became more frequent as speech rate increased. Y-word frequencies and transitional probabilities of palatal pairs were higher than for other variants (cf. Bush 2001). Palatals were also inhibited by prosodically strong environments (cf. de Jong 1995, Fougeron & Keating 1997). Sensitivity to these fluency factors suggests that palatals are largely introduced during articulation. Deletions were sensitive to some fluency factors, but also strongly conditioned by phonological context. Unlike preceding vowel contexts in the case of glottals, preceding consonant contexts result in deletions as a consequence of gestural overlap. The mixed nature of deletions indicates that they are a consequence of articulatory reduction from all other variants.

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## Effects of syllable preparation and syllable frequency in speech production

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The speech production model by Levelt, Roelofs and Meyer (1999) claims that the on-line construction of phonological syllables is followed by access of ready-made syllable motor programs from a mental syllabary. Prior studies using an implicit priming paradigm report syllable-preparation effects, strongly supporting the relevance of syllables in speech production (Cholin, Schiller, & Levelt, 2004). This effect, however, does not necessarily involve the retrieval of stored syllable programs. Effects that certainly provide evidence for the retrieval of syllable units from a mental syllabary are syllable-frequency effects as obtained in a recent study by Cholin, Levelt and Schiller (submitted): High-frequency syllables were produced faster than low-frequency syllables. This finding confirmed the assumption that speaker access precompiled syllable programs as only stored units are thought to exhibit frequency effects.

The purpose of the current study was to test whether or not the syllable-preparation effect includes the retrieval of stored syllable units. A reading-variant of the implicit priming paradigm was used to contrast the voice onset latencies for high- and low-frequency initial syllables in disyllabic Dutch pseudo-words. The items' form overlap and initial syllable frequency was simultaneously manipulated. Participants were instructed to read out loud Dutch pseudo-words. Pseudo-words consisted of a first syllable that was either high- or low-frequency and a second high-frequency syllable and were presented either in homogeneous or heterogeneous blocks of four items each. The homogeneous (high- and low-frequency) sets consisted of four items with an identical first syllable (e.g., kem.ta, kem.wa, kem.li, kem.jo). The corresponding heterogeneous sets were created by regrouping the items from the homogeneous sets. All experimental syllables had two counterparts of the opposite frequency differing only in onset or offset respectively, thus controlling for a maximum number of possible confounds.

As accessing and retrieving of low-frequency syllables takes longer than retrieving high-frequency syllables, it was predicted that the comparison of heterogeneous and homogeneous sets should yield a larger preparation effect for low-frequency sets than for high-frequency sets. The results mirror this prediction: No frequency effect was obtained for the homogeneous sets, but there was a significant difference between the (high- and low-frequency) heterogeneous sets. This interaction between frequency and preparation effect suggest that the preparation effect indeed includes access and retrieval of stored syllable units from the mental syllabary. These results converge with the other reported findings of syllable preparation and syllable frequency and add further evidence to the claim that syllables are core functional units in speech production.

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## Ignoring the Signal: Evidence from Vowel Epenthesis

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A number of languages have only open syllables in their phonological inventory and thus their phonotactic constraint prohibits consonant clusters. In production of foreign words containing consonant clusters, the phonotactic constraint is applied to eliminate the consonant cluster, for example, epenthesizing an extra vowel between the two consonants (e.g., Japanese, Brazilian Portuguese). In Japanese, the vowel [u] is used as a default epenthetic vowel (thus "Epson" is pronounced as /epuson/). In our previous study (Dupoux, Kakehi, Hirose, Pallier and Mehler 1999) contrasting Japanese and French speakers, we observed that Japanese speakers perceive a vowel [u] between consonants in VCCV stimuli, when the [u] vowel that was originally present was reduced, or not even present. The Japanese subjects also showed difficulty discriminating between VCCV and VCuCV stimuli. We proposed that epenthesis is a perceptual phenomenon that takes place from language-specific prelexical processes. We called this "illusion", whereby speakers "hear" a vowel that does not exist.

In the present study, we show the illusion can sometimes override the acoustic information supplied by an existing vowel, e.g., [i]. In the experiment, 13 different sequences of VCuCV and VCiCV nonwords were produced. The stimuli were edited into 6 different files by splicing out pitch cycles of the intervening vowel (either [u] or [i]) in 6 stages (stimuli 1 ~ 6), where stimuli 1 contained no (or very little) vowel and stimuli 6 was the closest to full vowel. Two other conditions where the vowel part remained intact (Stimuli Full) and where the stimuli were intentionally produced as VCCV (Cluster stimuli) were also included. Including fillers, there were 234 items in total. The subjects engaged in a forced-choice labeling task where they were asked to identify what they heard in the word medial position by choosing from [a],[i], [u], [e], and "None".

For the stimuli that derived from VCuCV, majority of the Japanese subject reported [u] even when the large part of the vowel information was removed. Even for the 0 condition, the subject perceived [u] in about 60 % of the cases whereas the choice "None" was under 40%, roughly replicating the previous study. Other vowels were hardly reported. In contrast, for the stimuli made from VCiCV, the choice rate for [i] dropped to about 30% in Stimuli 0 but interestingly, the [u] choice was made in 20% of the cases. For cluster stimuli, [u] was reported in 60% of the case, [i], less than 10%, and "none" about 30%. This provides further support that the vowel epenthesis is purely prelexical perceptual phenomenon caused by a language specific phonological filter installed in native speakers' brain, and that the illusion could even fool the perceiver, sometimes overriding existing acoustic information.

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## Repetition Blindness in Semantic and Lexical Processes

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Repetition Blindness (RB) refers to the deficit that subjects cannot recognize the second occurrence (T2) of a target (T1) in RSVP paradigm (Kanwisher, 1987). A variety of researches have been conducted since RB was first established. The overall result shows that RB is quite robust if T1 and T2 are identical. Besides, RB would also appear if T1 and T2 share some similarity: perceptual, orthographic, and phonological alike (Bavelier & Potter, 1992). What remains unclear is whether semantic similarity can yield RB or not. Kanwisher (1987) proposed Token Individuation Hypothesis to account for RB. As a perceptual account, they argued that semantic similarity itself cannot produce RB (Kanwisher & Potter, 1990), however, other study did show semantic RB using sentence presentation (Bavelier, 1994). In this study, six experiments were conducted to investigate the role of semantic similarity in RB. In Study 1, semantic related Chinese words and pictures were tested. Significant RB was found with pictures, but not with words. Distinctive features of pictures did yield RB in study 2. Semantic related characters yielded no RB in study 3. Cross modality experiment also suggested picture can produce RB, but not the words in study 4 (with individual stimulus) and study 5 (in sentences). Nonsense figures also yielded RB in study 6. Two major conclusions were then drawn. Semantic relatedness can produce RB if nonverbal stimuli were in use. And, the main reason verbal stimuli cannot produce RB may have something to do with the time course difference between these two types of stimuli. Lexical and semantic processes of Chinese characters and words were then discussed. Theoretical implication and other related issues (e.g., repetition deafness) were also discussed.

## Developmental Changes in the Optimal Viewing Position Effect

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Learning to read involves becoming proficient in a number of component processes of reading. While a good deal of recent research has been largely devoted to specifying the role of phonological skills in learning to read, little attention has been given to developmental changes in the way visual information is extracted from print. Analyzing the development of this competence could therefore serve the understanding of the system that supports reading and may help to identify deviating reading patterns early during acquisition. A typical finding about the perception of written words in adults is that the ease with which printed words are recognized depends on the position where the eyes initially fixate. Word-recognition performance is maximal slightly left of the word's center and decreases on both sides of this optimal viewing position (OVP) (O'Regan et al., 1984). Arguments for a relationship between reading ability and visuo-attentional processes are provided by the view that fixating the OVP aids word recognition (see O'Regan & Jacobs, 1992) and that this position may vary as a function of lexical factors. The recognition performance of a beginning reader can vary, for instance, with the ability to identify individual letters in words and/or with the degree to which the child can take advantage of redundancy in the structure of written language.

Using the fixation-contingent display, Ducrot et al. (2003) showed that the OVP effect emerges early at the end of the 1st year of reading instruction, thus suggesting that beginning readers extract visual information from print in much the same way as proficient readers do. However, we found some OVP-curve differences between beginning and dyslexic readers (i.e., absence of the characteristic left-right asymmetry), suggesting abnormal processing of information outside of foveal vision for dyslexics. It may be that skilled readers develop an automatic bias towards information processing in the right visual field (RVF) while less skilled readers fail to do so.

The purpose of the present study was twofold: (1) to explain the RVF-enhancement in good readers, and (2) to propose a mechanism that might account for the off-center location of the OVP. One way to do this was to conduct a longitudinal study on beginning readers. Word frequency (HF vs. LF), initial fixation location (5 positions) and training (3 vs. 8 months) were manipulated in a word identification task, in combination with the variable-viewing-position technique. In line with our first results, visual-field asymmetries comparable to those observed with adults were evident by the end of the first year of reading instruction. However, after 3 months of practice, beginning readers exhibited a symmetric curve comparable to that of dyslexics. Interestingly, effects of word frequency were also obtained for both levels. This factor did not interact with fixation position.

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## Conceptual Distance Effects in Category Noun-Phrase Anaphora

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Previous work on anaphoric category noun phrases (NPs) has produced two basic findings: effects of *typicality* in which anaphor processing times are faster when the antecedent is a typical exemplar of the category compared to when it is atypical (Garrod & Sanford, 1977; Rayner, Kambe & Duffy, 2000), and effects of *inverse typicality* when processing times are faster when the antecedent is atypical (Almor, 1999). Accounts of both these effects have argued that it is the conceptual similarity (e.g. Rips, Shoben & Smith, 1973) between the antecedent and the anaphor that underlie such effects. Further, Almor (1999) argued that inverse effects in particular were due to the interaction of conceptual similarity and the focus status of the antecedent, with easily reactivated antecedents triggering inverse effects. However, Almor only tested for inverse effects using antecedents placed in cleft constructions, e.g. *It was the robin that ate the worm*. This raises two questions: First, will other manipulations of conceptual similarity trigger typicality- and inverse typicality-like effects, and second, will inverse effects extend to other constructions that make the antecedent easily reactivated, or are they limited to only those cases when the antecedent is clefted (e.g. *robin* above).

We address both of these questions in two self-paced reading experiments in which reading times to both the anaphor and the sentence that contained the anaphor were collected. First, in Experiment 1, conceptual distance was manipulated via positions in a semantic hierarchy: Antecedents for a category NP anaphor ("reptile") were either one level ("snake") or two levels ("cobra") away, corresponding to typical and atypical antecedents, respectively. Following Almor (1999), we manipulated antecedent focus by using clefts. The results show a typicality-like effect when the antecedent is not focused, and an inverse effect when it is. This pattern is exactly analogous to the effects found by Almor, and suggests that (inverse) typicality effects are extendable to other manipulations of conceptual distance.

Experiment 2 addressed the second question by manipulating the prominence of the antecedent without the use of clefts. The antecedent was either the grammatical subject in an active sentence or the object of a by-phrase in a corresponding passive. The results show the same pattern as those from Experiment 1, and demonstrate that subject position also triggers inverse semantic distance effects, establishing that the inverse effect is not limited to cleft constructions alone.

Table: Reading times (in msec) at "The reptile"

Experiment 1		<u>snake</u>	<u>cobra</u>
Clefted:	What the mongoose stood up to was the [snake/cobra].		
	The reptile // hissed and got ready to strike.	574	542
Non-clefted:	It was the mongoose that stood up to the [snake/cobra].		
	The reptile // hissed and got ready to strike.	561	584
Experiment 2			
Subject:	The [snake/cobra] frightened the hunter.		
	The reptile // looked ready to strike at once if threatened.	623	597
Object:	The hunter was frightened by the [snake/cobra] for a moment.		
	The reptile // looked ready to strike at once if threatened.	576	619

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## Direct report and eye-tracking measures of semantic anomaly detection

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Failures to detect semantic anomalies (such as the Moses Illusion) are taken as being indicative of discourse sometimes receiving surprisingly shallow processing. Conditions under which anomalies are more-or-less easily detected provide a tool for investigating what controls shallow processing (e.g., Sanford & Sturt, 2002). With anomalies that are detected relatively easily, the effect of anomalies on the eye-tracking record may also be recorded. However, whether there is any effect of an anomaly on the eye-tracking record when they are not consciously detected has until now not been explored. Work on the detection of phonological anomalies, for instance using "week" when the correct word should be "weak", has shown that even if there is no conscious report of the error, the tracking record shows evidence of disruption (Daneman & Reingold, 2000) so, in principle, tracking should be sensitive to the detection of other anomalies, even if they are not consciously detected.

We investigated whether there is any evidence for the detection of semantic anomalies, even when they are not consciously detected. Using short passages in which anomalies of the kind .."they had to decide where to bury the survivors"... were embedded, subjects were eye-tracked while monitoring the passages for anomalies. The materials produced overall detect rates around 50%.

If subjects indicated a detection, they were taken off the bite-bar to verify their detection. If an anomaly was detected, there were many early and late effects on the eye-tracking record, demonstrated by a variety of measuring techniques. If an anomaly was present but not detected, there were no parallel effects on tracking. Comparison of undetected anomalies with similar non-anomalous controls suggested that failure to detect results from fast reading. The results show that for semantic anomalies, consciousness seems to drive, or run in parallel with, the tracking pattern, and that there is no evidence for unconscious influences of semantic anomalies on tracking performance.

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## Pronouns, reflexives, binding theory and information flow

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The observation that English pronouns and reflexives have a (nearly) complementary distribution is central to standard binding theory (BT). However, there are well-known exceptions, e.g. picture-NPs (ex.1), where pronouns and reflexives are acceptable despite BT-incompatible antecedents. Acceptability of BT-incompatible interpretations has been attributed to pragmatics/semantics ([1],[2],[3],[4],[5],[6]). We present two experiments testing (i) the idea—derived from Kuno [2]—that “source-of-information” referents can antecede BT-incompatible reflexives, and (ii) Tenny’s [6] observation that “perceiver-of-information” referents can antecede BT-incompatible pronouns. Conceptually, ‘source-of-information’ and ‘perceiver-of-information’ are two sides of the same coin. If BT-incompatible pronouns can acceptably refer to ‘perceiver-of-information’-antecedents, and BT-incompatible reflexives to ‘source-of-information’-antecedents, one might hypothesize that antecedents of pronouns and reflexives that are acceptable despite BT-incompatibility are in complementary distribution. To investigate this idea—and test Kuno’s and Tenny’s claims—we conducted two experiments:

(1) Picture-NP (example from [1]): Hanna found a picture of her/herself.

*Experiment 1:* Participants listened to sentences (ex. 2) while looking at scenes. Verb-type (*heard/told*) and anaphoric form (*pronoun/reflexive*) were crossed, creating four conditions, as illustrated in (2). The participants’ (N=24) task was to decide which picture the sentence referred to. BT predicts that reflexives refer to subjects and pronouns to objects.

(2) *Example item* [Visual scene: Peter, Andrew, a picture of Peter and a picture of Andrew]

- (a) Peter told Andrew about the picture of him on the wall. [told-pronoun]
- (b) Peter told Andrew about the picture of himself on the wall. [told-reflexive]
- (c) Peter heard from Andrew about the picture of him on the wall. [heard-pronoun]
- (d) Peter heard from Andrew about the picture of himself on the wall. [heard-reflexive]

*Results:* In accordance with Tenny’s perceiver-of-information claim, participants interpret pronouns as referring to the subject significantly more often with ‘heard’ than ‘told’ ( $p=.001$ ). Reflexives are usually treated as referring to the subject, in accordance with BT (Fig.1), but the object is chosen as the reflexive’s antecedent twice as often with ‘heard’ (object=source-of-information) as ‘told’—but this is not statistically significant. However, since all scenes include a BT-compatible picture, perhaps strong BT-effects are hiding verb effects for reflexives?

Figure 1: Experiment 1 Results, Percentage of subject and object interpretations

<i>told-reflexive condition:</i> 93% subject, 7% object	<i>heard-reflexive condition:</i> 86% subject, 14% object
<i>told-pronoun condition:</i> 32% subject, 68% object	<i>heard-pronoun condition:</i> 58% subject, 42% object

*Experiment 2:* To remove this trait in Exp. 1 that may have biased participants to follow BT and ignore discourse/semantics, we presented participants (N=24) with scenes that fit either the BT-compatible interpretation or the non-BT-compatible interpretation (scenes = two people, a picture of only one of them). The task was to say whether the sentences (structured like Exp.1 sentences) match the scenes.

*Results:* For reflexives, there is a marginal verb-type effect ( $p=0.06$ ); participants accept BT-violating reflexives more often when their antecedents are sources-of-information. For pronouns, there is a significant verb-type effect ( $p<0.01$ ); participants accept non-BT-compatible pronouns more often when their antecedents are perceivers-of-information. We are conducting an eyetracking study investigating the real-time processing underlying these responses, and will discuss these results too.

*Conclusions:* Both reflexives and pronouns are influenced by the direction of information flow, but the effects are stronger for pronouns, and it doesn’t look like any kind of pragmatics/semantics-driven complementary distribution arises. Discourse/semantic factors interact with BT, but affect pronouns with local antecedents more than reflexives with non-local antecedents. This asymmetry fits with the ‘discourse-oriented’ nature of pronouns, which, unlike reflexives, are used as free/non-bound discourse anaphora (ex. 3).

- (3) (a) He saw a picture on the wall.
- (b) Peter saw a picture of her on the wall.

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### Cognitive restoration of reversed speech in French.

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Understanding spoken language is rapid automatic and unconscious despite the involvement of numerous processes. Speech comprehension is robust: translation of speech sounds into meaning is achieved without awareness of intervening processes, and occurs despite background noises and inter-speaker variability (voices, accents...) that can be found in everyday life. The acoustic basis for this perceptual robustness remains unclear but may derive from compensatory mechanisms that are recruited when speech becomes difficult to understand. Models of speech comprehension are hierarchical and suggest the involvement of both lower level acoustic processes and higher level mechanisms (see Crouzet, 2000). These processes are not well understood and understanding them is crucial to the controversial issue of speech interactivity.

It is possible to explore the role of these two types of processes by varying speech intelligibility (Hoen & al., 2004). In this series of experiments, we addressed this issue by using speech reversion.

In experiment 1, we compared auditory words and non-words comprehension. Subjects had to hear and write 240 disyllabic items distorted by different types of reversions (the duration of the first half syllable, first syllable, first and a half syllable and whole item). Results showed lower intelligibility with higher distortion. This means that a cognitive capacity to reconstruct the speech signal exists. At comparable distortion levels, subjects were better with words than non-words, suggesting the involvement of lexical processes in speech reconstruction.

In addition, subjects who achieved low performances for non-words restitution were better than the other subjects for words restitution. This suggests that lexical strategies can compensate for low level acoustic perception lacks.

In order to identify the possible acoustic bases for this former observation we selected two groups of subjects according to their contrasted performances for non-words restoration. We submitted them to a complete audiometric testing procedure involving the testing of the functionality of the medial efferent system (Collet & al., 1990; Micheyl & Collet, 1996). The results of these audiometric measures show that subject's auditory performances correlate with their cognitive ability to understand reversed speech.

The results of experiment 2 indicate that the auditory system -especially the medial efferent system- is involved in speech reconstruction.

Together, the observations of experiment 1 and 2 clearly demonstrate the existence of a large interindividual variability in reversed speech comprehension which may come from the efficacy of the efferent system. These results are important because they help to understand the mechanisms involved in speech perception in normal ears and could lead a study with hearing impaired patients.

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## Focus particles and the construction of the discourse representation

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Rooth (1992) identified contrastive focus as an important aspect of language comprehension. Methods of placing sentential elements in focus include prosodic cues in spoken language (Selkirk, 1996), the use of syntactic constructions such as clefts in written language, or lexical specification through the use of focus particles such as 'only'. While a number of studies have investigated the influence of 'only' on parsing (Ni, Crain, & Shankweiler, 1996; Clifton, Bock, & Rado, 1999; Paterson, Liversedge, & Underwood, 1999; Liversedge, Paterson, & Claves, 2002; Sedivy, 2002), there has been no direct experimental demonstration that it causes readers to instantiate a contrast. Our eye movement experiments set out to provide such a demonstration for dative (e.g. 1) and double object constructions (e.g. 2), with 'only' preceding the direct object (e.g., 'chocolates') or indirect object (e.g., 'mother'), and the continuation providing an appropriate or inappropriate contrast (e.g., 'grandma' / 'flowers').

- (1). At Christmas Fred sent| (only) chocolates to (only) mother| but not  
Grandma/flowers| too because| he didn't have enough money.  
(2). At Christmas Fred sent| (only) mother (only) chocolates| but not  
Grandma/flowers| too because| he didn't have enough money.

For datives, readers made more regressions when the continuation was inappropriate and 'only' preceded the indirect rather than direct object. However, regression path and total reading times for the disambiguating region (e.g., 'too because') showed a main effect of continuation. Thus, the results indicated that while the earliest focus effects occurred when 'only' preceded the indirect rather than direct object, the incongruence ultimately was detected in both cases.

Experiment 2 investigated whether the difference in time course of detection was attributable to the linear order of constituents or the syntactic status of the constituent over which 'only' operated. First pass regression data for the disambiguating region showed a main effect of continuation with no interaction, suggesting that an appropriateness effect occurred when 'only' preceded either the indirect or direct object. However, first pass, regression path and total reading time data all produced an interaction such that an appropriateness effect occurred when 'only' preceded the indirect object, but not when it preceded the direct object.

It appeared that readers instantiated contrast sets for datives when 'only' operated over both the indirect and the direct object (with earlier effects for the former). By contrast, for double object sentences they were more likely to instantiate a contrast when 'only' operated over the indirect than direct object. Taken together the data from the two studies demonstrate that focus assignment is computed early in the course of processing a sentence and that the syntactic status of sentential constituents plays an important role in the assignment of focus during sentence comprehension.

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## Gender stereotypes influence the processing of ambiguous pronouns in Finnish

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In previous studies on the use of stereotypical gender information in pronoun and anaphora resolution, the focus has been on the linguistically marked gender agreement between the pronoun or anaphora and its possible antecedents (e.g., Carreiras et. al., 1996; Kennison, 2003; Kennison & Trofe, 2003; Sturt, 2003). The present eye-tracking experiment was carried out to investigate how stereotypical gender information affects the processing of Finnish personal pronoun *hän*, which is used to refer to both male and female antecedents. In Finnish, gender information is not linguistically marked in the pronoun, so the pronoun resolution has to be made on the basis of other linguistic and/or non-linguistic information available in discourse. In the present study, we studied the possible use of stereotypical gender information related to occupations and professions (e.g. make-up artists are typically female, whereas car mechanics are typically male). We used a visual world paradigm, in which the participants listened to mini stories about a female and male character and at the same time looked at pictures of these people on the computer screen (a picture of a tool and of a location mentioned in the story were also presented on the screen). Eighteen stereotypically masculine and 18 stereotypically feminine occupations were chosen on the basis of a rating test. The auditorily presented stories contained two context sentences. In the first sentence a male and a female person was introduced by giving their names, ages, and places of residence. In the second sentence, a scene is depicted where these two characters were involved in a discussion of an occupation. In the critical sentence, one of the characters was said to have experience with the occupation in question (e.g., *as a make-up artist*) followed by the gender-ambiguous pronoun *hän* (see below for an English translation of one experimental text).

On the screen you see Ville, who comes from Tervakoski and Saara, who comes from Kauniainen. Yesterday on the phone Ville (or Saara) discussed with Saara (or Ville) the make-up artists' possibilities to create impressive theater make-ups. After having studied to become a make-up artist, s/he (ambiguous pronoun *hän*) had noticed that the opportunities were quite slim.

In addition to the type of occupation (stereotypically female vs. male), we also manipulated the order of mention of the two persons (female first vs. male first). The participants' eye movements after hearing the pronoun were registered. The results showed when the pronoun referred to a stereotypically masculine occupation, the participants made more looks to the male than to the female character, and vice versa when the pronoun referred to a stereotypically female occupation. This main effect was qualified by an interaction suggesting that the order of mention was also influential. The study shows that stereotypical gender information is readily used in the interpretation of gender-ambiguous pronouns in Finnish.

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## Semantic Competition between Hierarchically Related Words during Speech Planning

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There is overwhelming evidence that, during speech planning, semantically related words become lexically activated and compete for selection with the to-be-produced target word. The vast majority of this evidence stems from studies using the picture-word task in which a distractor word drawn from the same semantic category as the target (e.g., target: "fish", distractor: "bird") was shown to inhibit the picture naming response more strongly than an unrelated distractor word (e.g., Damian & Martin, 1999; Glaser & Döngelhoff, 1984; Jescheniak, Schriefers, & Hantsch, 2001; Lupker, 1979; Rosinski, 1977; Schriefers, Meyer, & Levelt, 1990; Starreveld & La Heij, 1995; Underwood, 1976). By contrast, corresponding evidence from distractor words bearing a hierarchical relation to the target (e.g., target: "fish", distractor: "carp") is sparse and inconclusive (e.g., Roelofs, 1992, Vitkovitch & Tyrell, 1999). In a series of four picture-word experiments effects from subordinate-level distractors during basic-level naming were investigated as well as effects from basic-level distractors during subordinate-level naming.

Two sets of materials were used that differed with respect to the preferred naming level. In Experiments 1 and 2, pictures of objects with their preferred names located at the basic-level of abstraction (e.g., picture: CARP, preferred name: "fish") were used. In Experiments 3 and 4, pictures of objects with their preferred names located at the subordinate-level of abstraction (e.g., picture: SHARK, preferred name: "shark") were tested.

The experiments were conducted in German. 32 participants took part in each experiment. In all experiments auditory distractor words were presented at 4 different Stimulus Onset Asynchronies (SOAs: 0 ms, 100 ms, 200 ms, and 300 ms). Semantically related distractor words were hierarchically related to the target utterance (i.e. denoting the subordinate-level name alternative during basic-level naming [e.g., target: "fish"; distractor: "carp"] or the basic-level name during subordinate-level naming [e.g., target: "carp"; distractor: "fish"]). In addition to the semantic distractor condition a phonological distractor condition was included to demonstrate the sensitivity of the experiments in case of absent semantic effects. Unrelated control conditions were created by reassigning the related distractors to experimental pictures such that they shared no semantic or phonological relation.

In all four experiments (using two different sets of materials) hierarchically related distractor words were found to inhibit the naming response compared to unrelated distractor words. This semantic interference effect was thus obtained during basic-level and subordinate level naming and irrespective of the preferred naming level. These findings strongly suggest that hierarchically related name alternatives (at least from subordinate and basic-level of abstraction) compete for selection during speech planning. Conflicting findings and implications for current models of speech production will be discussed.

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## Naming without seeing

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A number of studies investigated speech production using eyetracking (e.g. Meyer, A.S., Sleiderink, A.M., & Levelt, W.J.M., 1998; Griffin & Bock, 2000;). One of the main findings was that objects that are named are fixated shortly before naming. At the onset of naming the next to be named object is fixated. This has been found for naming of multiple objects and description of scenes. Fixation duration was related to the difficulty of object recognition and name retrieval. A less explored issue is why objects are fixated before naming. One obvious reason might be that overt or covert deployment of attention is a necessary step for object recognition. This position has found strong support from visual search tasks which demonstrated that objects are represented as a list of unbound features before attention is devoted towards them (Treisman, A., 1986; Wolfe, J.M., 1998). There is some evidence that an object falls back into this stage after attention is taken away from it (Wolfe, J.M., Klempen, N., & Dahlen, K., 2000). On the other hand, there are several studies showing that the visual system is capable of processing highly complex images that are presented for very brief durations (28 ms), even if the scenes are presented in far peripheral vision and even if dual tasks have to be performed (Li, F.F., VanRullen, R., Koch, C., & Perona, P., 2002; Thorpe, S., Fize, D., Marlot, C., 1996; Thorpe, S., Gegenfurtner, K.R., Fabre-Thorpe, M. & Bülthoff, H.H., 2001.)

We addressed this controversy directly by presenting scenes consisting of two animate participants, and an object that was transferred (actions consisted mostly of giving and shooting). Coherence of scenes was manipulated by mirroring the animate participants. The scenes were presented for short durations (ranging between 100 and 300 ms) on different locations on the screen and masked right afterwards. The viewers had to name what they had seen. Viewers were able to judge coherence correctly (80% correct) starting at stimulus durations of 100 ms. Animate participants were correctly named (75%) at durations of 200 ms and longer. Actions and objects could not be named well. Performance did not increase significantly with longer presentation durations. Interestingly, performance was higher when scenes were coherent and when agents were located left. These results will be discussed with regard to current approaches to scene perception and description.

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## The role of the syllable is distinctly different in Mandarin and English

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Formal analysis backed up by observational and experimental evidence suggests that the deployment of syllables for language production differs fundamentally in Mandarin Chinese and in Germanic languages such as English and Dutch (Chen et al., 2002; O'Seaghdha & Wang, 2004). We propose that responsibility for segmental encoding is delegated from words to syllables in the production of Mandarin polysyllables. In Germanic languages, the complex word is the unit that regulates segmental encoding, with syllables playing only an intermediary role.

We explored this issue through experiments using a tongue-twister like word-pair repetition task. Participants repeatedly produced pairs of disyllables that shared (AB-AD related conditions) or did not share (AB-CD unrelated conditions) the first syllable. The dependent measure was number of error-free productions in a fixed (7 sec) interval. Previous research shows that production of related word pairs is more difficult in both languages. Our new research shows that:

- In Mandarin, production of novel disyllable compounds (arbitrarily combined monosyllables) led to similar difficulty as for existing words, suggesting novel words are rapidly compiled.
- In English, novel compounds showed only slow and tentative movement toward lexicalization over two experimental sessions separated by several days. However, just like mono-morphemic disyllables, existing English disyllable compounds that share a first syllable are difficult to produce. Thus, lexicalization eventually occurs in English but it is a much more reluctant process than in Mandarin.
- Crucially, producing either Mandarin or English disyllable pairs as sequences of four monosyllables (A-B-A-D) rather than as compounds (AB-AD), eliminates production difficulty, and in English even leads to substantial facilitation relative to controls (A-B-A-D sequences easier than A-B-C-D). This shows that the difficulty in producing related disyllables is lexically regulated and not merely articulatory.

Taken together, these findings strongly support our proposal that the syllable serves as a major controlling unit of phonological encoding in Mandarin but not in English. Natural and experimental error data – showing a preponderance of syllable errors in Mandarin and segmental errors in English – concur. We present explicit architectures for each language with syllable selection occurring only in Mandarin. We conclude that language-general models of phonological encoding must be formulated in terms of more abstract principles that transcend language-specific implementations.

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## The Pseudohomophone Baseword Frequency Effect Explained

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The pseudohomophone effect in visual lexical decision reflects the finding that nonwords with a pronunciation similar to a word (e.g., “brane” or “foks”) are harder to reject than nonwords that lack this similarity (e.g., “yabe”). Ziegler, Jacobs and Klüppel (2001) have augmented this effect by showing that the frequency of the baseword (“brain”, “fox”) influences the accuracy in visual lexical decision in an unintuitive way. Based on a single-shot retrieval mechanism, one would expect high frequent basewords to interfere more with the “nonword” decision than low frequent basewords. However, Ziegler et al found the opposite. They suggested that these results argue in favor of a verification mechanism that verifies the presented probe with the retrieved baseword (e.g., “brane” versus “brain”).

Based on this mechanism, one can also predict what should happen when participants are speeded. In a speeded condition a relatively high frequent word might be retrieved (“brain”) but the verification process would not always have sufficient time to complete, yielding an incorrect “word” answer to those high frequent pseudohomophones. At the same time, pseudohomophones derived from low frequent basewords will not be recognized in time, yielding correct “nonword” answers. This is the inverse pattern of results compared to the non-speeded condition.

This hypothesis was supported by data from an experiment that was conducted both at Carnegie Mellon University and Indiana University (as pseudohomophone effects are known to be unstable). As in the Ziegler et al study, pseudohomophones derived from high frequent basewords showed higher accuracy than the low frequent pseudohomophones in the non-speed stressed condition, whereas the inverse effect was observed in the speeded condition in which participants had to respond within 550 milliseconds.

The hypothesis’ viability was further corroborated by an extension of our ACT-R based word recognition model (Van Rijn & Anderson, 2003). In this model, words are retrieved from the mental lexicon on the basis of their mismatch to the current probe (e.g., brane is represented as [br,a,ne, /br/, /ain/]). As the CELEX wordform (Baayen, Piepenbrock & Van Rijn, 1993) frequencies determine the initial word activations, high frequent words are retrieved faster, often leaving sufficient time for a separate verification step. After training the model on the Balota et al (1999) dataset, it showed similar accuracy and latency patterns for both speeded and non-speeded conditions for the same sets of pseudohomophones as used in the experiments.

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## The Importance of the Magnocellular Pathway in Visual Word Recognition: Evidence from Monocular Occlusion

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I present an experiment using the monocular occlusion paradigm to investigate how disruption of the magnocellular visual pathway affects reading. There are two main visual pathways: Magnocellular and Parvocellular. Magnocells, found in the parafoveal and peripheral regions of the retina, transmit coarse-grain information and have a fast conductance rate. Parvocells, found in the foveal region, transmit fine-grain information and have a slower conductance rate. Stein and Walsh (1997) propose that disruption of the magnocellular visual pathway may cause developmental dyslexia. Dyslexics make shorter saccades and longer fixations (Biscaldi et al., 1998), suggesting that they do not get adequate preview information.

The human retina, including the fovea, is vertically split (Brysbaert, 1994; Shillcock et al., 2000). The left hemisphere receives the RVF information; the right hemisphere receives the LVF information. Occluding one eye ensures that hemispheres cannot receive information from their opposite visual field's monocular zone. The monocular zone is the part of the visual field that can only be viewed with one eye. This should be important for RVF information due to the right attentional bias in English and the language dominance of the left hemisphere, as suggested by the effect of length on reading times in the LVF but not the RVF (Young & Ellis, 1985).

The current experiment tests the proposal that the RVF's monocular zone makes use of the magnocellular signal to facilitate visual word recognition. Participants made a lexical decision to four or seven letter words and orthographically and phonologically legal non-words presented at the central fixation point, the LVF, or the RVF. Participants' left or right eye was covered, or both eyes were uncovered. Occluding the right eye should cause greatest disruption.

There was no difference between LVF and RVF presentations with the left eye covered or both eyes uncovered. In accordance with the length effect found by Young and Ellis, four letter words were recognised faster than seven letter words in the LVF but not the RVF when both eyes were uncovered. However, with the right eye covered, there was a length effect in the RVF but not the LVF, suggesting that the RVF monocular zone is important for the perception of stimuli in the RVF.

The right attentional bias in normal, English readers suggests that the RVF monocular zone is more important than the LVF monocular zone. Magnocells are mostly found in parafoveal and peripheral retina, suggesting that the magnocellular pathway is responsible for this preview information. Extending Stein and Walsh, I argue that the fast, coarse-grain magnocellular pathway is a feedback mechanism that primes the Parvocellular representations of words, facilitating word recognition.

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### The differential representation of action verbs and action nouns in the brain. Behavioural and fMRI evidence

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Background. The dissociation between noun and verb processing is well documented in the literature. In aphasia patients with noun specific impairments often show left temporal lesions while patients with verb specific impairments have lesions usually involving the left prefrontal cortex (Daniele et al., 1994), compatible with neural separability of nouns and verbs. Neuroimaging studies, however, provide mixed results. A study in Italian, showed that in a lexical decision task verbs activated left dorsolateral frontal cortex (BA 45,46, 9) while no areas specifically activated for nouns was found (Perani et al., 1999). On the contrary, in a very similar study carried out in English no differential activation between noun and verb processing was reported (Tyler et al, 2001). One reason for different results is that most studies did not distinguish between semantic or grammatical class processing, as the distinction between nouns and verbs is confounded with the distinction between objects and actions. In a study in which the semantic correlates of grammatical class were controlled, no difference between verbs and nouns was found (Vigliocco et al., in prep). Moreover, specific activations in LIFG for verbs have also been accounted for as resulting from differential demands on morphological processing (Tyler et al, 2004). To test these hypothesis we performed an er-fMRI experiment in which 1) we disambiguated between nouns/objects and verbs/actions using verbs and nouns referring to actions and 2) we manipulated task demands in order to stress morphological processing.

Method. Eight subjects viewed pictures depicting actions and named them overtly. Before each picture, subjects saw a label indicating whether they had to produce: 1) verb in infinite form (to run-correre); 2) verb in third singular form (he runs-corre); 3) action noun (the run-corsa); 4) name of the object (shoe-scarpa). Each pictures was presented four times, one time per run, in a different condition in each run.

Results. Behavioral results indicated that RTs in the "action noun" condition were significantly longer than all other conditions. In the fMRI study we observed in all four conditions activations in temporal-occipital areas compatible with the neural network previously observed during naming tasks. In the direct contrasts, we found a specific left frontal activation, including Broca's area, in the case of the "action noun" condition. These results are discussed with References to the role of semantics and morphological marking in noun-verb processing.

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## Using eye-movements to investigate speed-accuracy trade-off in visual word recognition

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Models of visual word recognition differ as to which factors known to affect lexical access they consider the most central. On one extreme, parallel direct access models place emphasis on primitive word features such that the more features a word-candidate shares with a real word in the mental lexicon, the faster it reaches threshold for successful recognition (respectively, a 'false alarm' in case of a non-word). On the other extreme, serial search models consider word frequency the most important factor in determining speed of recognition: high frequency words are accessed quicker via serial search than low frequency words. Both classes of models appear more or less capable of explaining basic findings on visual word recognition. However, a potential problem with these findings is that they are based on reaction times from lexical decision tasks where participants have to decide as quickly as possible whether a given word candidate is, in fact, a word or not. For such tasks, it is known that subjects often trade-off speed for accuracy, making it difficult to assess whether longer reaction times truly reflect a slow-down in the underlying processing dynamics or whether a decrease in accuracy truly reflects impaired discriminability between words and non-words – even in situations where higher reaction times coincide with higher error rates (as is the case for the majority of effects obtained in standard lexical decision experiments) it is hard to draw a definitive conclusion about the underlying processing characteristics because (a) discriminability typically grows in a non-linear fashion and (b) the strategies that perceivers use to balance speed and accuracy are usually not known.

The present eye-tracking experiment was designed to overcome such limitations by analysing speed-accuracy trade-off using a visual lexical decision task: participants saw displays comprising two three-letter word candidates simultaneously, one being a real word (the target), the other one being a non-word (distractor). By instructing participants to look at the target word (and to ignore the distractor), we were able to analyse the likelihood of a 'hit' (gaze on the target) in comparison to the likelihood of a 'false alarm' (gaze on the distractor) as a continuous function of time, providing a detailed account of both the dynamics and accuracy of visual word recognition. Two experimental factors were manipulated: lexical frequency of the target word (*high vs. low*) and 'wordness' of the distractor. The latter factor had six levels: in the BL condition, the distractor consisted of a blank space (no distractor present); in the NA condition, the distractor was a non-alphabetical character string; in the LL condition, the distractor consisted of a non-pronounceable letter string; in the CV condition, the distractor was a pronounceable letter string; the UN condition comprised a pronounceable distractor string matching a regular word in unigram frequency; and the BG condition comprised a pronounceable distractor string matching a regular word in bigram frequency (1).

(1)	Condition:	Target:	Distractor:	Condition:	Target:	Distractor:
	HI-BL	hit		LO-BL	wed	
	HI-NA	due	!&	LO-NA	gel	?%€
	HI-LL	arm	xgi	LO-LL	gig	mwt
	HI-CV	tax	boc	LO-CV	ilk	iya
	HI-UN	ran	pon	LO-UN	keg	zuy
	HI-BG	sit	bip	LO-BG	mod	fap

We analysed the average probability of a gaze on the target word minus the probability of a gaze on the distractor as a continuous function of time (over a time-period of 0-2000ms after stimulus onset), using a non-linear curve fitting approach (cf. McElree, & Griffith, 1995). The results indicated that the two experimental factors indeed have an effect on both speed and accuracy of visual word recognition: (i) the more features distractors had in common with regular words, the more slowly (and error-prone) target word recognition proceeded, as reflected in reliable rate, offset, and asymptote contrasts across all six distractor conditions; (ii) lexical frequency of the target word also had an effect on these parameters, but only if there was sufficient competition from the distractor (most notably, there were no frequency effects in the BL and NA distractor conditions), resulting in a significant *frequency by distractor* interaction. The fact that the presence of a lexical frequency effect depended on the type of distractor suggests that word recognition takes place in two major phases: first, word candidates are analysed purely in terms of orthographic features (the more similar the distractor is to a real word, the longer it takes to reject it as a potential word candidate, regardless of whether it competes with a high or low frequency target word); second, if orthographic analysis is not sufficient to reject the distractor, lexical frequency of the target word becomes decisive (faster and more reliable recognition of high rather than low frequency target words in case of alphabetical distractors). Overall, these results seem to be in line with hybrid models of word recognition (e.g. Becker, 1976). Importantly, while results from 'traditional' methods are equivocal as to whether the considered factors affect only accuracy, only speed, or have an effect on both, the present study provided clear evidence for the latter.

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## On the representation of boundstem morphemes in memory

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Two morphologically related words that share the same stem morpheme share also same form and meaning (e.g., *baker* – *bakery*). In French, some words share the same boundstem (e.g., *facteur* – *facture*) but because boundstems do not occur in the language as free lexical items (i.e., *fact* doesn't mean anything in French) it is sometimes hard to consider them as polymorphemics; however they are. Five visual masked priming experiments were conducted in order to examine how complex words composed with boundstems are represented in memory and where, in the lexical architecture, morphemes are located. Indeed, within interactive activation models of localized units, morphemic units can be either located before word units, in this case it implies that any morphologically complex word is decomposed into morphemes to access word units (the *sublexical* hypothesis) or situated above word units, then morphemes stand as units of organization of the word level (the *supralexical* hypothesis). The first experiment demonstrated that words sharing the same bound stem primed each other and this could not be explained by formal relationships between primes and targets (i.e., *facteur* – *facture* differed from *facétie*-*facture* where *facétie* is a monomorphemic word). The results of Experiment 2 showed that boundstem primes (e.g., *fact*-*facture*) produced shorter reaction times than unrelated primes as well as orthographic primes (e.g., *bact*-*facture*), suggesting that the observed priming effects were formal in nature. Experiment 3 revealed that when the effect of morphologically complex word primes (e.g., *facteur* – *facture*) were directly compared to boundstem primes (e.g., *fact*-*facture*) only the former primes significantly facilitated target processing relative to unrelated primes. Finally, Experiment 4 and 5 explored the effect of the illegal derivation of boundstem primes on target processing (e.g., *factier* – *facture*, where *factier* corresponds to the illegal combination of the boundstem *fact*- and the suffix *-ier*). Whereas Experiment 4 showed that only morphologically complex word primes (e.g., *facteur*) facilitate target processing, Experiment 5 demonstrate that any effect observed using illegal derivation primes are formal in nature (*factier* did not differ from *factape* where *-ape* is not a suffix morpheme). The present results demonstrate that boundstems are represented in memory as separate morphemic units of processing and suggest that morphemic units can not stand as access units to the word level but instead are located at the interface of semantic and word units, hence supporting the supralexical hypothesis of morphological representation in memory.

## A memory-based learning account of Dutch plural inflection

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We examine the Dual-Mechanism model of inflectional morphology (Marcus et al., 1995; Pinker, 1999) in relation to the inflection of Dutch plurals. An important claim of the Dual-Mechanism model is that non-canonical roots, such as names and unassimilated borrowings, are necessarily inflected by a symbolic system and cannot benefit from similarity with items stored in memory. Whereas we agree with the claim that single-mechanism models must include more than phonological coding, we will argue that these extra-phonological features do not necessarily reduce to a symbolic rule. We will show that the correct plural inflection for unassimilated borrowings in Dutch can be produced by a memory-based learning model based on the nearest-neighbour algorithm if the model is able to exploit orthography-based similarity.

In comparative simulations on 3145 Dutch monomorphemic nouns taken from the CELEX database, we found that a memory-based learning model using phonological representations was able to predict a correct plural in about 87% of the cases. By including word spelling in the learning procedure, mean accuracy was significantly increased to about 91 %, an increase that was mainly due to the higher accuracy in predicting the plural for borrowings. This contrasts with the claim made by Dual-Mechanism models that non-canonical roots cannot benefit from similarity with stored exemplars. To investigate whether actual language users can appeal to this orthographic information when making plurals, we ran an experiment in which we asked participants to produce the plural of pseudowords that were auditorily presented in a Dutch sentence context. Conditions differed in whether participants saw the pseudoword's spelling or not, and, if so, whether the spelling contained a typically English (i.e., borrowed) spelling pattern or not. Participants used the -s plural more often when the pseudowords contained an English spelling pattern than when they had only Dutch spelling patterns, even though the Dual-Mechanism model would predict that the -en plural should be the default. Since the same phonology was used in all conditions, the increase in preference for the -s plural must have been due to the change in spelling pattern and the resulting increase in similarity with stored unassimilated borrowings. In simulations on the experimental stimuli, we obtained similar response patterns as in the experiment by using a two-stage memory-based learning procedure that first tries to predict spelling from phonology for each word in the training set and then uses this information in the plural prediction task. By using this procedure, borrowings tend to cluster together because of their deviant spelling patterns. We interpret the outcome of these simulations to support the idea that participants also identify borrowings in this way. Taken together, all empirical data fail to support the claim of the Dual-Mechanism account that the inflection of non-canonical roots requires a symbolic default mechanism.

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## Processing agreement

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We will present an activation-based model of verb-production and comprehension that captures a wide variety of known evidence on agreement errors. We claim that agreement processing at the verb depends on the accessibility of subject's plural marking at that time. The activation of plural-marking chunks decays over time, so that it might not be found when its retrieval is attempted at the verb, resulting in a general singular error (Hemforth and Konieczny, 2003). This effect is then modulated by task and construction specific variations. The model will come in variants for different experimental paradigms based on the same core model for verb-production and comprehension. We will present two variants here: one variant performs a completion task for written production and is hence a combined sentence processing and production model. The second model performs an error detection task.

Both read two NPs first, embedded in either a Subject-Modifier-Verb (SMV) construction, or in a Subject-Object-Verb (SOV) construction. The first model next produces a verb, the second reads a verb and computes agreement. Modifier attraction errors (cf. Bock & Miller, 1991; Vigliocco & Nicol, 1998) result wrongly assigning the plural marking of the modifier-NP to the Subject-NP. This effect is due to the necessity of reactivating the Subject-NP for attachment of the modifier-NP and is therefore restricted to modifier-NPs (Hemforth & Konieczny, 2003) and absent in SOV. In SOV, however, the general singular error is reduced with plural objects (Hemforth & Konieczny, 2003). This is predicted by the model, because an Object-plural can reactivate a plural marking of the Subject when both NPs have to be retrieved for incremental interpretation of the proposition.

Both models are built atop ACT-R 5.0's architecture, which provides us with mechanisms for i. declarative chunk activation and decay, ii. cost-dependent rule selection, and iii. task-specific modelling. We are planning to extend the model to other types of tasks (as pure production tasks) to be able to account for task-specific differences. We will argue that many of the cross-linguistic evidence on agreement errors in production is due to an interaction of the task demands of the specific paradigm used (basically whether or not intermediate recall and time pressure were involved, cf. Fayol, Largy, Lemaire, 1994; Hartsuiker et al., 2001) and properties of the (language specific) constructions (basically their lengths).

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## Processing noncanonical word order in Czech

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In relatively free word order languages like Finnish and Hindi, when discourse context is not provided, deviating from canonical order results in increased processing difficulty (Hyona and Hujanen 1997, Vasishth 2003). However, it has been recently shown that in such relatively free word order languages, discourse context can facilitate the processing of noncanonical order (e.g., (Kaiser and Trueswell 2004)). These constraints also seem to apply in languages with not as free a word order, such as English (Altmann and Steedman 1988).

It is nevertheless possible that in languages like Czech, which have even freer word order than Finnish and Hindi, the relatively high frequency of noncanonical orders (Kruijff and Vasishth 2003) could have the consequence that processing is not adversely affected by noncanonical order even *without* any supporting discourse context.

To test this prediction for Czech, we conducted a self-paced reading study (n=42) involving six conditions, each a permutation of the string containing the agent (AGNT), patient (PAT) and the verb (V). These were structures like (1) below. Reading time at the main verb immediately following the permuted string was taken as a measure of processing difficulty since the integration of the permuted string into the sentence would occur at that point at the earliest.

(1) Uz mesic / se / Zdenek / knihu / snazi / najit / bez vysledku  
 AGENT PATIENT VERB MAIN-VERB  
 Already for a month himself Zdenek book aims to-find with no result  
 'Zdenek has been trying unsuccessfully to find the book for a month already.'

The prediction of the frequency-based view is the null hypothesis: in Czech there should be no difference in processing difficulty with canonical versus non-canonical orders. The alternative possibility is the standard one assumed in the literature: noncanonical order should adversely affect processing in the absence of preceding context.

In order to argue for the null hypothesis, we did not use the standard technique of computing so-called observed power along with p-values because this has been shown to be an incorrect use of power. It is a fallacy to assume that, in the face of a null result from a t-test or ANOVA, high power (say, greater than .80) provides grounds for accepting the null hypothesis: a nonsignificant p value *entails* low observed power (see (Hoenig and Heisey 2001) for details). Consequently, we used a statistical technique called (bio-)equivalence testing (Berger and Hsu 1996); this is commonly used in the pharmaceutical industry to demonstrate, for FDA approval, effective equivalence of brand-name versus generic drugs. In equivalence tests (specifically, two one-sided t-tests or TOST), the null hypothesis is treated as the alternative hypothesis, and vice versa.

Assuming that a difference of less than 25 milliseconds amounts to effective equivalence, the results show that there is effectively no difference in processing ease with agent-before-patient versus patient-before-agent orders (only SVO vs. OVS was inconclusive using TOST). Thus, the absence of discourse context does not necessarily have an adverse effect on noncanonical order processing: a critical cross-linguistic variable is the degree of word order freedom available *a priori*. Languages with freer word order do not suffer the effects of noncanonical order to the extent that comparatively rigid order languages do.

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## Relative clauses processing in Brazilian Portuguese and English: a self-paced study

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It is well known that sentences with multiple center-embedded clauses are far more difficult to process than sentences with multiple right-branching clauses (Miller & Chomsky (1963)). However, a number of studies of English have found that this generalization does not extend to cases of single embedded clauses, where right-branching structures have been found to be more difficult than center-embedded clauses (Hakes et al., 1976; Holmes, 1973). Some recent accounts of this effect predict that it is either cross-linguistically general (Gibson et al., in press) or specific to English, due to the apparent absence of the effect in off-line studies of Brazilian Portuguese (Gouvea, 2003). This study presents results from parallel on-line studies of English and Brazilian Portuguese that lend support to the language-general account.

In order to distinguish between general versus language-specific accounts, we conducted a fully parallel self-paced reading study of relative clause processing in English and Brazilian Portuguese. Target sentences in both languages contained center-embedded (1) and right-branching (2) subject and object relative clauses.

- (1a) The student that hugged the colleague with the long hair insulted the teacher after the exam at the public school. [center-embedded, subject RC]
- (1b) The student that the colleague with the long hair hugged insulted the teacher after the exam at the public school. [center-embedded, object RC]
- (2a) The teacher insulted the student that hugged the colleague with the long hair after the exam at the public school. [right-branching, subject RC]
- (2b) The teacher insulted the student that the colleague with the long hair hugged after the exam at the public school. [right-branching, object RC]

The BP results (n=30) showed that right-branching relatives presented longer reading times than center-embedded relatives,  $F_1(1,29)=3.9$ ,  $p=.05$ ,  $F_2(1,23)=7.6$ ,  $p<.05$ . Preliminary English results (n=25) show a non-significant tendency in the same direction. Clearly, neither language shows evidence for increased difficulty in the center-embedded conditions, for subject and object relative clauses alike.

Gouvea (2003) argued that the increased difficulty of right-branching single embeddings is due to the ambiguity created in English right-branching relatives by the availability of extraposition structures like (3). In support of this account, Gouvea shows that extraposition is unavailable in Brazilian Portuguese, and presents results from an off-line study (RSVP grammaticality judgment task) that shows that center-embedded relatives induce more errors in Brazilian Portuguese, whereas right-branching relatives induce more errors in English.

- (3) Any girl<sub>i</sub> could break the table easily that<sub>i</sub> takes karate lessons.

In order to verify the role of extraposition in explaining the patterns of difficulty, all participants in the on-line studies completed an acceptability rating questionnaire. This study replicated Gouvea's finding that extraposition is far more acceptable in English than in Brazilian Portuguese and excluded the possibility that our findings might have differed from Gouvea's due to differences in the acceptability of extraposition in our Brazilian subjects.

In sum, these results lend support to accounts that link the difficulty of single-embedded right-branching relatives to an inherent syntactic or discourse property of these structures (Gibson et al., in press), as opposed to ambiguity-based accounts.

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## Prosody and relative clause attachment in Spanish: Evidence for early but asymmetric effects

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We report a series of experiments about the role of prosody in spoken sentence comprehension in Spanish. Our aim was twofold: first, to explore the role of intonation and pause distribution in the interpretation of locally ambiguous sentences; and second, to examine the time course of prosodic disambiguation. Sentences contained a restrictive relative clause (RC) modifying one of two previous nouns mismatched in number in a complex NP. All sentences were disambiguated by number marking at the verb in the RC.

1. Este mes visitarán a los hijos del hombre que fue/fueron duramente castigado/castigados  
This month (they) will visit the children of the man who was/were severely punished[sg/pl]
2. Este mes visitarán a los hijos del hombre que se ... MARCHÓ/MARCHARON  
This month (they) will visit the children of the man who ... LEFT [sg/pl]

Prosodic phrasing of the stimulus utterances (produced by a trained speaker) was manipulated by introducing a break after the first (N1) or second noun (N2) of the complex NP, with rising intonation before the break. This prosodic manipulation was either congruent or incongruent with the sentence's resolution toward high (N1) or low (N2) attachment of the RC, thus yielding four experimental conditions: "high attachment, congruent prosody", "high attachment, incongruent prosody", "low attachment, congruent prosody" and "low attachment, incongruent prosody". High- and low-attachment prosodic phrasings were established by having subjects listen to prosodically biased (as described above) and neutral versions of fully ambiguous RCs (as those in example 3) and indicate their attachment preferences.

3. Este mes visitarán al hijo del hombre que fue duramente castigado  
This month (they) will visit the son of the man who was severely punished

*High attachment bias:* ((Este mes visitarán al hijo del hombre H-) (que fue duramente castigado L-L%))

*Low attachment bias:* ((Este mes visitarán al hijo H-) (del hombre que fue duramente castigado L-L%))

Five different tasks and two parallel sets of materials were employed across the experiments: (1) forced-choice attachment decision in a written questionnaire (Experiment 1); (2) sentence-final grammaticality judgment (Experiment 2); (3) online anomaly-detection (Experiment 3); (4) cross-modal completion judgment (Experiment 4); and (5) cross-modal word-naming (Experiment 5). In the completion judgment task, subjects had to indicate whether a visually-presented word (a verb agreeing with N1 or N2), was a correct continuation for the sentence fragment presented aurally. Fragment offsets were always at the right edge of the relative pronoun. In the naming experiment, subjects had to name a visually-presented word appearing at the offset of the sentence fragment. Attachment decisions and judgment tasks are thought to tap late processes, whereas detection and naming tasks are arguably more sensitive to early processes. For the grammaticality judgment and anomaly detection tasks, passive RCs with two disambiguation points were used (auxiliary and past participle) (example 1 above); for the completion judgment and naming tasks, single verb RCs were used (example 2 above).

The key results are summarized as follows. First, low attachment prosody is much more restrictive than high attachment prosody. Consequently, high attachment prosody seems to be a default case for parsing. Second, prosodic effects appear to occur relatively early, particularly in forced low attachment sentences. We discuss the implications of these results concerning the role and time-course of prosodic processing in parsing.

## Does implicit prosodic “chunking” mediate individual differences in relative clause attachment preferences?

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An influential finding in psycholinguistics is that the resolution of the relative clause (RC) attachment ambiguity (as in 1) varies across languages (Cuetos & Mitchell, 1988). For instance, whereas English speakers show an NP2 preference (e.g. the actress shot herself on the balcony), Dutch speakers show an NP1 preference (e.g. the sister shot herself on the balcony). The present study was designed to (1) show that individual differences in working memory (WM) capacity accounts for a significant amount of variance in the RC attachment preference independent of language and (2) further investigate how exactly WM influences RC attachment preferences.

- (1) The sister of the actress who shot herself on the balcony was under investigation.

We used an individual differences design that measured verbal WM using a variant of the reading span task, spatial WM using a spatial span task, and RC attachment preferences using an off-line questionnaire. In line with previous findings, English participants showed a low attachment preference (47% NP1) and Dutch participants showed a high attachment preference (56% NP1). Notwithstanding this cross-linguistic difference, both languages showed a correlation between reading span and attachment preference (when spatial span was controlled) but no correlation between spatial span and attachment preference (when verbal span was controlled). More surprisingly, this significant correlation was negative (English:  $-.29$ ,  $p < .01$ ; Dutch:  $-.36$ ,  $p < .01$ ): High-span participants preferred NP2 attachment, whereas low-span participants preferred NP1 attachment. Given our large sample, the genuine individual differences design and the identical pattern across both languages, this is a very robust finding, even though it is surprising given the preponderance of theories touting recency as the most helpful tool to save working memory resources.

In a second experiment we are currently testing an explanation of this finding in terms of the Implicit Prosody Hypothesis (Fodor, 1998). Whereas languages such as Dutch may tend to insert a prosodic break between the complex NP and the RC during speech, English tends to leave such a break out. The break seems to force higher attachment. An intriguing possibility is that something like this prosodic parceling during silent reading not only mediates cross-linguistic differences, but also individual differences in attachment tendencies. Perhaps high-spans “chunk” more material together as they read silently than do low-spans. This would cause the complex NP and the relative clause to be processed all at once, leading to the tendency to attach low. On the other hand, low-spans may insert a break between the complex NP and the relative clause, which presumably would cause the RC to seem more pertinent to the head of the complex NP. To test this possibility, we forced participants to parcel in a certain way by presenting the sentences in chunks: the complex NP (*the sister of the actress*), the RC (*who shot herself on the balcony*), and the matrix VP (*was under investigation*). If different “chunking” strategies underlie the individual differences, forcing participants to chunk in a specific way should eliminate the differences between high- and low-span readers.

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## Processing of relative clause Sentences in Korean

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English subject relatives (SR) have long been found to be easier to process than object relatives (OR) across a variety of measures (King & Just 1991, King & Kutas 1995, Just et al 1996, Caplan et al 1999, Grodzinsky et al 1999).

SR The reporter who attacked the senator admitted the error.

OR The reporter who the senator attacked admitted the error.

(King & Just 1991)

Results for prenominal relatives in SVO (Chinese: Hsiao & Gibson 2003, Hsu 2004) and head-final languages (Japanese: Nakamura 2000, Miyamoto & Nakamura 2003) have produced mixed results. The SR advantage, at least in English, has been given the following accounts: structural distance (STD, O'Grady 1997), accessibility hierarchy (AH, Keenan & Comrie 1977), filler-gap domain (FGD, Hawkins 2004), storage-/integration-based DLT (DLT-str/HLT-int, Gibson 2000), canonical word order (CWO, Pinango 2000), and perspective shift (PRS, MacWhinney 1982). To test which of these processing theories is correct, a self-paced reading time study of relative clauses was conducted in Korean, where these hypotheses make different predictions.

Account	English		Korean	
	OS	OO	OS	OO
DLT-int	√			√
DLT-str	√			√
FGD	√		equal	
STD	√		√	
AH	√		√	
CWO	√		no prediction	
PRS	equal		equal	

√: processing advantage, the stimuli included: subject head/subject gap (SS), subject head/object gap (SO), object head/ subject gap (OS), object head/object gap (OO), possessive head/subject gap (PS), and possessive head/ object gap (PO) (N=40 for each type; 24 subjects)

The results show processing advantage of SR over OR in Korean (SS > SO, OS > OO, PS > PO) and are consistent with STD and AH only. While accounting for the Korean data, the STD implies the use of a counter, and is limited to configurational languages. As an alternative, we propose an analysis in which the processing advantage of SR is cast in terms of the predication relation between head noun and relative clause. Additionally, the informational contribution made by the referent of a head noun to the interpretation of its clause accounts for the slight advantage of relative clauses modifying possessor heads over object head relatives.

In sum, subject gaps are found to be easier both in Korean and English despite differences in word order (SOV vs. SVO; pre- vs. postposed relative clause) and relative clause formation rules (empty vs. overt relativizer). This shows that usual accounts of the SR processing advantage are in need of revision.

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## Why we have a hard time processing queue-like structures in language: a dynamical systems approach

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Stack-like syntactic structures have been found to be far more frequent in natural languages than queue-like ones. Typical stack-like structures are palindromes "abccba" which occur naturally when one marks grammatical dependencies in e.g. nested relative clauses by matching parentheses:

(1) (\_a The mouse (\_b the cat (\_c the dog teased )\_c caught )\_b escaped )\_a  
(2)

The most prominent example of similar queue-like structures "abcabc", a duplication, is the ordering of infinite verbs in Dutch:

(3) "Aad heft Jantje de lerare de knikkers laten helpen opruimen."  
(4) Aad has Jantje the teacher the marbles let help collect  
(5) Aad let Jantje help the teacher to collect the marbles.'  
(6)

or abusing brackets in marking matching constituents:

(7) [\_a Aad heft [\_b Jantje [\_c de lerare de knikkers laten ]\_a helpen ]\_b opruimen ]\_c

The traditional explanation of the different frequencies of stack-like and queue-like syntactic structures relies on a symbolic computing view of human language processing and uses the Chomsky hierarchy: stack-like structures belong to the class of context-free languages while queue-like ones need context-sensitive grammars. Thus processing queue-like structures is computationally more difficult.

Yet, within the framework of connectionism human cognition has been described using subsymbolic processes as in neural networks and dynamical systems. Since the "hardware" in the connectionist framework is rather an analog computer than a symbolic one it is not obvious whether the argumentation with a language's rank in the Chomsky hierarchy applies here.

Therefore we set up simulations with simple recurrent networks (SRN) trained on binary palindrome and duplication languages, respectively: the copy language was more difficult to acquire mirroring the lower frequency of queue-like structures in natural languages.

In order to find an explanation of this fact, we analysed the networks' emerging dynamics and found that successful networks represented their language as simple dynamical systems in two dynamical variables: while these variables essentially evolve independently for the palindrome language, their dynamics were coupled for the duplication language, rendering the dynamical system more complex and thus harder to implement in a SRN.

In conclusion, we have analysed how SRN represent and process stack-like and queue-like structures and found an explanation why queue-like structures are harder to process even in an analog computing or connectionist setting.

## Parsing Self-Embeddings: A Grammatical Approach

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Self-embedded sentences are considered to be grammatical sentences that pose severe processing difficulty, as in (1):

- 1 The man the cat the dog chased bit died.

These sentences have been a focal point of psycholinguistic research, but not so much of theoretical linguistic research. It was found that in Korean, people could understand two levels of self-embeddings of object relativized clauses with relative ease, in contrast to English (Rosenbaum and Kong-On, 1976). The explanation relied on processing limitations. This will be proven here to be a myth.

The current proposal will predict the processing difficulty of self-embeddings in English, and the lack of it in Korean, by the application of principles that were defined within the generative tradition, especially the Minimalist Program (Chomsky, 1995) and Derivation by Phase (Chomsky, 1999). Hence, the goal of this paper is to show that self-embeddings can be of interest to theoretical linguistics, since they potentially contain implications for grammatical theory.

Specifically, the proposal demonstrates how self-embeddings are parsed in an erroneous manner, leading the parser to make a local erroneous parse decision, which brings the parser to the wrong tree branch. This in turn causes a violation of the complex NP constraint, and to the stranding of a null-operator. The generated structure is uninterpretable in logical form—the source of the low comprehensibility of these structures. For the first time, it is shown how the same uninterpretable situation found also in weak islands, namely the Weak Island Generalization (Manzini 1993, 1998), is found in self-embeddings, too.

Additionally, the human sentence processor is demonstrated to obey the Minimal Link Condition and Attract, as defined in the Minimalist Program. Independent experimental support to the proposal is provided both from left-branching and right-branching languages, explaining and predicting conflicting experimental results. For example, in a reading time experiment in Chinese, it was found that two levels of self-embeddings of subject relativized clauses were more difficult to understand than two levels of self-embeddings of object relativized clauses (Hsiao and Gibson, 2003). Again, this was in contrast to what was known about English. The conflicting results are explained in a straightforward way in accordance with Derivation by Phase.

In view of the experimental data from various languages, and the proposal here, it is argued that the human sentence processor is indeed universal. The view that the human sentence processor is transparent—i.e. a parser that can use operations coded in grammar alone (such as attract)—is supported here since this view can predict processing difficulties in self-embeddings in various languages.

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## Constraints of case and definiteness on German word order

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Linguists have formulated ranked constraints to account for German word order variation (e.g., Müller, 1999). Kempen & Harbusch (2004) report frequency counts on the NEGRA2 corpus (<http://www.coli.uni-sb.de/sfb378/negra-corpus/>) which indicate that German word order variation in subordinate clauses is fairly restricted by factors such as case and animacy.

In the experiments reported here, we looked at German main clauses with the subcategorising verb in sentence-final position. Frequency counts on NEGRA2 revealed a strong prevalence of sentences including a nominative and one oblique argument as opposed to such including a nominative and two oblique arguments, irrespective of the case of the second constituent (accusative or dative).

In Questionnaire 1, subjects were asked to complete sentence fragments varying in case of the second argument.

- (1) Der Doktor wird den/dem Krankenpfleger ...  
 the<sub>nom</sub> doctor will the<sub>acc/dat</sub> nurse ...

As predicted by our corpus data, subjects completed nom-acc fragments significantly more often without a third (dative) argument and a verb than with a verb only, but contrary to our expectations, they added significantly more often a third (accusative) argument and a verb after nom-dat fragments than a verb only.

In Questionnaire 2, subjects were asked to complete fragments which varied in case and definiteness of the second argument.

- (2) Der Doktor wird den/einen/dem/einem Krankenpfleger ...  
 the<sub>nom</sub> doctor will the<sub>acc/dat</sub> nurse ...

The case effect found in Questionnaire 1 was replicated. Definiteness only had an effect in the nom-dat condition. When the second argument was indefinite and subjects completed sentences with a third (accusative) argument, they inserted more often a definite than an indefinite article. This result contradicts predictions based on a linear precedence rule which disapproves definites after indefinites (Müller, 1999).

Two self-paced reading experiments were conducted to investigate effects of case and definiteness in more detail. Materials included verb-final sentences with three arguments.

In Experiment 1, case and definiteness of the second argument were varied.

- (3) Der Doktor wird den/einen/dem/einem Krankenpfleger einem/einen Rollstuhlfahrer zeigen.  
 the<sub>nom</sub> doctor will the<sub>acc/dat</sub> nurse a<sub>dat/acc</sub> wheel chair person point out to

A significant main effect of case was found with longer reading times on the third argument in the nom-acc-dat condition as compared to the nom-dat-acc condition. Definiteness had no significant effect.

In Experiment 2, case of the second and definiteness of the third argument were varied.

- (4) Der Doktor wird einen/einem Krankenpfleger dem/einem/den/einen Rollstuhlfahrer zeigen.  
 the<sub>nom</sub> doctor will a<sub>acc/dat</sub> nurse the/a<sub>dat/acc</sub> wheel chair person point out to

This time, a significant main effect of definiteness and a significant interaction of case and definiteness emerged with longest reading times on the third argument in the nom-acc-dat-indefinite condition.

To summarize, we found a robust case effect with a strong preference for two-argument structures when the second argument was marked for accusative. In contrast, when the second argument was marked for dative, there was a less strong preference for three-argument structures. We suggest that these preferences hold for sentences with animate subject referents only. To account for the reported definiteness effects, we propose that the parser prefers narrow focus over wide focus. This constraint is ranked below the constraints referring to case (cf. Keller, 2000). As available frequency data are too sparse to speak to these issues (Kempen & Harbusch, personal communication), our interpretation of the results waits for confirmation by subsequent corpus counts.

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## Did Tom tattoo the girl? Differential effects of reader's interpretation on the time course of reanalysis.

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Effects of plausibility on sentences containing subordinate clause ambiguities have been explored (Pickering and Traxler, 1998, & Christianson, Hollingworth, Halliwell, and Ferreira, 2001) and differences found in the extent of reanalysis depending on how the sentences were understood. In a series of experiments employing eye-tracking that examined reanalysis in such sentences, we explored the way that semantics influences the time course of reanalysis. Although the syntactic ambiguity between sentences was identical the sentences differed in how they could be interpreted. In (1) the subject of the main clause could be inferred to be also the object of the subordinate clause, a dual-interpretation; in the single-interpretation case (2), that dual-interpretation was rendered implausible.

- (1) As Tom tattooed the girl tried not to move.
- (2) As Tom tattooed the girl paced up and down.

Readers were then required to respond "True" or "False" to a statement (3).

- (3) True or False? Tom tattooed the girl.

These responses were used as a measure of understanding. Having explored differences between reading times and having found that (1) tends to be read more quickly than (2), we examined differences in reading contingent on how participants responded to the comprehension question. Rereading was generally shorter when the reader made the "expected" response: "True" to (1) and "False" to (2). Readers who answered "False" following (2) read almost as quickly as those answering "True" to (1). This effect was especially noticeable when a prior context sentence supported the "expected" meaning. When the context for (1) was not supportive of the inference readers took longer, rereading both the target sentence and the context sentence. Differences persisted in a third experiment in which punctuation was introduced to preclude the ambiguous construction.

In a sentence completion task participants, given (4), produced many more sentences similar to (1) that were clearly dual-interpretation (71%), while sentences of the single-interpretation type such as, (2), were much less common (17%).

- (4) As Tom tattooed, the girl...

This finding bolsters the supposition that readers may find the dual-interpretation sentences more probable constructs and that this could also be a factor in the difficulty readers have with sentences such as (2).

Readers are known to be inconsistent in the way they apply inference: they may focus on *what the words mean* or *what is meant* (Benjamin, 1968). Employing inference when it matches input is easy and results in less rereading. More time spent rereading does not signify more thorough processing, and therefore better understanding but more, and possibly unresolved, difficulty.

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## Syntactic processing in L2 speakers

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How do L2 learners represent knowledge of grammar of the new language and use this knowledge in language production? Is the architecture of the new linguistic system similar to that constructed in a first language (L1) speaker, who has been exposed to the syntax from childhood? Recent monolingual production models (e.g., Levelt, Roelofs, and Meyer, 1999) incorporate nodes at the lemma level representing syntactic information, including combinatorial information – how a particular lexical item can be combined with other items to build up syntactic structures (Pickering & Branigan, 1998; Cleland & Pickering, 2003). Evidence for the existence of representations of abstract combinatorial information comes from studies on syntactic priming, or the tendency for people to repeat a syntactic structure they have heard in a preceding, otherwise unrelated sentence. In L1 speakers, this syntactic persistence occurs in the absence of lexical overlap between prime and target, implying that combinatorial nodes are primed independent of specific lexical items but are linked to all lemmas sharing that feature. However, lexical overlap between prime and target boosts the priming effect in L1 speakers, implying that the link between a combinatorial node and specific lemma can also be primed. If the same priming effects can be found in L2 speakers this would imply a similar architecture being used in syntactic processing as in L1 speakers.

We report the results of three experimental studies which investigated syntactic priming effects in L2 and L1 speakers. Experiments 1 and 2 examined priming for Passive (example (1) below) vs. Active (example (2)) structures in two different settings, with the prime presented by either a native Spanish confederate or a computer. In addition, we varied whether the prime and target used the same verb or not, as repetition of the verb has been shown to boost priming effects in native speakers. There were three groups of participants: L1, intermediate L2 or advanced L2 level of Spanish (n=12 per group in Experiment 1, n=16 per group in Experiment 2).

- (1) El tren persigue el camión                      *The train chases the lorry*  
(2) El camión es perseguido por el tren      *The lorry is chased by the train*

Both experiments showed an overall syntactic priming effect for both L1 and L2 speakers. Participants produced 36% more passive structures after hearing a passive than after an active structure, and this tendency was 13% stronger when the verb was repeated. Although there was reliable priming for all groups, it was significantly stronger for L2 speakers (49% priming effect) than for L1 speakers (10%).

Experiment 3 was designed to test priming of an L2 structure not found in the learners' L1. Primes included either preverbal (SV; example (3) below) or postverbal (VS; example (4)) subjects and participants described experimental pictures using unergative verbs.

- (3) El perro baila                      *The dog dances*  
(4) Baila el perro                      *Dances the dog*

Results from 20 intermediate and advanced L2 speakers showed a 28% priming effect: significantly more VS structures were produced following VS than SV primes. The effect was significantly stronger when the verb was repeated. Because VS constructions are not permitted in English, this priming cannot be attributed to the transfer of syntactic representations from the learner's L1. An L1 Spanish group (n=20) also showed an 11% priming effect and a tendency for stronger priming with repeated verb. As in the first 2 experiments, the priming effect was significantly smaller in the L2 speakers than the natives.

Our results demonstrate that syntactic production in L2 speakers is influenced by prior syntactic context, just as in L1 speakers, and in ways that cannot be attributed to influences from L1. From this we can infer that a similar architecture and mechanisms are employed in L2 syntactic processing as in L1 production. These L2 speakers must possess abstract representations for combinatorial information shared between different lemmas, and residual activation of these representations allows syntactic persistence in the absence of lexical overlap between prime and target sentences. In addition, because the priming effect was boosted in the verb-repetition conditions, the links between this combinatorial information and specific lemma nodes can themselves be primed in L2 speakers like in L1 speakers. The fact that stronger priming is found in the non-native groups suggests that the abstract syntactic representations possessed by L2 speakers may be weaker than those of L1 speakers, and as such more susceptible to effects of prior context.



## Saying it twice: consequences for the lexicalization of subjects

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Decades ago, Roger Brown (Brown & Bellugi, 1964; Brown & Fraser, 1963;) characterized early child English as telegraphic, a term for the short utterances that resulted from children's many errors of omission. What gives rise to the lacunae in children's speech? Now, as then, we do not know why children's utterances are short, but it is likely that different constituents are absent for different reasons and that each lacuna is the product of several factors acting simultaneously (Allen, 2000; Bloom, Miller, & Hood, 1975; Valian, 1994; Valian & Eisenberg, 1996). (We use the term 'non-lexicalization' rather than 'omission' in order to avoid an implication that a speaker has a word or morpheme in mind and then deletes it.)

This elicited imitation study used a new task - double imitation - to investigate the factors that contribute to children's failure to lexicalize sentence subjects. Two-year-olds heard a triad of sentences singly and attempted to imitate each; they then again heard the same triad singly and again attempted to imitate each. Comparisons between the two attempts showed that children's second passes were more accurate than their first. In addition, independent of sentence length, children increased their inclusion of pronominal and expletive but not lexical subjects. Children included verbs more often from sentences with pronominal than lexical subjects, suggesting a tradeoff. Children included subjects more often in short sentences than long ones, and increased subject inclusion only in short sentences. The results suggest that children's language production is similar to adults': a complex interaction of syntactic knowledge, limited cognitive resources, communicative goals, and conversational structure.

In every sentence, multiple influences will shape the child's inclusion of subjects and other sentence constituents. Influences that play a major role in some sentences will play a minor role in others. When lengths are equated, for example, the effect of subject type is evident. When subject types are balanced, the effect of length is apparent. By manipulating sentence characteristics we can systematically examine the importance of different influences on the child's behavior. The present experiment suggests the need to look broadly at children's lexicalization of constituents, seeing each as a vector of forces - an important one of which is limited cognitive resources - that affect all constituents, to a greater or lesser extent in any particular sentence.

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## Anticipation and Early Disambiguation: A Model of Sentence Comprehension in Visual Worlds

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Evidence from anticipatory eye-movements in a number of visual worlds studies shows that people integrate both linguistic (e.g., syntax, plausibility) and non-linguistic (e.g., scene) constraints during sentence comprehension. In the present study, we apply a simple recurrent network that has been modified to accept a compressed representation of a visual scene as additional input in order to model the results from three recent experiments that have demonstrated integration of diverse constraints.

Kamide, Scheepers, and Altmann (2003) presented participants with scenes containing, e.g., a rabbit, a cabbage, and a fox, while hearing utterances such as (1) or (2). Anticipatory eye-movements to the appropriate second NP (cabbage or fox) suggest people are able to use both case and plausibility to predict upcoming referents. Scheepers, Kamide, and Altmann (submitted) further substituted experiencer/theme ("psych") verbs such as "interessieren" for the agent/patient verbs like "frisst" used earlier, demonstrating that verb argument structure is used compositionally in predicting subsequent referents.

In a more recent experiment by Knoeferle, Crocker, Scheepers, and Pickering (2003), plausibility was offset by using sentences in which characters were engaged in non-stereotypical behaviors, but in which actions were depicted. For example, a scene might depict the actions in both sentences (3) and (4). Because the feminine is not marked in German for either the nominative or accusative case, these sentences are ambiguous as SVO or OVS until the post-verbal referring expression is reached. Their results showed that listeners were able to integrate information from the scene to resolve linguistic ambiguity and predict the correct upcoming argument.

These results were modeled by training a simple recurrent on a grammar that generated sentences randomly from the empirical materials, but held out the actual experimental items themselves for testing. Care was taken to ensure that the network was able to learn the appropriate selectional restrictions in the first set of experiments, while still allowing for the non-stereotypicality of the events in the last experiment.

More interestingly, the network was able to learn to integrate scene information with its sentence processing and still function properly when the scene was absent or irrelevant. The model captures the experimental behaviors very well, showing early disambiguation when provided with scene information, as well as general incremental interpretation typical of such models. More generally, the model contributes to a better understanding of the influence of immediate contextual effects (the visual environment) and the long-term linguistic experience reflected by the model's training.

- (1) SVO: "Der Hase frisst gleich den Kohl"  
The rabbit[NOM] eats just now the cabbage[ACC]
- (2) OVS: "Den Hasen frisst gleich der Fuchs"  
The rabbit[ACC] eats just now the fox[NOM]
- (3) SVO: "Die Prinzessin waescht offensichtlich den Pirat"  
The princess[NOM] washes obviously the Pirate[ACC]
- (4) OVS: "Die Prinzessin malt offensichtlich der Fechter"  
The princess[ACC] washes obviously the Fencer[NOM]

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## Informativeness and Optimal Visual Word Fixation: A Computational and Psycholinguistic Investigation.

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Human readers demonstrate a preferred viewing location (PVL) in normal reading and a comparable optimal viewing position (OVP) for recognition of isolated words. The OVP is the fixation point in a word that gives the fastest, most accurate recognition of that word. The link between, and factors contributing to these effects are still under debate. The key challenge is to explain the asymmetry of these curves; the PVL and OVP fall to the left of word centre in longer words. What we propose to explore here is the possible role of informativeness.

Some models of reading behaviour suggest that identification of written words is made faster by fixating towards more informative parts of the word, where it is best distinguished from other word candidates (e.g.: Clark & O'Regan, 1998; Legge et al. 1997). Evidence of this effect in humans comes from various studies by O'Regan and others (e.g.: O'Regan et al., 1984; O'Regan and Levy-Schoen, 1987). These studies found an influence of information distribution on the OVP curve, although rarely a complete reversal in the curve for end informative words as might be predicted.

Such a role of informativeness is captured in the Split-Fovea Model of Shillcock et al. (2000). This model assumes that the parts of the words at the left and right of the fixation point are projected to the contralateral hemisphere. They define the optimal fixation point to be where both the left and right parts of the word are the most informative (i.e., shared by the smallest number of words in the lexicon). Using a computational algorithm based on these principles, correct predictions for OVPs in both English, a 'left-to-right' language, and Hebrew, a 'right-to-left' language, have been generated (Shillcock et al. 2000; McCauley, AmLaP, 2002).

However, while the simulation results resemble the nature of the OVP curve, no systematic comparison of the degree of skew in the OVP curves has been made between simulation and human data.

We propose to directly contrast the model's predictions with human data. First we investigate how OVP predictions from the algorithm actually correspond to human OVPs for particular word lengths. Various parameters of the algorithm are changed and compared, including the incorporation of word frequency.

Next we present a version of 'moving OVP' experiment in English. The algorithm is used to generate stimuli, processing words and non-words to generate beginning- and end-informative stimuli sets. The experiment uses forced fixation with a lexical decision and word identification task, in order to directly test predictions from the model of the effect of information profile on location of the OVP.

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## Competing Event-based Interpretations Mediate Anticipatory Eye Movements in Visual World Studies

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We examine the role of event-based representations in the interpretation of visual scenes and the mapping of concurrent spoken language onto these interpretations.

Experiment One established that objects in a scene prime spoken words referring to actions in which those objects can participate (cf. Vanderwart, 1984). The same scene, depicting a man, candy, and a motorbike, primed both 'eat' and 'ride' (lexical decision times were compared in the contexts of the same scenes with the critical objects - the candy or the motorbike - removed). This priming effect suggests either that event-based representations were encoded when viewing the scenes (encoding the man eating the candy), thus facilitating the recognition of verbs with semantically overlapping event-representations, or that the actions in which each object typically participates were encoded as a part of that object's representation, regardless of whether a scene-specific event representation was entertained (e.g. encoding that candy can be eaten, regardless of whom by).

Experiment Two examined whether the mapping of spoken language onto a visual scene is mediated by scene-specific event relations. We constructed two versions of each scene, depicting an agent and two objects with which the agent could engage (e.g., a businessman, a pipe, and a cigarette). Each alternative version added a different 'contrastive agent', who was strongly associated with either one or the other object (according to prior norms). For the businessman scene, the contrastive agent was either a sailor (more likely to smoke the pipe), or a debutante (more likely to smoke the cigarette). The sentences 'The businessman will smoke the cigarette/pipe' accompanied these scenes ('cigarette' with the sailor present and 'pipe' with the debutante present).

Eye movements launched between verb onset and the onset of the target noun ('pipe' or 'cigarette') were influenced by the identity of the contrastive agent: there were more looks towards the object more likely to engage with the contrastive agent (e.g. to the pipe when the sailor was present), independently of looks to the contrastive agent. We interpret this as a contrast effect (cf. Sedivy et al., 1999) but one where the computation of the alternative events in the scene (who is smoking what) is required. This suggests that participants' interpretation of spoken language in the context of a visual world can be mediated by non-linguistically determined event-based relationships between scene objects. Event-based representations are thus central to human cognition, determining both visual and linguistic representations and the interaction between the two.

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## The influence of beliefs about an interlocutor on lexical and syntactic alignment: Evidence from Human-Computer dialogues

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Evidence from Human-Human dialogues indicates that individuals align their utterances with those of their interlocutor (e.g. Branigan, Pickering & Cleland, 2000). We present five experiments using Human-Computer dialogues to investigate the influence of beliefs about the mental state of an interlocutor on lexical and syntactic processing. Naïve participants believed they were interacting with a computer or a person during a picture-describing dialogue game. In fact, their “interlocutor” was always a computer program that produced pre-scripted utterances.

If alignment is unaffected by beliefs about an interlocutor, we should expect alignment with both “human” and “computer” interlocutors. However, if alignment is affected by beliefs about an interlocutor, there are a number of potential mediating factors: Align only with interlocutors with similar mental states, leading to alignment with “human” only; align more with interlocutors perceived as similar, leading to more alignment with “human” than “computer”; align more with interlocutors that are less (possibly linguistically) competent, leading to more alignment with “computer” than “human”.

Experiments 1-2 investigated syntactic alignment. We presented pictures of ditransitive actions, manipulating the syntactic structure that the “interlocutor” produced (Prepositional Object vs. Double Object, as in [1-2]), and examined the syntax that the participant used to describe the subsequent picture. The prime and target picture involved different (Experiment 1) or same verbs (Experiment 2). There was a strong tendency to align, but participants aligned more when they believed they were interacting with a computer than a human in Experiment 2 (though not Experiment 1).

Experiments 3-5 investigated lexical alignment. We presented pictures of objects, manipulating whether the “interlocutor” produced a preferred term (e.g., ‘chair’) or dispreferred term (e.g., ‘seat’) for an object, and examined which term the participant used to describe the same object subsequently. Participants believed that they were interacting with a computer or a person (Experiments 3-4), or with an advanced, up-to-date computer or a basic, antiquated computer (Experiment 5). There was a strong tendency to align, but participants aligned more when they believed they were interacting with a computer than a human (Experiments 3-4), and when they believed they were interacting with a basic computer than an advanced computer (Experiment 5).

The pervasive alignment with both humans and computers supports an automatic component to alignment (Pickering & Garrod, in press). The increased alignment with “computer” over “human” (in Experiments 2-4) and with “basic computer” over “advanced computer” (in Experiment 5) suggests a strategic component that may be due to perceived competence.

- |     |  |                      |
|-----|--|----------------------|
| (5) | The pirate handing the cake to the sailor. | Prepositional Object |
| (6) | The pirate handing the sailor the cake.    | Double Object        |

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## Reference frame alignment in dialogue: The importance of the origin.

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Reference frames are an axial, co-ordinate system that are imposed upon a scene and allow the description of the location of a figure object in relation to a reference object. In a series of three experiments using a confederate priming paradigm (Branigan, Pickering & Cleland 2000) we show that interlocutors align reference frames when describing object location. Participants were more likely to use a reference frame if they had just heard an utterance using that reference frame than they were an alternative reference frame. We show that alignment cannot be attributed to lexical priming because the alignment was the same magnitude when the target and prime were different (alignment therefore required using a different preposition) as when the target and prime were the same.

The tendency towards reference frame alignment allows the nature of reference frame representation to be investigated. Traditionally, reference frames have been divided into absolute (environment-centred), intrinsic (object-centred), and deictic (egocentric). Under this taxonomy, descriptions such as "The car is in front of us" and "The car is left of the tree" are both categorised as deictic. Levinson (1996; 2003) argued against this, proposing instead a tripartite taxonomy of absolute, intrinsic, and relative: Intrinsic descriptions are binary with the origin of the reference frame situated upon the reference object, whilst relative descriptions are ternary, where the origin, reference object and figure object are all different. This makes the description "the car is in front of us" an intrinsic description and so different from "the car is left of the tree". Under the traditional taxonomy, interlocutors should be more likely to use a relative reference frame after hearing "The car in front of us", since both are deictic descriptions; under Levinson's taxonomy, however, interlocutors should be more likely to use an intrinsic reference frame after hearing "The car in front of us", since both are treated as intrinsic descriptions.

The results of a fourth experiment testing this hypothesis support the first three experiments. Participants were more likely to use an intrinsic reference frame after hearing their partner use an intrinsic reference frame (e.g. "The tree in front of the car"), and were more likely to use a relative reference frame after hearing a relative reference frame description (e.g. "The car left of the tree") ( $p < .05$  by subjects;  $p < .05$  by items). However, subjects were more likely to use a relative reference frame than an intrinsic reference frame following a sentence like "The car in front of us". Hence they treated such sentences as involving a relative reference frame. This supports the traditional taxonomy, and provides evidence against Levinson's taxonomy of reference frames.

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## Alignment in dialogue: Effects of feedback on lexical overlap within and between participants

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Recent speech production studies have shown that priming not only affects participants in monologue but also in dialogue situations (e.g., Branigan, H.P., Pickering, M.J., & Cleland, A.A. 2000). Additionally, it has been shown that in dialogue, self-priming effects are stronger than effects of other-priming (Pickering, M.J., Branigan, H.P. & McLean, J. 2003). This effect was attributed to priming being stronger within subjects (due to a monitoring mechanism), and not to the increase of interactivity in a dialogue situation.

Priming mechanisms form a fundamental part of the interactive alignment model (Pickering, M.J., & Garrod, S. (in press), which assumes that in dialogue, people reuse words or constructions they have recently heard or used themselves. In other words, people “align” on all levels of linguistic representation. This alignment is regarded as a consequence of the (automatic) priming mechanisms.

With respect to the above-mentioned findings, we would then expect alignment within subjects to be higher than between subjects (as a consequence of self-priming or other-priming, respectively), regardless of the degree of interactivity. To test this, we conducted a task-oriented dialogue experiment.

In this experiment, two participants had to move around shapes and negotiate names for them. The two subjects were each seated in front of a monitor, but were separated by a dividing wall.

We manipulated the type of feedback participants could give. In the verbal-feedback condition, participants were allowed to talk freely, and in the visual-feedback condition no verbal feedback was allowed, but the monitors were connected, so that participants could see which item was moved by their partner. We also included a full-feedback condition (both verbal and visual) and a no-feedback condition (neither verbal nor visual).

Our dependent measure was the lexical overlap between subsequent utterances of same or different speakers.

We found a main effect of type of feedback on lexical overlap: overall, the visual-feedback and no-feedback revealed more overlap between subsequent utterances than the full-feedback and the verbal-feedback. However, we did not find an effect of self-alignment versus other-alignment on lexical overlap and no effect of type of feedback on self- or other-alignment.

The results suggest that feedback can influence lexical alignment in a task-oriented dialogue. With respect to self-alignment and other-alignment, participants' explicit negotiations in verbally interactive conditions might be responsible for the absent effect: participants suggested new names for shapes instead of reusing the expressions proposed. Without verbal feedback, however, subjects tried to ensure understanding by reusing the expressions previously used. This further suggests different (additional) mechanisms underlying lexical and syntactic alignment, which will be addressed.

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## Working memory capacity in expert and novice simultaneous interpreters

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Simultaneous interpreting undoubtedly is one of the most complex language tasks. As such, it has repeatedly been supposed to be very demanding with respect to cognitive resources like attention and working memory (e.g. Cowan, 2000). This is also what is suggested by findings from experimental studies comparing memory span measured after simultaneous interpretation and other conditions (Daro & Fabbro, 1994). It is generally assumed that professional practise gradually develops cognitive abilities with growing expertise. Studies aimed specifically at testing working memory capacity in conference interpreters, however, either fail to provide evidence for differences in cognitive abilities between novice and expert interpreters (Liu, Schallert & Carroll, 2004; Nordet & Voegtlin, 1998), or do not yet allow clear conclusions about the nature of the cognitive advantages in these subjects (Moser-Mercer, Frauenfelder, Casado & Künzli, 2000; Padilla Benitez, 1995). This has led to put into doubt the usefulness of the concept of working memory in the context of research on simultaneous interpreters. Experimental data, however, are still scarce, and the few studies having investigated working memory in professional interpreters present some methodological shortcomings and were generally conducted with very small subject groups.

Furthermore, the concept of working memory is used in a rather large sense in these studies. What is called for at the present state of research, therefore, seems to be larger studies involving more subjects and starting from a more differentiated theoretical ground. One aspect of memory performance which could be promising with respect to simultaneous interpreting is the dissociation between phonological and semantic aspects in short term memory, as evidenced by pathological cases (Martin, Shelton & Yaffee, 1994; Martin & Saffran, 1997). In simultaneous interpreters several skills might be particularly developed: on the one hand, interpreting clearly focuses on semantic aspects and can be supposed to rely heavily on semantic verbal working memory; on the other hand, interpreting has been supposed to require the inhibition of phonological interference mechanisms which should lead to better performance of phonological working memory. The investigation of these questions was the aim of the present study involving a total of 79 participants: 21 professional interpreters, 18 2<sup>nd</sup> year interpreting students and two control groups (20 students and 20 multilinguals matched in age and education level with the interpreters). In order to get a more complete picture of their cognitive abilities, subjects performed a series of tests involving either short term retention alone (digit span, word span (including a phonological and semantic condition), non word span); short term retention and attention as in a recall task with articulatory suppression, a listening span task (adapted from Desmette et al. 1995), and a category and rhyme probe task; or attention alone as in a unilingual and bilingual Stroop task. All tasks were performed in French (the dominant language of all subjects), except the Stroop task which was done in English and French.

The findings show that there are no differences between subjects in tasks involving short-term memory alone (simple span tasks) and in the Stroop. On the whole, these tasks give rise to only little variation both across and within groups. Results are more complex in tasks involving both memory and attention: 3 tasks lead to significant differences between groups - namely free recall with articulatory suppression, the category probe task and the listening span task - and variation across subjects (both within and across groups) is generally much greater, suggesting the presence of individual strategies in this kind of tasks. Interestingly, it is in all cases not the group of professionals who performs best, but the group of novice interpreters, i.e. interpretation students. Firstly, it has been argued (Moser-Mercer et al., 2000: 108) that students obtaining the final diploma might be considered experts in this domain. Secondly, it will be suggested that working memory might play a more important role in beginning interpreters, possibly compensating for the lack of professional experience. Furthermore, the findings seem to underscore the hypothesis that novice and expert interpreters (i.e. professionals and students) might be advantaged in memory tasks allowing the use of semantic strategies (which are more likely to be called for in free recall than in a word span task for instance). The findings are taken as an indication that the investigation of working memory and other cognitive skills in simultaneous interpreters is worth doing, provided that it is done with larger subject groups and grounded on more specific theoretical backgrounds.

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## Evidence for a modality congruency effect in immediate sentence recall

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It was repeatedly demonstrated that short-term memory of sentences is based on both conceptual and surface representations. In the present experiments, we test whether the degree to which surface representations contribute depends on the relation between modality of presentation and modality of recall (i.e., modality congruency hypothesis). In our experiment, we used a modified version of Potter and Lombardi's (1990) intrusion paradigm (cf. Rummer & Engelkamp, 2003). First, we presented a word list, then a sentence was presented and finally, participants had to recall this sentence. The materials were constructed in such a way that (in the experimental condition) one of the words included in the word list is semantically similar to a target noun in the sentence. The proportion of lure intrusions is indicated by the degree to which surface information contributes to recall. The subsequent example illustrates the trial structure of our experiment. Presentation of a word list with lure word (or control word, respectively): "turtle recipe booth castle/vowel medal"  
Presentation of a sentence with target word: "The knight rode around the palace searching for an entry."  
Sentence recall: "The knight rode around the palace/castle searching for an entry."

In our study, we aimed at demonstrating that more surface information (particularly phonological information) is used in immediate sentence recall if presentation and recall take place in the same modality. We varied "presentation modality" (auditory vs. RSVP) x "recall modality" (oral vs. written recall) x lure condition (the list included the lure word vs. the list included an unrelated control word).

As lure words (i.e., castle) and target words (i.e., palace) differ with respect to phonology but are semantically similar, the fact that lure words intrude more frequently into sentence recall if they were part of the word list indicates that semantic information is crucial for sentence recall whereas surface information does play a negligible part. In contrast, no difference between the lure and the control condition demonstrates that surface information does contribute substantially. Thus, the modality congruency hypothesis suggests the absence of a lure intrusion effect if the modality of presentation and recall can be assigned to the same modality, and a strong intrusion effect if modality of presentation and recall are incongruent.

The data support our assumptions: In the auditory group, there was no intrusion effect if recall was oral but a strong effect in the writing condition. The results for RSVP were vice versa, that is, with written recall there was no intrusion effect whereas with oral recall a clear intrusion effect was observed. These findings suggest that the contribution of surface information is restricted to those conditions in which presentation and recall can be assigned to the same modality.

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## Why Quebec is sky-blue, and society tastes of onions: What synaesthesia can tell us about language processing.

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Synaesthesia is a genetically inherited neurological condition in which perceptual and cognitive activities trigger incongruous sensory percepts. For example, colours may be seen in response to smells (Cytowic, 1993) and tastes may be experienced in response to words (Ward & Simner, 2004). Brain imaging techniques have illustrated the neurological basis of the condition (e.g., Nunn et al., 2002) and provide evidence that such reports are genuine and perceptual. I examine the cognitive basis of linguistic synaesthesia and ask what this might tell us about the ordinary functioning of memory and language.

I describe an unusual case of developmental synaesthesia, in which speech sounds induce an involuntary sensation of taste that is subjectively located in the mouth (Ward & Simner, 2003). In a study of over 1000 word-taste pairings (e.g. the word 'couple' tastes of caramel) our participant, JIW, shows a significant, highly structured, non-random relationship between particular combinations of phonemes and the resultant taste. Moreover, JIW's synaesthesia is influenced by a number of fine-grain linguistic properties (e.g., allophony, syllabicity). For instance, different tastes are significantly associated to allophonic variations of a triggering phoneme (e.g., clear /l/ tastes of potato; dark /l/ tastes of egg white). Moreover, there is evidence for the role of phonological features, since certain triggers are underspecified for place, manner or voicing (e.g. /S/+/K/ triggers the taste of milk, whether voiced - as in 'Glasgow', or unvoiced - as in 'ask'). Our results provide evidence for the cognitive reality of linguistic constructs such as phonemes, allophones and phonological features.

I describe additional findings (from Ward, Simner & Auyeung, 2004) which compare two profiles of synaesthesia: word-colour and word-taste. I show how different linguistic mechanisms are responsible for the synaesthetic percepts in each group, and how each might inform us of the functioning of ordinary language comprehension. For example, participant IB experiences coloured photisms triggered by graphemes and words, such that words are coloured by their initial vowel (e.g. 'a' = green, so 'hat' = green). Crucially, such cases provide evidence on matters where theories of grapheme processing disagree. For example, theorists dispute whether or not 'u' constitutes its own grapheme in 'qu' clusters (as in 'Quebec'). Evidence from IB suggests that it does not, since words such as 'Quebec' (and 'queen' and 'quest' etc.) are coloured by the 'e' rather than the 'u', suggesting that 'u' does not constitute a separate vowel grapheme in such words.

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## The Interaction of Thematic Fit and Ambiguity in Main Clause Structures

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Rapid influences of a number of semantic and contextual variables on ambiguity resolution have been illustrated in numerous studies. These demonstrations typically involve using variables to make ambiguous less-preferred structures easier to understand. However, Frazier (1995) stated that a stronger test is to examine how constraints influence processing of a preferred structure. According to the garden path model, constraints should show no influence on initial processing of preferred structures. In this research, we demonstrate such an effect.

Binder, Duffy, and Rayner (2001) attempted to use thematic fit to bias a main clause structure toward being interpreted as a reduced relative. They used sentences such as, "The child (had) rescued the stray dog and went home." They failed to obtain an effect of thematic fit because their manipulation was weak, and because a postverbal "the" is an extremely strong cue for a main clause.

We conducted a similar study using stronger manipulations. First, we measured and manipulated thematic fit (animate NPs only). Second, our sentences contained postverbal PPs followed by a direct object NP. Based on a series of sentence completion and role/filler typicality norming studies, we constructed 20 sets of sentences such as

The host/guest (had) invited to the luncheon three old buddies who really had no business being there.

Subjects read sentences such as these using one-word-at-a-time self-paced reading. We analyzed reading times at the verb, postverbal PP, and shifted NP. The major result was a thematic fit by ambiguity interaction at the postverbal PP,  $F_1(1,44) = 6.38$ ,  $p < .02$ ,  $F_2(1,16) = 10.10$ ,  $p < .01$ . This interaction occurred because reading times with good agent ("host") sentences were a nonsignificant 7 ms longer for the ambiguous no-had condition, whereas reading times for good patient ("guest") sentences were 41 ms shorter for the ambiguous versions. Good patient ambiguous sentences were relatively easy in this region because thematic fit and the postverbal PP biased readers toward a reduced relative interpretation. However, the competition between those cues and the preverbal "had" caused reading time difficulties with the unambiguous main clause sentences. With good agents however, because thematic fit and the main clause bias both supported a main clause reading, there was little effect of the presence/absence of "had". According to Frazier and Binder et al., this is precisely the type of influence of a semantic variable that is extremely strong evidence for constraint-based models.

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**Neurochronometry of the syntax-semantic interplay:  
ERP evidence from spoken French relative clauses**

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The present research investigated whether syntax and semantics interact during the auditory processing of French relative clauses that specify the subject noun phrase semantically (e.g., *The man who is in the house is sleeping*). In an electrophysiological experiment using an acceptability judgment task, event-related brain potentials (ERP) were recorded while twenty native speakers of French listened to syntactically and/or semantically correct or incorrect French relative clauses. The critical items were sentence-final monosyllabic verbs which were either syntactically and/or semantically congruent or incongruent with the preceding context. The processing of semantically anomalous sentences [e.g. *Le caillou qui est dans la piscine DORT* (The stone which is in the swimming pool is sleeping)] elicited an enhancement of the N400 component in a time window of 300-600 ms. Phrase structure violations that were due to the omission of the last element in the embedded clause [e.g., *Le chauffeur qui est dans la  $\phi$  DORT* (The driver which is in the  $\phi$  is sleeping)] elicited an early anterior negativity (150-300 ms) and an anterior negative shift (300-600 ms) followed by a P600 (600-1000 ms). The same triphasic ERP sequence was also found for the processing of sentences that were both syntactically and semantically anomalous [e.g., *Le fauteuil qui est dans la  $\phi$  DORT* (The couch which is in the  $\phi$  is sleeping)].

In the semantic condition, we interpreted the N400-effect as reflecting lexical-semantic difficulties to integrate the critical items into the prior context due to a violation of their selectional restrictions. In the syntactic condition, we proposed that the anterior negative shift might reflect unsatisfied reference specifications of the preceding argument. We labelled this ERP component "reference-related negativity". In the combined condition, the absence of an additive effect (i.e. an N400 in addition to the anterior negative shift) in the time window of 300-600 ms provides strong evidence that a word category violation can disturb on-line lexical-semantic integration. In sum, the present ERP data show that an incorrect parsing output can affect some aspects of the semantic processing such as lexical-semantic integration. However, it has no impact on some other aspects of the semantic processing such as reference specification. We conclude that the present findings are consistent with serial models of language comprehension that postulate an initial phase of local structure-building. This initial phase is followed by a second phase during which syntactic and referential processes work parallel and independent of lexical-semantic information.

## Cross-modal semantic priming and gender-marked context in French

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Homophones are words having the same sound, but differing in meaning and usually in frequency and in gender. For example, although their pronunciation is identical /sel/ is masculine whereas /selle/ is feminine and less frequent than /sel/. This particularity was used in this study to determine whether a context marked in gender can constrain the processing of homophones in visual word recognition in French for native and non native speakers.

Indeed, an interesting phenomenon during the process of second language acquisition is the way in which learners manage successfully to acquire certain aspects of this second language whereas for other fields, they present systematically weaker competence, which is the case for grammatical gender acquisition. Recent studies in natural language have suggested contribution of grammatical gender (masculine vs. feminine) to word recognition process (Schierfers & Jescheniak, 1999; Colé & Ségui, 1994) at a post lexical stage and other ones had shown that the activation of multiples lexical candidats is modulated by preceding context marked for grammatical gender (Spinelli & Alario, 2002). However it is not clear yet where is the locus of the effect of gender during second language process. The question of *when* grammatical gender effects occur during word recognition is crucial to explain the specific problem it seems to pose for all second language learners.

We report several cross-modal semantic priming experiments. This technique is based on diffusion of the activation of a lexical element to the other elements connected semantically. Listeners are required to make a lexical decision on target presented visually after hearing a prime word. We used as prime, the phonological code of homophones, and as targets meanings related to each orthographical codes (/sel/ is related to 'poivre' meanings whereas /selle/ is related to 'cheval' meanings). In the first experiment homophones were presented in isolation (/sel/). In the second experiment, there were preceded by a gender-marked definite article congruent with the less frequent meaning of the homophone (/la selle/).

In natural language, according to the first experiment, when homophones were presented in isolation, priming was found only for the semantic representation associated with the most frequent meaning of the homophones (reaction times were faster for 'poivre' than for 'cheval'). On the other hand, in a context marked in gender, a facilitation effect was found only for targets preceded by a congruent definite article that is the less frequent meaning.

We will discuss why these results differ from Spinelli & Alario ones.

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## Beyond Unrestricted Interaction: the priority of depicted events over stored knowledge

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Findings from utterance comprehension during scene-inspection suggest that virtually any type of available information rapidly influences comprehension (e.g., Altmann & Kamide, 1999; Chambers et al., 2002; Tanenhaus et al., 1995; Sedivy et al., 1999). They are compatible with an unconstrained-interaction account of online sentence comprehension. We argue that to further improve our understanding of how precisely diverse information sources are applied online, we must determine "how they combine" (Tanenhaus et al., 2000, p.94). We propose one way of achieving this is to determine the relative importance of distinct informational sources. Studies on spoken sentence comprehension in visual scenes have revealed the absolute importance of linguistic/world knowledge (Kamide et al., 2003), as well as of depicted events in incremental thematic role-assignment (Knoeferle et al., in press). Our research aims at replicating both of these findings, while at the same time determining the relative importance of depicted events versus stored linguistic/world knowledge. To this end, we monitored people's eye-movements in depicted scenes while people were listening to related OVS (PATIENT-VERB-AGENT) sentences. An image showed two events, e.g., wizard-spying-on-pilot, and detective-giving- food-to-pilot. Crucially, one entity on each image was a plausible agent for the depicted event action performed by the other agent (the detective as plausible agent for the depicted wizard-spying event). By manipulating the verb people heard, we created four conditions,

crossing the factors target-agent ("depicted agent/plausible agent") with verb-manipulation ("unambiguous"/"ambiguous"). For the verb-manipulation-unambiguous condition (1), the verb permitted either a depicted or plausible agent only: "verköstigen" ('givefood- to') determined the detective as depicted agent (1a) ; "verzaubern" ('jinx') identified the wizard as plausible agent. For the verbmanipulation- ambiguous sentences, the verb "bespitzeln" ('spy-on') allowed two agents: the wizard, depicted as performing a spying-action (2a), and the detective, a plausible agent for a spying-action (2b).

- (1a) Den Piloten verköstigt gleich der Detektiv.  
'The pilot (PAT.) gives-food-to soon the detective' (depicted AGENT)  
(1b) Den Piloten verzaubert gleich der Zauberer.  
'The pilot (PAT.) jinxes soon the wizard.' (plausible AGENT)  
(2a) Den Piloten bespitzelt gleich der Zauberer.  
'The pilot (PAT.) spies-on soon the wizard.' (depicted AGENT)  
(2b) Den Piloten bespitzelt gleich der Detektiv.  
'The pilot (PAT.) spies-on soon the detective.' (plausible AGENT)

Within one study, eye-movements revealed for the unambiguous conditions (1) that two diverse information sources – stored knowledge and depicted event – can each be effectively used for disambiguation ( $ps < 0.01$ ). In the interesting cases where the verb was compatible with both the depicted and the plausible agent (2), however, the comprehension system relied on depicted event over stored knowledge ( $ps < 0.001$ ). This finding reveals the nature with which verbs are integrated with depicted events as opposed to stored knowledge. We further suggest similar designs might allow determination of the relative priority of other distinct information sources in language comprehension.

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## On-line Processing of Universal vs. Language-specific Constraints

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Previous research on backwards anaphora has shown that the search for an antecedent is narrowed by general grammatical constraints on anaphora (e.g. Binding Principle C: Chomsky, 1981; Kazanina et al., 2004), paralleling findings on island constraints in filler-gap dependencies (e.g., Stowe, 1986). Most studies in both areas have focused on linguistic constraints that are structural, cross-linguistically widespread and mastered very early in development. Here we present results that show that even highly specific language-particular constraints on pronoun interpretation act as immediate filters in processing, based on the results of a reading-time study of universal and language-specific constraints in Russian.

- (35) \*Ona uchila biletu po fizike, poka Vera slushala reportazh s "Evrovideniya". (Principle C, universal constraint)  
On Sunday she was studying for her physics exam while Vera was listening to a live broadcast from "Eurovision".
- (36) \*Poka ona uchila biletu po fizike, Vera slushala pryamoy reportazh s "Evrovideniya". (Russian-specific while-constraint)  
On Sunday while she was studying for physics exam Vera was listening to a live broadcast from "Eurovision".
- (37) Do togo kak ona voshla v sostav sbornoy, Natasha byla sovershenno neizvestna specialistam. (No constraint control)  
Before she joined the national team, Natasha was completely unknown to specialists.

(The judgments marked are for the coreference reading. Each sentence is acceptable on a disjoint-reference reading.)

The first of the three pairs of conditions (1: 'Universal constraint conditions') tested a configuration in which backwards anaphora is uniformly excluded across languages (Principle C, Chomsky 1981). The crucial second pair of conditions tested a configuration in which backwards anaphora is ruled out by a Russian-specific constraint (2: 'Russian-specific conditions') that applies specifically to Agent subject NPs in clauses headed by the conjunction poka 'while'. The language-specificity of this constraint is unambiguous, both because the English counterparts are fully acceptable, and because it is mastered later in development than Principle C (Kazanina & Phillips, 2001). This constraint does not extend to other temporal conjunctions like do togo kak 'before', which were used in a control condition pair in which backwards anaphora is freely available in Russian and English alike (3: 'no-constraint conditions'). Results of a questionnaire study (n=48) strongly confirm these coreference possibilities. The on-line experiment used a gender congruency manipulation with a prediction of a gender mismatch effect for condition pairs in which upon encountering the pronoun the parser actively constructs a coreference relation with the NP in the following subject position (van Gompel & Liversedge 2003). Moreover, to ensure that all items in the on-line study allowed grammatical backwards anaphora, an additional subject NP was included that was always an acceptable antecedent for the pronoun (underlined), as exemplified below using an example from the universal-constraint conditions in (1).

- (38) Hotya v voskresenje ona uchila biletu po fizike, poka Vera/Ivan slushala/slusal pryamoy reportazh s "Evrovideniya", Rita umudryalas' ne obrash'at' vnimanie na proshodyash'ee.  
Although on Sunday she was studying for her physics exam while Vera/Ivan was listening to a live broadcast from "Eurovision", Rita managed not to pay attention to what was going on.

Results of the self-paced reading study (n = 40) show a significant effect of gender mismatch at the second word following the critical (boldface) name in the no-constraint-conditions ( $F(1,39)=4.16$ ,  $p<.05$ ,  $F(1,11)=3.36$ ,  $p=.068$ ) and no corresponding effect in the other conditions. Instead, in the Russian-specific conditions there was a significant gender match effect starting at the fourth word of the second clause ( $F(1,39)=5.36$ ,  $p<.05$ ,  $F(1,11)=4.66$ ,  $p<.05$ ). We claim that the absence of the gender mismatch effect in the universal-constraint and Russian-specific conditions (i) supports our earlier claim based on English data that active dependency construction is sensitive to syntactic binding constraints such as Principle C and, (ii) suggests that the parser is capable of immediately considering very specific cues while processing long-distance dependencies. We take the gender match effect in the Russian-specific condition to indicate the parser's (late) assessment of the sentence with respect to the while-constraint (which only targets Agent NPs) provided that the pronoun and the following subject match on gender. We discuss our findings in the broader context of the representation of universal vs. language-specific grammatical information at different levels.

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## Evidence against (even mild) delay models of structure building

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Current evidence on incrementality in syntactic processing is compatible with a range of different models, which vary in the degree to which they permit delays in structure-building. Here, we report two reading eye-tracking experiments that test the predictions of two particular models: pure bottom-up parsing with a flexible-constituency grammar (expt 1), and head-driven parsing in a head-initial language (expt 2).

Bottom-up algorithms are usually seen as unsuitable for modelling human parsing, because of the structure-building delays they predict for right-branching structures (Abney & Johnson, 1991). However, this conclusion depends on the grammar formalism assumed: combined with a flexible constituency formalism such as Combinatory Categorical Grammar (CCG) bottom-up strategies allow a much more plausible degree of incrementality (Steedman, 2000). However, delays are still predicted in some cases, such as coordination. Assuming a standard coordination schema (e.g.  $X \rightarrow X \text{ and } X$ ), bottom-up algorithms require the second conjunct to be complete before the two conjuncts can be combined into the larger phrase, even in CCG (see Schneider, 1999).

Experiment 1 tested items like 1a-d):

- 1a) The pilot embarrassed John and put himself in a very embarrassing situation.
- 1b) The pilot embarrassed Mary and put herself in a very embarrassing situation.
- 1c) The pilot embarrassed John and put him in a very embarrassing situation.
- 1d) The pilot embarrassed Mary and put her in a very embarrassing situation.

Early eye-movement measures showed a stereotypical gender effect from first fixation onwards on the reflexive (1a < 1b), at a point where the second VP was still incomplete (as judged in a completion pretest). The lack of such an effect for the pronouns (1c = 1d) suggests that the 1a-b difference was based on structural configurations (e.g. c-command relations) rather than superficial strategies. We conclude that the coordinate structure has already been combined with matrix subject very early in the second conjunct, contra the the bottom-up delay model.

Experiment 2 tested the predictions of head-driven parsing models in English, according to which syntactic nodes are delayed until bottom-up recognition of the head-daughter has taken place in the input. Despite evidence against head-driven parsing in head-final languages, it is not currently known whether head-initial languages allow head-driven delays.

The experiment used backwards anaphora as in 2a-d (see also Kazanina et al, 2004):

- 2a) After (PRO) making herself a cup of tea, the nurse very carefully examined the patient.
- 2b) After (PRO) making himself a cup of tea, the nurse very carefully examined the patient.
- 2c) After (PRO) making her a cup of tea, the nurse very carefully examined the patient.
- 2d) After (PRO) making him a cup of tea, the nurse very carefully examined the patient.

We assume that PRO is controlled by the matrix subject ("the nurse"). Binding constraints determine the gender of PRO in 2a-b), but not in 2c-d). There was a first-pass effect at the first of two adverbs ("very") in the reflexive conditions (2a < 2b), but not in the control conditions (2c = 2d). Thus a dependency between subordinate and main clause was established well before the head of the main clause, contra the predictions of the head-driven delay model, which would have required the verb to have been processed in order to build the main clause structure. The result of this experiment is consistent with a model in which an anaphor without an antecedent triggers the active search for the antecedent in the following string, and that this search can be "switched on" or off, in response to syntactic constraints, in this case, binding and control principles. Thus, the experiment replicates Kazanina et al (2004), where active processing was found to be constrained by the on-line application of principle C of Binding Theory.

We conclude that psychological models should avoid algorithms that allow delay strategies. Instead, we should turn our attention to strategies that allow full connectedness of syntactic structure.

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## Pronoun Resolution in the L2: An Eye-tracking Study with Turkish-Dutch Bilinguals

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In Dutch the use of overt subject pronouns is obligatory, whereas Turkish is a null-subject language where null and overt subject pronouns have different distributional properties. The use of overt subject pronouns in Turkish is governed by discourse and pragmatic factors and they can only have a disjoint reading (Erguvanly-Taylan, 1986; Gürel, 2002). In contrast, null subjects are unconstrained in their binding properties like subject pronouns in Dutch. With this syntactic contrast between Turkish and Dutch as the background, we investigated 24 Turkish-Dutch bilinguals' L2 pronoun resolution processing in comparison to 29 Dutch controls. All participants also undertook an off-line acceptability judgement task with the same experimental materials.

In the experimental conditions (below), the critical segment contained a verb and a subject pronoun, either in the singular or the plural [eet hij/eten zij]. A local antecedent is offered for this pronoun [Peter], and the preceding context sentence offers a distant antecedent, either a plural NP [De werknemers] or (one of) two singular NPs [Peter en Hans]:

- |      |  |
|------|--|
| (1a) | De werknemers zitten in het kantoor. Terwijl Peter aan het werk is, eet hij een boterham. Het is een rustige dag.  |
| (1b) | Peter en Hans zitten in het kantoor. Terwijl Peter aan het werk is, eet hij een boterham. Het is een rustige dag.  |
| (2a) | De werknemers zitten in het kantoor. Terwijl Peter aan het werk is, eten zij een boterham. Het is een rustige dag. |
| (2b) | Peter en Hans zitten in het kantoor. Terwijl Peter aan het werk is, eten zij een boterham. Het is een rustige dag. |

(The workers/Peter and Hans are sitting in the office. While Peter is working, he is/they are eating a sandwich. It's a quiet day.)

We assume that the more accessible an antecedent, the easier the co-reference process when reading the pronoun, reflected in the experiment by shorter fixation durations on the critical region. The learners' total fixation times revealed an advantage for [1a] (660ms) over [1b] (700ms) which was absent in the Dutch (548ms vs. 530ms). This is suggestive of an L1 influence; the learners may have considered both the local and (one of the) non-local NPs as a potential antecedent in [1b], leading to longer fixation times in comparison to [1a] where such a choice was grammatically unavailable. The learners' off-line interpretations of these conditions did not, however, differ from the Dutch.

For both groups we expected to find the pragmatically odd condition [2b] comparatively problematic, since neither the local nor the non-local antecedent is readily accessible. This was confirmed in total reading times and off-line judgements, but the groups differed in that the effect was more immediate in the bilinguals: first pass reading times were significantly longer in this condition (417ms) compared to [2a] (351ms), with no such difference for the Dutch (238ms vs. 245ms). Thus the bilinguals in this study appear to have acquired the binding possibilities of Dutch pronouns, but at the earliest stages of processing, possibly under the influence of their first language, they are more sensitive on-line to pragmatic factors than the monolinguals.

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## Resolving ambiguous pronouns in spoken Finnish: The effects of order-of-mention and grammatical role

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A major question in psycholinguistic research is how ambiguous pronouns are interpreted. According to Gernsbacher and Hargreaves (1988), general cognitive principles favor coreference of a pronoun to the first-mentioned NP in the preceding clause, regardless of other factors. This results in a preference for he in (1) to refer to Blair. Alternatively, pronoun resolution may be affected by other factors. For example, the subject-preference account predicts that the grammatical subject is the preferred antecedent (e.g., Fredriksen, 1981; Crawley et al., 1990). This also predicts a preference for Blair in (1).

- (1) Tony Blair shook hands with George Bush in the White House. He was interested in the situation in Iraq.

We conducted two visual world eye-tracking experiments to investigate ambiguous pronoun resolution. In order to distinguish between the subject and first-mention preference account, Experiment 1 investigated the processing of pronouns in a language with a free(er) word order, namely Finnish. In Finnish, the first sentence in (1) can have either subject-verb-object or object-verb-subject order:

- (2) (SVO) Tony Blair kätteli George Bushia Valkoisessa talossa. Hän oli kiinnostunut Irakin tilanteesta.  
[Tony Blair (sub) shook hands with George Bush (obj). He was interested in the situation in Iraq.]
- (3) (OVS) George Bushia kätteli Tony Blair Valkoisessa talossa. Hän oli kiinnostunut Irakin tilanteesta.  
[George Bush (obj). shook hands with Tony Blair (sub). He was interested in the situation in Iraq.]

According to the subject preference account, Tony Blair should be the preferred antecedent of hän (he) in both sentences, whereas the first-mention account predicts that the preferred antecedent should be the first NP, being Blair for (2) and Bush for (3). Analyses of the number of first visits to subject and object showed effects of both first mention and grammatical role. However, analyses of the time course of the effects showed that the subject preference occurred earlier.

Because in Experiment 1 the pronoun was the sentential subject, the subject preference may have been enhanced by a grammatical role parallelism effect, according to which a pronoun is preferentially interpreted as coreferent with a NP that has the same grammatical role (e.g., Chambers & Smyth, 1998; Smyth, 1994). Therefore, in Experiment 2 two further conditions were added where the pronoun was the object of the second sentence:

- (4) (SVO) Tony Blair kätteli George Bushia Valkoisessa talossa. Häntä kiinnosti Irakin tilanne.  
[Tony Blair shook hands with George Bush. Him interested the situation in Iraq]
- (5) (OVS) George Bushia kätteli Tony Blair Valkoisessa talossa. Häntä kiinnosti Irakin tilanne.  
[George Bush (obj). shook hands with Tony Blair (sub). Him interested the situation in Iraq]

Analyses of the number of first visits showed an effect of grammatical role parallelism in addition to a first-mention and subject effect. The time course analyses replicated the results from Experiment 1: The subject preference occurred earlier than both other effects. The results from both experiments show that various heuristic strategies affect pronoun resolution. They provide evidence against Gernsbacher's first-mention account, which claims that only the first-mention preference affects pronoun resolution. They are also inconsistent with Kaiser and Trueswell's (2003) claim that *hän* prefers assignment to the subject regardless of word order. Therefore, in contrast to one-factor models, our results make clear that pronoun resolution is determined by a delicate interplay of several factors.

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## Effects of grammatical category and semantic relatedness during the processing of words and pictures

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Psycholinguistic studies of semantic processing have often been carried out with restricted sets of stimuli: noun targets exhibiting categorical relationships with primes/distractors. As a result, important research questions have remained unanswered. First, do words from different grammatical categories prime (or interfere with) each other (e.g., noun-verb pairs). Second, do words from the same grammatical category (e.g., verb-verb pairs) affect processing to a greater extent than words from different grammatical categories (e.g., noun-verb pairs)? Finally, does grammatical category information affect processing both in visual word recognition tasks and in lexicalisation tasks?

We report two experiments. The first experiment utilizes lexical decision, with verbs as targets, and assesses the amount of priming produced by semantically related or unrelated nouns or verbs. The second experiment utilizes the picture-word interference (PWI) paradigm and assesses the amount of interference for the same experimental manipulations. Semantic relatedness between primes/distractors and targets was established using measures derived from Vigliocco et al (in press). We found that semantic relatedness affected the processing of the target verb in both tasks (i.e., priming effects in Experiment 1 and interference effects in Experiment 2 for semantically related primes and distractors respectively). However, whereas an effect of grammatical category (faster RTs for same vs. different grammatical class primes) was found in Experiment 1, grammatical category did not affect the lexicalization process in Experiment 2 (this latter result replicates the findings reported by Vigliocco et al. [in press] in Italian). There was no interaction between semantic relatedness and grammatical category in either experiment.

We discuss these results in terms of the differences in processing requirements in visual-word recognition vs. lexicalization tasks. In particular, we argue that whereas grammatical category information can affect the processing of single words, this information is not necessarily recruited when the task, instead, requires lexicalization from pictures (along the lines proposed by Bowers et al., 1999).

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## Translation and Associative Priming with Cross-lingual Pseudohomophones: Evidence from Dutch-English Bilinguals.

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Using a masked priming paradigm with a lexical decision task performed by Dutch-English bilinguals, we showed that the recognition of visually presented L1 (e.g. *TOUW*) and L2 (e.g. *BACK*) targets is facilitated by respectively L2 and L1 primes, which are pseudohomophones (*roap* and *ruch*) of the target's translation equivalent (*rope* and *rug*). In two further experiments, we found that recognition of L2 targets (e.g. *CHURCH*) was also facilitated by L1 pseudohomophones (e.g. *pous*) of related words (paus [pope]). Contrastingly, no significant effect was obtained for L1 targets (e.g. *BEEN* [leg]) and L2 pseudohomophone associative primes (e.g. *knea*). In two last experiments, we found that a L2 target word (e.g. *CORNER*) is facilitated by an L2 (intra-lingual) homophone (e.g. *hook*) of its L1 translation equivalent (hoek). The same was not true for respective L1 targets (e.g. *DAG* [day]) and primes (e.g. *dij*). These findings are in line with recent research of Brysbaert, Van Dyck and Van De Poel (1999) and Van Wijnendaele and Brysbaert (2002). These studies showed that phonological representations from both known languages are accessed during the early stages of visual word recognition in bilinguals, and are therefore in line with a strong phonological theory of visual word recognition (Frost, 1998).

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## Lexical Category Information Influences Lexical Selection Processes

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Some theories of lexical selection argue that grammatical features cannot influence selection processes (e.g., Levelt et al., 1999) while others argue that lexical category features constrain the set of competitors activated for selection (e.g., Dell, 1986). Thus, whereas the former theories predict that priming lexical category features should not affect the outcome of selection processes, the latter predict that it should. We test these predictions in two primed ambiguity resolution studies.

If prior activation of grammatical features can influence subsequent lexical selection processes, the presentation of unambiguous noun and verb primes, e.g., *thorn*<sub>n</sub> or *send*<sub>v</sub>, should influence ambiguity resolution for category ambiguous targets. To test this prediction, we selected English target words that were orthographically ambiguous between nouns and verbs but phonologically distinct, such as *convict* (conVICT<sub>v</sub> vs. CONvict<sub>n</sub>). In Experiment 1, ambiguous target words were preceded by unambiguous noun, verb, and letter (control) primes (see 1). Because it is well known that lexical category is correlated with semantics (e.g., nouns often refer to entities), a second experiment was designed to distinguish grammatical from semantic loci. In Experiment 2, adjective primes, which are semantically similar to verbs in that they are both predicates and denote eventualities (eventualities is the union of events and states, (Bach, 1986)), replaced verb primes. Furthermore, abstract nouns replaced the concrete nouns from Experiment 1. In both experiments, prime-target pairs were semantically and orthographically dissimilar and targets were equally frequent as nouns and verbs (Francis and Kucera, 1982). Participants were instructed to pronounce both prime and target words as quickly as possible. The dependent variable was the pronunciation type, namely as a noun or verb.

(1) Target	Unambiguous Nouns	Unambiguous Verbs/Adjectives	Letter	Control
Experiment 1	Thorn	Send	L	Convict
Experiment 2	Greed	Pure	L	Convict

In both experiments we found an influence of the lexical category of the prime on the speakers' naming preference for the targets; speakers were more likely to name ambiguous targets as nouns following noun primes and more likely to pronounce the same targets as verbs following verb primes, compared to the control condition. Interestingly, adjectives did not lead speakers to produce more verbs but abstract nouns did biased speakers to produce more nouns, suggesting that the effect is grammatical, not semantic.

The results of these two primed ambiguity resolution studies demonstrate that facilitating access to a particular lexical category feature can influence the outcome of lexical selection processes. They also suggest that lexical category, and not the semantic characteristics, of the prime influenced speakers' selection of the appropriate lexical item for production.

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## Semantic density and the processing of regular and irregular verbs

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It has been claimed (see Pinker and Ullman, 2002) that the difference between regulars and irregulars is restricted to form. Other studies (see Ramscar, 2002; Patterson, Lambon Ralph, Hodges and McClelland, 2001) suggest that semantic factors are also relevant. A recent lexical statistical survey (see Baayen and Moscoso del Prado Martín, 2004) revealed that regulars and irregulars differ in semantic density: Irregulars have denser semantic networks than regulars, as evidenced by, for instance, larger numbers of synonyms.

Using on-line available response latencies for English (see Spieler and Balota, 1998), it was observed that the differences in semantic density co-determine the word naming latencies for the present tense forms, which are themselves fully regular. This suggests that there is a confound in the current literature between regularity and semantic density.

We have begun to explore this confound for Dutch regular and irregular verbs, with a series of visual lexical decision experiments using a regression design with 143 regular and 143 irregular verbs matched for lemma frequency. We conducted four parallel experiments. For the first experiment we used verbs in the infinitival forms (which are identical to the present plurals, ending in the suffix "-en"). For the second experiment we used the corresponding past tense plurals (ending in the suffix "-den" or "-ten" for regulars and "en" for irregulars). For the third and fourth experiments we used the present and past stem forms of the verb, respectively. In this abstract, we only report the effects involving regularity.

Regulars elicited shorter latencies than irregulars. Verbs in the past tense forms elicited longer latencies than verbs in the present tense forms, irrespective of regularity. For regulars, the effect of inflectional entropy (see Moscoso del Prado Martín, Kostic and Baayen, to appear) was stronger than for irregulars. The semantic density (the number of synsets listed in WordNet) was negatively correlated with the response latencies, but only for irregular past plurals. A logistic regression analysis of the errors showed that regulars elicited fewer errors, especially in the past tense form. A greater inflectional entropy led to fewer errors, but only for irregular verbs and more so for women than for men. (On average, women also responded faster than men.)

These results support the semantic density hypothesis. In visual lexical decision, complex plural past tense forms elicited shorter latencies when their semantic density as estimated by the synset measure was greater. Furthermore, regulars and irregulars appear to be differentially sensitive to the informational complexity of their inflectional paradigms.

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## The Effect of Word Spacing on the Reading Speeds of Chinese Third Graders and College Students

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Spaces between words in a text are essential for reading. They serve as perceptual cues for guiding eye movements. Removing or masking them can affect a reader's preferred viewing position for a word, slow down lexical access, and impair reading (Rayner & Pollatsek, 1982; Morris, Rayner, & Pollatsek, 1990; Rayner, Fischer, & Pollatsek, 1998). In languages that do not use word spaces in their texts, a few studies have shown that inserting word spaces can facilitate reading (e.g., Inhoff, Radach, & Heller, 2000 for German complex compounds; Hsu & Huang, 2000 for Chinese short phrases; Yang, 1998 for Chinese dyslexic children). However, the evidence presented tended to be limited and inconclusive. The present study reexamined the issue in Chinese with a new theoretical perspective. Printed Chinese texts are arranged by characters with no extra spaces between words. We reasoned that reading such a text requires word segmentation, an extra process and cognitive load that are not present in reading an English text. The extra cognitive load might claim a price in slow readers but not in fast readers. Therefore, it was hypothesized that adding word spaces might facilitate reading for slow readers but not necessarily for fast readers.

In Experiment 1, college students were asked to read aloud non-spaced and word-spaced short texts. Reading speeds were compared between the two types of texts and for the top quarter (fast) and the bottom quarter (slow) of the students according to their speed of reading the non-spaced texts. Results showed a benefit of word spacing for the slow group but not for the fast group. In Experiment 2, third graders participated in three sessions of reading non-spaced texts and another three sessions of reading word-spaced texts. The benefit of spacing did not show in the first session, but emerged in the second session, and grew significant in the third. In Experiment 3, it was further hypothesized that adding word spaces might facilitate reading under time pressure but not reading with no time pressure. The results from a group of college students were consistent with the hypothesis.

Taken together, the results from the three experiments supported the general hypothesis that the lack of word spaces places an extra cognitive load on the Chinese readers, and that slow readers or reading under time pressure could enjoy the benefit of added word spaces because of the low supply or inefficient allocation of mental resources.

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**Representation and processing of cross-script cognate and non cognate translations:  
masked priming with Greek-French bilinguals**

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One of the important questions in the domain of bilingual performance is the nature of the connections between the lexical systems of the two languages. The two experiments reported here used Greek-French materials and the masked priming technique, to investigate how different degrees of form relatedness across translation equivalents influences translation priming effects.

In the first experiment we compared priming from cognate translation primes with cross-language morphologically related primes. We found that the morphological facilitation induced by Greek (L1) primes on French targets (L2), measured relative to a phonological control condition, appeared later, and was of smaller amplitude than the cognate priming effect. Thus the typical advantage for cognate primes relative to non-cognate translation primes is unlikely to be due to a common cross-language morphological representation in the former.

In Experiment 2 we examined how level of form overlap (phonological overlap in the present study, given the different scripts) influences translation priming. Priming effects from high and low-overlap cognates as well as non-cognate translation primes were evaluated relative to both phonologically related and unrelated control primes. When measured against the unrelated baseline, the typical cognate advantage was observed with priming effects increasing as a function of amount of form-overlap across translation equivalents. On the other hand, when measured against the phonologically related baseline, translation priming effects did not vary as a function of form-overlap. The results of Experiment 2 suggest that when measured against unrelated controls (as is typically the case) translation priming effects result from the combination of facilitation arising from 1) shared prelexical phonological representations, and 2) a common semantic or conceptual representation.

However, these two mechanisms alone cannot account for the clear dissociation in cognate and morphological priming observed in Experiment 1. It is argued that non-homogeneity in within-level connections across lexical representations (in a language-independent system) is the additional mechanism at play. Connections between translation equivalents would have a special status compared with connections between non-translates such as morphologically related words. Thus translation priming reflects bottom-up (shared form), top-down (shared meaning), and within-level interactions among the representations of words in both of the bilingual's languages.



## The role of semantics in processing morphosyntactic information in Turkish

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Turkish is a language that allows all 6 orders of subject, verb, and object, with an underlying order of SOV. We hypothesize that, because order alone is not a dominant cue to thematic roles in Turkish, speakers will rely heavily on other information, such as morphological case and semantics, to interpret NVN sentences. In the absence of both morphological case and semantic support, speakers will have difficulty interpreting sentences that are not in the underlying word order (SOV), even though they are grammatical.

In Turkish, nominative case is morphologically null regardless of sentence position. Accusative case can also be morphologically null, but only in two word orders: SOV and OVS (Kornfilt, 1997). When objects are indefinite, morphological case must be null and the object must appear to the left of the verb so that it can receive structural case (Kornfilt, 1994, 1997). Although OVS sentences without morphological case on the object are grammatical, it is not clear if adults can interpret such sentences absent semantic support. We accordingly tested adults' ability to interpret OVS sentences where both the subject and object are animate and equally capable of being the agent. In that situation, semantics provides no aid; adults must rely on word order alone unless an indefinite determiner appears with the object.

Twenty-eight adult native speakers of Turkish listened to a total of 48 SOV and OVS sentences with animate subjects and animate objects. We included three types of sentences: those where morphological case on the object was present (1), those where it was absent but an indefinite determiner was present (2), and those where it was absent and there was no determiner (3).

(1)a. S O <sub>Acc</sub> V	At      fil-i      it-sin. The horse elephant-ACC push-OPT 'Let the horse push the elephant'	b. O <sub>Acc</sub> V S	Fil-i      it-sin      at. The elephant-ACC push-OPT horse '(Let it be that) the elephant the horse push(es)'
(2)a. S det O V	At      bir fil      it-sin. The horse an elephant push-OPT 'Let the horse push an elephant'	b. det O V S	Bir fil      it-sin      at. An elephant push-OPT the horse 'Let (it be that) an elephant the horse push(es)'
(3)a. S O V	At      fil      it-sin. The horse elephant push-OPT 'Let the horse push an elephant'	b. O V S	Fil      it-sin      at. An elephant push-OPT the horse 'Let (it be that) an elephant the horse push(es)'

We were particularly interested in how participants would interpret OVS sentences where the object did not have morphological case and where the object was or was not preceded by an indefinite Determiner (2b and 3b). The adults' task, after hearing the sentence, was mark on the answer sheet which of two animals corresponded to the agent. They also rated the grammaticality of sentences on a 5 point scale.

SOV sentences were presented to ensure that adults had no difficulty with them. As we expected, adults interpreted these sentences, which were treated as fillers, correctly 95% of the time. In OVS sentences where morphological case on the object was present, adults were virtually perfect (97 % correct). When morphological case was absent but a Determiner was present, adults performed better than chance (71 %) but worse than with sentences where case was marked. Adults performed worst, and lower than chance (37 %), on sentences where the object was neither morphologically casemarked nor was preceded with a Determiner. Adults rated SOV sentences to be significantly better than OVS sentences (3.9 vs. 3.4). They rated sentences with morphologically casemarked objects to be significantly better than sentences without morphological casemarking (4.0 vs. 3.2). They also rated sentences with a Determiner to be better than sentences without a Determiner (3.5 vs. 3.0). For half of the experimental sentences a context sentence preceded them, however context did not play a significant role in neither sentence interpretation nor grammaticality judgment.

Thus, despite their grammaticality, Turkish OVS sentences with animate subjects and objects are very difficult to process if the objects lack morphological case and lack an indefinite Determiner. Structural case alone appears to be a very weak cue to speakers and needs buttressing either by a semantic cue which indicates which NP is more likely to be the subject or by an indefinite Determiner. Thus, it is likely that adult Turkish speakers are biased, in the absence of casemarking, for the first argument in a sentence as being a subject, especially, if the NP is animate. We also conjecture that, in the competition between the NPs for subjecthood, speakers take a definite NP to be a better subject than an indefinite one and correspondingly interpret an indefinite NP as a better object than a definite one.

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## Phonologically deviating distractors influence picture-naming: What counts as a lexical competitor?

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Quite a number of crossmodal studies have shown that visually presented words (e.g., banana) are reacted to faster in lexical decision or naming tasks, when slightly mispronounced words were presented as spoken primes. These primes could either be form-related to the target (e.g., \*danana) or derived from words that are semantically related to the target (e.g., \*nango, from mango). The deviation between the original word and the mispronounced word was often varied in terms of phonological features. The data showed that small deviations between speech input and word form representations in the mental lexicon do not preclude activation of lexical representations. Even stimuli deviating more than one feature from the original word can facilitated lexical decisions (Connine, Blasko & Titone, 1993; Bölte & Coenen, 2002).

In this study, we investigated whether mispronounced variants of identical and semantically related words facilitate or hinder picture naming. Naming a picture (e.g., of a banana) is faster when the name of the picture is presented concurrently with the picture. However, a semantically related word, from the same semantic category as the target (e.g., mango), can considerably slow down picture naming. This is explained in terms of competition at the lemma level (see Levelt et al., 1999). In our study, we combined pictures with seven different distractors: (1) with the identical word (banana), (2) with a minimally deviating pseudoword (\*danana), (3) with a maximally deviating pseudoword (\*kanana), (4) with a semantically related word (mango), (5) with pseudoword that deviated minimally from the semantically related word (\*nango), (6) with a maximally deviating semantic pseudoword (\*pango), and finally (7), with an unrelated control word (window). Distractors were presented via headphones with an SOA of -150 ms or +150 ms or with an ISI of 200 ms.

The findings were as follows: Identical word distractors and semantically related distractors affect picture naming in the expected manner. While identical distractors facilitated picture naming relative to the unrelated control, semantically related distractors inhibited it. The conditions with the phonologically deviating distractors showed similar effects. In the semantic condition phonological distance in terms of phonological feature did not further affect the inhibition effect. In the phonological condition, an identical distractor and a minimal pseudoword bring about the same facilitation effect while the maximal distractor gives less facilitation. These data show clearly that more lexical units operate as competitors than was suggested up to now.

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## Processing of grammatical gender information in French as first and second language: Evidence from ERPs

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The present study used event-related brain potentials to observe how grammatical gender information influences syntactic parsing in French both as first and second language. In the first experiment, native French speakers had to read French sentences in which the target noun was either preceded by a correct or an incorrect definite article (examples : Hier la<sub>fem</sub> neige<sub>fem</sub> était partout / \*Hier le<sub>masc</sub> neige<sub>fem</sub> était partout). The reaction in the case of gender mismatch between the definite article and subsequent noun, was a large P600 effect. The present results confirm those obtained for monolinguals for the same violation in Dutch (Hagoort and Brown, 1999) and in Dutch and Spanish for noun-adjective gender agreement violations in sentence contexts (van Berkum et al., 2000; Barber et al., in press). In the second experiment, the same task was given to proficient German-French late bilinguals, to examine the influence of the same grammatical gender violation in non-native speakers. The results showed the same P600 effect as provoked by gender mismatch between the critical noun and the preceding definite article for native speakers. It is important to note that the coherence of language was taken into consideration, that is to say that half of the stimuli presented did not share the same gender in French and German. Overall, this factor did not influence the size of the P600 effect. As such, the present results reveal highly similar patterns for native speakers and proficient late bilinguals in line with results from several eye-movement studies (Frenck-Mestre, in press, 2001, 1997; Frenck-Mestre & Pynte, 1997) and recent ERP studies (Hahne, 2001; Hahne & Friederici, 2001; Kotz, 1991) of syntactic parsing. The present results extend this finding to grammatical gender processing. Note that the responses assessing of the acceptability of the sentences revealed two sub-groups among German subjects. Indeed, only the most proficient subjects showed a P600 effect when there was incongruence between articles and nouns which did not share the same gender in the two languages. These results show that the immediate processing of grammatical gender in second language within a sentence context depends upon proficiency in this language, and thus extend the data obtained in previous bilingual studies (cf. McLaughlin, Osterhout & Kim, in Press).

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## Pronoun resolution across languages

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We will present a series of questionnaire, on-line reading, and visual-world experiments in German and French to investigate in how far the information structure of messages as well distributional properties of languages play a role in anaphor resolution in sentences like "The actor fascinated the director, when he introduced himself.". When the pronoun "he" is processed, there are the potential antecedents that it can be bound to: "the actor" and "the director". The results of a series of off-line and eye-tracking studies in German indicate that there is a preference for first NP, irrespective of syntactic function, thematic role, or case (Konieczny & Hemforth, 2001). The sentence initial position is a default topic position. Therefore the preference for the first NP may be a preference for topics.

In a series of French studies on sentences like (1-4), we obtained a very different preference pattern than the earlier German experiments. Here, we also varied the type of connective (après que / after, avant que/before, quand/ when, pendant que/while) and the position of the antecedent. In contrast to the German results, reading times as well as acceptability judgements in particular for sentences with "quand" (when) and "avant que" (before) suggest a preference for the object of the matrix clause as the antecedent of the pronoun.

One of the reasons why we find these differences between French and German may lie in the number of ways to express the relations involved in these sentences: In French, there are two structurally different ways to express the fact that Paul first had lunch and then talked to Paul: either by means of a sub-clause with a pronoun as in most sentences so far, or via the highly frequent participial construction like "Peter talked to Paul after having lunch", provided the pronoun refers to the subject of the matrix clause (object-reference is not a valid option in these participial constructions). Interestingly, this participial construction does not exist at all in German. Off-line questionnaires show that this difference has a strong effect on final interpretations. Whereas in German a strong subject/topic preference was found for sentences like (5) and (6), in French participants strongly preferred the object interpretation. In parallel constructions like (7) and (8) however, both languages show an equally strong preference for the subject interpretation.

We finally ran two visual world eye-tracking experiments in French and German to test whether the cross-linguistic preferences we found in our reading studies are reflected in on-line visual scene inspection while subjects are listening to sentences like (5) and (6). Subjects listened to sentences presented over headphones. Time logged to the critical regions in the spoken sentence, we measured their eye-movements using the SMI head mounted eye-tracker. In our experiments on German, inspection times on the two characters revealed that participants showed a very early preference for the subject/topic interpretation. First analyses of the French data suggest a preference for the non-topic/object-NP.

We conclude that apart from thematic roles and information structure, distributional properties play a major role in anaphor resolution as well. These may be Gricean strategies, so that the mere existence of the alternative is driving the preference. The preference may be just frequency-based.

Examples (a):

- (2) Le journaliste interviewe la politicienne après qu'il/elle est sorti de la salle de conférence.  
The journalist interviews the politician(fem) after he/she left the conference room.
- (3) Le journaliste interviewe la politicienne avant qu'il/elle sorte de la salle de conférence.  
The journalist interviews the politician(fem) before he/she leaves the conference room.
- (4) Le journaliste interviewe la politicienne quand il/elle sort de la salle de conférence.  
The journalist interviews the politician(fem) when he/she is leaving the conference room.
- (5) Le journaliste interviewe la politicienne pendant qu'il/elle sort de la salle de conférence.  
The journalist interviews the politician(fem) while he/she is leaving the conference room.

Examples (b)

- (6) Le facteur rencontre le balayeur avant qu'il nettoie la rue.  
The postman meets the street-sweeper before he cleans the street.  
Der Brieftraeger trifft den Strassenfeger bevor er die Strasse saeubert.
- (7) Le facteur rencontre le balayeur avant qu'il livre les lettres.  
The postman meets the street-sweeper before he delivers the letters.  
Der Brieftraeger trifft den Strassenfeger, bevor er die Briefe ausliefert.
- (8) Le facteur rencontre le balayeur. Puis il nettoie la rue.  
The postman meets the street-sweeper. Then he cleans the street.  
Der Brieftraeger trifft den Strassenfeger. Dann reinigt er die Strasse.
- (9) Le facteur rencontre le balayeur. Puis il livre les lettre.  
The postman meets the street-sweeper. Then he delivers the letters.  
Der Brieftraeger trifft den Strassenfeger. Dann liefert er die Briefe aus.

## How world knowledge and morphological gender influence reference resolution in German

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Two eye-tracking experiments studied reference resolution focusing on how morphological gender on the one hand and world knowledge about gender stereotypicality on the other hand influence the ease of assigning an anaphor to a role-name antecedent. Previous studies investigated at what point in time the one or the other information is being used during reference resolution. Stereotypicality has been shown to be available and used in early stages of the resolution process (Duffy & Keir, in press; Sturt, 2003), whereas morphological gender appears to have an influence only after some delay (De Vincenzi, 1999; van Gompel & Liversedge, 2003).

In the present studies role names with differing gender stereotypicality and morphological gender were tested. A first sentence made a general statement about a social or professional group ("Sometimes artists can be very moody."). Following some intermediate information a reference was made that specified the mentioned group members as female or male ("This is at times difficult for their husbands.") "Their husbands"/"their wives" as well as "these men"/"these women", which was also used as a co-referring expression, consist of the same number of letters in German so that eye-tracking measures of these phrases could be compared.

The first experiment tested masculine role names that can be gender inflected and whose morphological gender has a semantic reflex (e.g. Autoren (masc. plural)/authors). Experiment 2 tested epicenes that cannot be inflected for gender and do not carry morphology-based information about referents' gender (e.g. Gäste (masc. pl.)/guests; Geiseln (fem. pl.)/hostages). In both studies the respective forms of morphological gender occurred in role names with differing gender stereotypicality.

Results show that first fixations and first pass reading times in the reference region ("their wives", "these men", etc.) are slowed down by mismatches between the antecedent's morphological gender and the co-referring expression (e.g. Kunden (masc. plural/customers) – diese Frauen (fem. plural/these women)). Effects of stereotype-based mismatches between antecedent and co-referring expression (e.g. Schreibkräfte/typists (fem. stereotype) – diese Männer/these men) were found in early as well as late eye-tracking measures. Feminine stereotypes appear to interfere less with non-matching co-referring expressions than masculine stereotypes. The effect of morphological gender was found for nouns that can be gender inflected as well as for epicenes, indicating that in both cases morphological gender is used as a semantic cue for referents' gender in reading (cf. Cacciari, Carreiras & Barbolini-Cionini, 1997). Furthermore, when no structural ambiguities are involved gender information from morphological gender as well as world knowledge is used in early stages of reference resolution.

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### Influences on lexical bias in phonological speech errors.

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Phonological speech errors tend to result in real words more often than chance would predict. There are two competing accounts of this 'lexical bias' effect: either due to phoneme-to-wordform feedback in word production, or pre-articulatory editing for lexical status. Support for the latter account comes from a study showing that the effect is modified by context (Baars et al., 1975); in a task designed to elicit exchange-type phonological errors, participants appeared to suppress nonword errors if real words were present in the context, but not otherwise.

Recently, however, Baars et al.'s findings have come into question. Using variants of the Baars et al.'s (1975) SLIP task, Humphreys (2002) reports an advantage for real-word exchanges regardless of context, whereas Hartsuiker et al. (submitted) find that the numbers of real-word exchange errors increase in contexts which include lexical items.

The current paper reports two experiments, using the SLIP technique, designed to investigate and account for the differences in recent findings. Participants were required to name word pairs (e.g., "tult cug") in an attempt to elicit spoonerisms (responding "cult tug"); an exchange error that would result in either real words, as above, or in nonwords ("tult cust" -> "culm tust"). Each critical pair was preceded by several filler items, which were not read aloud. The fillers included "bias" pairs with onsets designed to make spoonerisms of the target items more likely (e.g., "cu.. tu..") as well as unrelated items. In one condition (nonword context), all unrelated items were pairs of nonwords; in the other (mixed context), the majority of unrelated items were real word pairs.

Both experiments manipulated response-time constraints (in a block design, participants were required to respond within 500 or 900ms) to investigate whether faster responses lead to a larger (Humphreys, 2002) or smaller (Dell, 1986) lexical bias across conditions. Additionally, in Experiment 2, participants were required to listen to white noise throughout the task (as was the case for Baars et al., 1975, and Hartsuiker et al., submitted, but not Humphreys, 2002) in an attempt to establish whether differential access to internal/external monitoring could account for the differences between studies.

Responses are currently being transcribed. We hope to show that Humphreys' (2002) speculations as to effect of response time on lexical biases are partially correct, but that existing experimental findings can only be accounted for by allowing for both feedback and self-monitoring within one model of speech production.

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## Agreement and Case Cues in Sentence Processing: Evidence from Subject / Object Ambiguities in Greek

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This study investigates the use of morphological cues, namely agreement and case marking, in the parsing of subject / object ambiguities by native speakers of Greek.

Sentence (1) exemplifies this ambiguity; the preposed adverbial clause contains an optionally transitive verb (*mend*) and the DP (*the sock*) might be analyzed as the direct object of the embedded verb or as the subject of the main clause:

- (1) While Mary was mending the sock fell.

Studies with adult native speakers of English (Frazier & Rayner, 1982 among others) have shown that in (1) English speakers are garden-pathed when encountering the main verb. This finding has been attributed to the operation of the late closure strategy. However, subcategorization information as well as semantic plausibility have been found to influence the processing of sentences like (1) (Frenck-Mestre & Pynte, 1997; Pickering & Traxler, 1998).

Highly-inflected languages offer the possibility to test the interaction between morpho-syntactic and thematic cues on one hand and structural parsing strategies on the other. We thus conducted two self-paced reading grammaticality judgment tasks with 80 native speakers of Greek. The materials used were minimal pairs of optionally transitive and intransitive verbs. The optional transitivity and intransitivity of the verbs employed in the experiments was verified by the native speakers' interpretations in a sentence completion task. For transitive verbs, the ambiguity was resolved either by case marking on the DP following the embedded verb (2a&b), or by agreement on the main verb (3) with a DP unmarked for case. Intransitive verbs were similarly presented. However, one member in each pair was ungrammatical (4) and the other grammatical (5):

- (2a) Kathos etroghe tus axinus epese sto patoma.  
While was-eating-3s the-acc sea-urchins-acc fell-3s on-the floor
- (2b) Kathos etroghe i axini epesan sto patoma.  
While was-eating-3s the-nom sea-urchins-nom fell-3pl on-the floor
- (3) Kathos etroghe ta biskota epesan / epese sto patoma.  
While was-eating-3s the biscuits fell-3pl / fell-3s on the floor
- (4) \* Kathos etrexe ta biskota / tus axinus epese sto patoma.  
*While was-running-3s the biscuits / the-acc sea-urchins-acc fell-3s on the floor*
- (5) Kathos etrexe ta biskota / i axini epesan sto patoma.  
*While was-running-3s the biscuits / the-nom sea-urchins-nom fell-3pl on the floor*

Our results showed that verb subcategorization information is available in on-line processing. In addition, in sentences like (3) the native speakers were not garden-pathed when encountering the main verb marked for plural, which disambiguated the sentences in favor of the subject reading. On the other hand, the subjects took longer time to read the DPs marked for nominative in (2b) than the DPs marked for accusative in (2a).

We argue these results support the existence of cross-linguistic differences in sentence processing, even in the case of primary phrases (Frazier & Clifton, 1996). We propose that in morphologically rich languages structurally-based parsing strategies such as late closure interact with morphological cues to determine processing choices. In case morphological cues are underspecified the processor generates parallel structures until it receives unambiguous morphological information.

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### Three way attraction effects in English

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Attraction effects are well established for plural local nouns (e.g., Bock & Miller, 1991). Eberhard (1997) proposed a binary distinction between marked plurals and unmarked singulars, but some theories suggest a markedness hierarchy, i.e. singular < plural < dual (Corbett, 2000). Harrison et al. (2004) exploited Slovene's three-way number distinction to address this question, and found that the latter accounted for more of the Slovene data, but that any account of attraction effects needed to treat head and local nouns separately.

Corbett's hierarchy relates to morphology. In English, there are only occasional remnants of the distinction between dual and plural (e.g., in lexical items like "both" and in structures like "neither ... nor"), but no systematic distinction. Some accounts assume that attraction errors reflect syntactic influences exclusively. Under those accounts, because the distinction between "two" and "many" is semantically but not syntactically encoded in English, this distinction should not affect attraction error rates. According to Bock and colleagues' MMM theory (2004; 2001), however, agreement involves two separate processes: marking, which can make reference to semantics and which marks the entire noun phrase with a number value; and morphing, which cannot refer to semantics. The notional number of a head noun can influence its agreement (Bock et al., 1999), thus it could affect susceptibility to attraction.

To test this hypothesis, 99 native English speakers performed a sentence completion task involving visual presentation of preamble (complex NP containing head noun and local noun) and key word; speakers were told to repeat complete the preamble aloud and complete it with the key word. Number values of head and local noun were crossed, yielding 9 conditions.

Key word	Sentence preamble			
disabled	A bull	which	a proud matador has	skewered
	Two bulls		two proud matadors have	
	Many bulls		many proud matadors have	

1. In common with previous findings but unlike in Slovene, the attraction effect is stronger after a singular (4.5%) than a plural (2.8%) head noun, despite number marking on singular determiner - attraction effects with "two" and "many" after singular head.
2. Significantly more erroneously-produced singular agreement after "two" (8.2%) than "many" (4.7%) head - singular attraction effect after "two" but not "many"!
3. As predicted, little difference between the "two" and "many" local noun conditions after "two" (4.5% vs. 5.3%) or "many" (both 3%) head.
4. Unexpected difference between "two" (7.2%) and "many" (3.6%) local noun conditions with singular head noun.

Our results show that semantic differences do affect agreement production.

We show that a smaller number value "two" is associated with more singular attraction errors than the more plural "many". It is unlikely that this is simply due to "two" being problematic, since, unlike in Slovene, the error rates after a plural head noun do not vary between the "two" and "many" local conditions.

Results 2 and 3 provide some support for the claim that the same semantic information is available to aid normal agreement control (morphing) but unable to affect error rates in the local noun position (marking).

However, result 4 is problematic for MMM; where there is a grammatical mismatch between the head and local noun, it appears that the local noun's semantic information is somehow available. We discuss the results' implications for models of agreement production.

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## Happy Endings in Language Acquisition: Discovering Lexical Categories Using Word Endings

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In language acquisition, discovering syntactic constraints requires being able to assign individual words to lexical categories, such as nouns and verbs. However, lexical categories are only useful insofar as they support syntactic constraints. In this paper, we assess whether morphological cues in the form of word endings may enable the child to begin solving this “bootstrapping” problem.

Intuitively, morphology provides obvious cues to the discovery of lexical categories (Maratsos & Chalkley, 1980), e.g., most English words ending in *-ing* are verbs. However, other English-word endings, such as *-s*, are highly ambiguous, pointing to different lexical categories (third-person singular verbs and plural nouns). Because no studies yet have determined empirically whether such ambiguity undermines the potential usefulness of morphological cues, we carried out a series of (leave-one-out cross-validated) discriminant analyses involving corpora of child-directed speech from the CHILDES database (MacWhinney, 2000).

We extracted the 4500 most frequent words from a multi-million-word corpus of English child-directed speech. Each word was assigned a phonological representation and a lexical category using CELEX. Our set of words contained a total of 37 linguistically motivated morphological suffixes, which were used as predictors of noun and verb categories. When these suffixes were used to make a three-way distinction between nouns, verbs and other (comprising the remaining lexical categories), 62.6% of the words were correctly classified. This level of overall correct classification was significantly higher than what was obtained for the baseline condition, in which the lexical category labels for each word were randomly reassigned, resulting in only 24.5% correct classification ( $\chi^2 = 1323.18$ ,  $p < .001$ ).

However, an important objection to our first analysis is that children are not spoon-fed a list of relevant morphological suffixes. To investigate whether a more psychologically plausible learning mechanism could potentially uncover word-ending information useful for the discovery of lexical categories, we developed a simple procedure to detect word-ending cues without prior knowledge of morphology. As children are highly sensitive to word endings (Slobin, 1973), our procedure simply identifies all possible word-final vowel and consonant cluster combinations. For comparison with our first analyses, the 37 most frequent of these word-ending clusters were used as lexical-category predictors. When the word endings were used to classify words as nouns, verbs or other, 57.0% overall correct classification was obtained. This level of performance was significantly better than the random baseline of 28.3% ( $\chi^2 = 759.33$ ,  $p < .001$ ).

Although the performance of our simple word-ending procedure compares well with the linguistically informed analysis, it is not clear that it would generalize to languages with more complex morphological systems. We therefore applied the procedure to an equivalent corpus of French child-directed speech with phonological representations and lexical categories drawn from BRULEX. We analyzed the 3000 most frequent words in the corpus and found that 51.2% of words were classified correctly as nouns, verbs or other. The level of performance obtained in the random baseline condition was significantly lower at 27.5% ( $\chi^2 = 351.99$ ,  $p < .001$ ).

In conclusion, word endings provide useful cues that the child can exploit without prior knowledge of morphology to discover lexical categories. These results suggest that simple computational principles can be quite powerful in isolation. However, a complete account of language acquisition is likely to require a combination of many simple computational principles for the detection and integration of multiple sources of probabilistic information (Christiansen & Monaghan, in press).

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## Noise, Efficiency, and Stability in Modeling Language Acquisition

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An important issue for psycho-computational models of language acquisition is sensitivity to 'noise' in the input. Noise has been shown to have both advantages and disruptive effects (see Briscoe, 2000, Frank and Kapur, 1996, Jain et al., 1999, Nyberg, 1992, Turkel, 1998, Villavicencio, 2000). Our work seeks to clarify the complex relationship between noise and learning efficiency.

We adopt a standard definition of noise as sentences from non-target UG-compatible languages. We measure efficiency in terms of the number of sentences consumed before convergence on the target grammar (G-target). Here, we give data from one learning model, the Minimal-Connections-STL, whose efficiency and reliability in the absence of noise have been documented (see Fodor and Sakas, 2004, Sakas, 2003, Sakas and Fodor, 2003). It gives up its current grammar hypothesis (G-current) only on encountering an incompatible input sentence; it then changes to a grammar compatible with that sentence. It has no memory for past inputs or past grammar hypotheses.

In 1,000 trials (cf. 1,000 children) for each of 3,072 G-targets, learning efficiency improved with 10% noise for 51% of all G-targets, decreased for 26%, and had no significant effect on 23%. Investigating which cases are which gives insight into how and why noise affects learning.

Noise had a positive effect only when the sequence of grammars hypothesized en route to G-target was stable, in the sense that the learner made relatively few grammar changes, to either a previously entertained grammar ('OLD') or a previously unexplored one ('NEW'). Given a stability measure defined as  $1 - (\text{average grammar changes per trial} / \text{average sentences consumed before convergence})$ , noise increased learning efficiency only for stabilities  $> 0.65$ .

A possible explanation is that "stability" is in fact a tendency to get locked into a non-target grammar that is compatible with many of the target-language sentences. A noisy (non-target) input could help by jogging the learner out of that hypothesis. (Turkel (1998) offers a similar explanation for benefits of noise in escaping local maxima in hill-climbing learners.)

Furthermore, when the 51% of noise-benefited learners did change their hypotheses, they often reverted to previously rejected grammars - an inevitable risk for memoryless learners. Repeatedly revisiting one small set of grammars could result from a consistent strategy for selecting which grammar to move to next (as in the Minimal-Connections-STL). Once again, noise might jog the learner out of its repetitive tendencies. In support of this, our results show that the stable grammars for which noise was advantageous were those with a high OLD-ratio, defined as  $(\text{average changes toward an OLD grammar} / \text{average grammar changes})$ .

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## Being ahead of time. A number of neural network simulations exploring the anticipation of clause-final heads.

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Gibson's (1998) „Dependency Locality Theory“ (DLT) predicts longer reading times at a clause-final verb due to higher integration costs for sentences in which more arguments have to be integrated at the verb. However, in an eyetracking experiment using German subordinate clauses, Konieczny & Döring (2003; KD) found that contrary to DLT's prediction, reading times decreased when more verb arguments were introduced. They argued that there must be a „syntactic anticipation“ mechanism that allows to constrain the class of possible verbs in clause-final position. KD also presented a neural network simulation using an SRN (Elman 1990). Anticipation is at the core of SRNs, as they acquire linguistic knowledge by being trained on the prediction task (predict the next word in a sentence). In this poster we present a series of simulation studies to explore the nature of anticipation in SRNs (Döring 2004).

It has been argued that anticipation and backward-oriented integration are antagonistic mechanisms, such that integration cost is the dominant factor in sentences with high memory load, while anticipation is dominant in easy constructions (Konieczny, 2000). In SRNs, however, no difference could be found for easy vs. difficult context. In two further simulations, two factors simultaneously present both in the experiment and in the simulations were explored separately: the anticipation effect could have been due to a better reliability of positive compared to negative evidence (a verb permitting a dative can directly be anticipated by the existence of a dative; a verb not allowing a dative can indirectly be anticipated by the non-existence of a dative in sentences with an accusative, given a grammar with strict word order); or it could as well have been due to the time the evidence was given (constraining the verb class early or late in the subordinate clause). The simulations showed that SRNs were sensitive to whether the context provides positive or negative evidence when specificity was kept constant, but that the time the evidence was given did not play a role.

Altogether, the simulations show that in SRNs, (1) integration cost and anticipation are not complimentary principles, where integration dominates in difficult, and anticipation in easy contexts, (2) that the time evidence is given does not play role for anticipation; while (3) the explicitness of the evidence (positive or negative) does play a role. These results provide detailed predictions for future human sentence processing studies.

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## The role of frequency and distributional regularity in the acquisition of word order: A cross-linguistic comparison.

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Studies of spontaneous speech (Pine, Lieven & Rowland, 1998) suggest that early use of word order to mark agent-patient relations is restricted to highly frequent, distributionally regular lexical items. The effect of verb frequency and distributional regularity on the ability to use word order as a grammatical marker was tested using the weird word order methodology (Akhtar, 1999), where children are taught verbs in novel word orders to see whether they will adopt the weird order or prefer to use the canonical order(s) of their language.

### Study 1: Verb frequency

Ninety-six, English-speaking children aged 2;9 and 3;9 were divided into three groups that heard either high frequency, medium frequency or low frequency verbs. Each child saw a video of puppets enacting four verbs. Seven enactments per verb were described by the experimenter in a weird SOV order. A further five enactments per verb were used to elicit responses from the children by asking them 'What's happening?'. Children aged 2;9 were significantly more likely to adopt the weird SOV order with low frequency verbs than with higher frequency verbs and reverted to canonical order with more arguments as verb frequency increased. Children a year older preferred to use canonical order regardless of verb frequency and used fewer pronouns to this end.

### Study 2: Distributional regularity

In French clitic (pronoun) and lexical objects do not share the same distribution, potentially hindering word order acquisition (lexical arguments follow the verb, clitic arguments precede it). One hundred and fourteen French children aged 2;10 and 3;9 heard either low or high frequency verbs in either a VSO or SOV weird order. Both ages were more likely to use weird orders with low frequency verbs. There was also a significant effect of modelled word order, which suggests that, for children aged 3;9 who heard high frequency verbs, SOV models had primed SV responses whereas VOS models primed SVO responses with a subject clitic. French children were significantly less likely than English children to express objects either lexically or with a pronoun, supporting the prediction that a lack of overlap in lexical and clitic objects should slow acquisition.

To summarise, the studies suggest that the ability to use word order develops from lexically specific schemas into more abstract, productive schemas as experience of the language is accrued. Verb frequency and distributional regularity play key facilitating roles in this process.

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## Toward an Integrated Model of Structure and Frequency

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Previous work on case ambiguities in German has considered possible influences of frequency only with respect to complete syntactic constructions. In this paper, we will present a more fine-grained analysis by looking at a particular interaction of lexical and syntactic ambiguity. A relevant example is given in (1).

- (39) a. Ich glaube, dass ein Professor [den Studenten]-DAT/PLURAL geholfen hat.  
I believe that a professor the students helped has  
"I believe that a professor helped the students."  
b. Ich glaube, dass ein Professor [den Studenten]-ACC/SINGULAR unterstützt hat.  
I believe that a professor the student supported has  
"I believe that a professor supported the student."
- (40) a. Ich glaube, dass [den Studenten]-DAT/PLURAL ein Professor geholfen hat.  
I believe that the students a professor helped has  
"I believe that a professor helped the students."  
b. Ich glaube, dass [den Studenten]-ACC/SINGULAR ein Professor unterstützt hat.  
I believe that the student a professor supported has  
"I believe that a professor supported the student."

The determiner "den" is ambiguous between Dative/Plural and Accusative/Singular. With nouns like "Studenten" which are ambiguous themselves, the ambiguity of "den" is inherited by the complete DP. This ambiguity allows to combine a lexical number/case ambiguity with different syntactic constructions.

In a first corpus study, we counted the singular respective plural occurrences of 48 ambiguous nouns like "Studenten", finding 80% plural instances. Secondly, we counted the use of NPs with the article "den" in two syntactic environments: (a) Subject-object sentences and (b) object-subject sentences. With respect to (a) and (b), the corpus counts showed a strong interaction: for the SO-order, "den"-NPs were mainly used as accusative-NPs, whereas for the OS-order, dative "den"-NPs prevailed.

Following the corpus analysis, three experiments using the method of speeded grammaticality judgments were run. These experiments tested ambiguous sentences as in (1) and (2) together with unambiguous control sentences. Furthermore, the sentences either contained two animate NPs and an action-verb (cf. (1) and (2)), or an animate NP (always the "den"-phrase) together with an inanimate NP and a psych-verb. For action-verbs, the SO word-order is unmarked whereas the OS word-order is marked. For psych-verbs, both word-orders are unmarked.

The main results were as follows: (i) For sentences with action-verbs, the experimental results mainly matched the corpus counts. For SO-sentences (corpus: accusative more frequent than dative), dative but not accusative disambiguation led to a garden-path effect. For OS-sentences (corpus: dative more frequent than accusative), unambiguous accusative sentences were judged substantially worse than unambiguous dative sentences, and ambiguous accusative sentences were judged even worse than unambiguous one, showing a clear garden-path effect. Not mirroring corpus frequencies, a significant garden-path effect occurred for dative OS-sentences. (ii) For sentences with psych-verbs, ambiguous sentences caused garden-path effects throughout, with accusative sentences causing stronger effects in both word-orders.

We will show how a model of the HSPM that combines structural parsing-principles with lexical frequencies (pertaining to the number-ambiguous nouns used in our experiments) can account for the experimental results described above. Finally, we will show how our results resolve the recent debate between Bornkessel et al. (2002) and Kempen/Harbusch (2003).

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## Processing Moved Verbs in Dutch Sentences: Gap-Filling or Something Else?

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In Dutch declarative matrix clauses the verb is not in its base position, but has been moved from the end of the clause to second position (Koster, 1975). In two previous Dutch Cross-Modal Priming experiments, we found results suggesting that moved verbs show a different on-line activation pattern from moved NPs (De Goede et al., 2003; for English NPs, see e.g. Love & Swinney, 1996, but see Pickering & Barry, 1991 for an alternative interpretation). We found evidence for continued activation of the verb which ended only after the conjunction linking the matrix to the embedded clause. As all sentences ended with the object noun phrase, our suggestion was that the verb is kept active to 'find' its arguments in order to theta-mark them. We assumed that activation of the verb would dissipate once thematic roles had been discharged.

In the present Cross-Modal Priming experiment we tested SVO sentences with an adjunct immediately following the direct object (1). This allowed investigation of the *Argument Structure Hypothesis* which suggests that saturation of the argument structure of the verb is the basis for deactivation of the verb.

- (41) De domme gedetineerden beroven [1] vijftien rijke bejaarden tijdens hun [2] eerste proefverlof [3], dus ...  
(lit) *The stupid detainees rob [1] fifteen rich seniors during their [2] first parole [3], so ...*

Our lexical decision probes were verbs related to the moved verb, unrelated matched controls and non-words derived from verbs. Faster RTs to verb-related relative to unrelated control probes ending at the adjunct (that is, after the second argument) would suggest that the moved verb is maintained active until the gap or until all arguments have been encountered. The prime - related probe - unrelated probe triads were proven successful in two previous CMP-experiments; we found a contrastive pattern of both activation and deactivation of the moved verb, suggesting that any positive results cannot be due to bias in the items.

The results showed verb activation shortly after the verb (probe point [1];  $t_1(44) = 3.08, p = .002$ ;  $t_2(41) = 1.75, p = .044$ ), 700 ms after the onset of the adjunct (so at least 700 ms after the final argument had been processed; probe point [2];  $t_1(44) = 2.35, p = .012$ ;  $t_2(41) = 2.39, p = .011$ ) and at the end of the clause (probe point [3];  $t_1(44) = 2.59, p = .007$ ;  $t_2(41) = 1.77, p = .042$ ). Thus, moved finite verbs in Dutch declarative matrix clauses are maintained active throughout their entire clause, even after all arguments have been saturated.

According to the Argument Structure Hypothesis, verbs remain active to be able to assign theta roles to their arguments. This hypothesis was falsified in the current experiment which showed activation of the verb during an adjunct phrase placed after the final argument. The results can be interpreted within a (revised) gap-filling account (suggesting that the verb is maintained active until, and because of, the gap) if it is assumed that the base position of the verb is at the end of the clause in the sentences we used. However, current linguistic theories disagree about the role of adjuncts and therefore it remains unclear whether the base position of the verb should be postulated at the end of the clause (so after the adjunct) or after the direct object (in front of the adjunct). Three alternative accounts are proposed that match the data well: a syntactic account (based on VP-shell Theory, Van Zonneveld & Bastiaanse, 2000), a semantic account (based on the 'underspecification model', Pickering & Frisson, 2001) and a psychological account (e.g. building a 'mental model' of the sentence).

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## Filler-gap in visual worlds: Evidence from 'confirmatory' eye movements

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Filler-gap processing has provoked an extensive volume of psycholinguistic research. Converging evidence indicates that the processor forms the filler-gap dependency as soon as a potential gap is identified given verb information, as found in experiments using reading paradigms (e.g., Stowe, 1986) or 'stop-making-sense' tasks (e.g., Boland et al., 1990, 1995). More recently, Sussman & Sedivy (2003) have investigated the processing using the 'visual-world' eye-tracking paradigm (Cooper, 1974), and found the processor actively searches for a possible referent for the gap during the lifetime of the verb in filler-gap sentences.

The present experiment aims to investigate the use of verb's semantic information in filler-gap processing in the visual-world paradigm using a relative clause construction such as:

(1a) The cake which the boy will eat soon was made for his birthday.

(1b) The cake which the boy will move soon was made for his birthday.

These sentences are based on Altmann & Kamide's (1999) simplex sentences (e.g., 'The boy will eat/move the cake.'). presented with the same pictures from their study (e.g., a scene containing a boy, a cake (target: the only edible object), a ball, a toy train, and a toy car). Note, in these sentences, the referent for the gap ('the cake') is overt in the filler NP; thus, in principle, the filler-gap processing at the verb should produce no difference in the probability of eye movements towards the cake in the two conditions. In contrast, more looks to the cake in (1a) than in (1b) at the verb would suggest verb's selectional restrictions guide eye movements irrespective of the overt filler, presumably due to a complete absence of filler-gap processing in the region, or at least a lack of effects of the processing onto eye movements.

The results turned out to be neither of the two patterns: more eye movements towards the cake were found during 'eat/move soon' in (1b) than in (1a). This pattern is opposite to A&K's results ('anticipatory' eye movements), which was taken as evidence for prediction of the direct object at the verb. (However, note there is no need to predict the direct object at the verb in our sentences). Thus, a possible implication of the results would be that, prior to the verb, the processor 'anticipates' certain semantic properties for the forthcoming verb given the constraints by the visual scene and the linguistic items. Then, when the verb turns out not to fit the prediction particularly well ('move': presumably either because 'move' does not co-occur with 'cake' particularly often in the language or because 'move' could be applied to other objects as well in the particular scene), some extra processing is required to confirm the filler-gap dependency, which results in an increased number of eye movements towards the referent of the filler.

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## Implicit causality immediately affects sentence comprehension: new evidence from an eye tracking study

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Following up on a self paced-reading experiment (Koornneef, Waaijer, & Van Berkum, 2002), we will report the results of an eye-tracking experiment designed to study the online influence of implicit causality on sentence processing. Implicit causality is a property of certain transitive verbs that provides the reader with implicit information about the underlying cause of the described event. For example, in the sentence "John praised Linda because...", the sentence most likely continues with some information concerning Linda (e.g., "she did a good job"). Thus, the verb "to praise" is somehow biased towards the object noun phrase. However, the sentence could also continue with information about John (e.g., "he was very proud"). Numerous studies have shown that people have a preference for a continuation that is consistent with the bias of the verb (in this case "she did a good job"), suggesting that implicit causality information affects sentence comprehension. An as yet unresolved issue, however, is when during processing implicit causality information becomes available. In contrast to recent claims (e.g., Garnham, 2000; Stewart, Pickeringh, & Sanford, 2000), but in line with the results of our self-paced reading experiment, our results show that implicit causality information is available quickly and furthermore, is immediately brought to bear on the interpretation of a referential pronoun.

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## Only in Context

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*Only* typically expresses contrast (Rooth 1992, Kadmon 2001). *Only John died* means that no one but John, out of a contextually given or inferred set of alternate referents, died. In isolation, where a contrast set must be inferred, *only* biased but did not disambiguate ambiguous ellipsis sentences (1) (Carlson 2004).

- (1) On Monday, (only) the curator embarrassed (only) the gallery owner in public, not the artist, though later everyone made up.

But what happens when sentences with *only* are placed in a context that provides the necessary contrast set? The current work finds that context and *only* have additive effects on interpretation, but do not fully disambiguate the sentences, even together. Further, *only* suggests but does not force the discourse coherence relation of contrast (Kehler 2001). Sentences with *only* are interpreted similarly in context and in isolation, and *only* need not indicate contrast with upcoming material.

To explore how context affects the processing of *only* and ellipsis, two self-paced reading studies placed ambiguous ellipses in contexts highlighting subject or object interpretations (2-3).

- (2) Subject Context: A lot of Republican bigwigs were at a fancy dinner party at the embassy the other night. The newspapers were particularly interested in who stayed around for coffee with the diplomat. Apparently, (only) the judge joined (only) the diplomat for coffee, not the senator, although other people had been invited.
- (3) Object Context: A lot of Republican bigwigs were at a fancy dinner party at the embassy the other night. The newspapers were particularly interested in who the judge stayed around to have coffee with afterwards. Apparently, (only) the judge joined (only) the diplomat for coffee, not the senator, although other people had been invited.

The ellipsis clause was read faster in conditions where *only* focused the object, encouraging object contrast, than conditions with subject *only*. Also, reading was faster when the position of *only* was consistent with the context than when it conflicted. Answers to sentence-final questions revealed that context and *only* had additive effects on ellipsis resolution, rather than context outweighing *only* or fully disambiguating the sentences. Additionally, the object contrast was favored overall, echoing recent sluicing work and Carlson's null-context results.

To further explore the usage of 'only,' simple first clauses plus conjunctions (4) were presented in a written completion study.

- (4) Apparently, (only) the judge joined (only) the diplomat for coffee, but \_\_\_\_\_

Without *only*, completions were primarily (80%) sentences or VPs expressing following events, but rarely expressing contrast with any argument. With subject *only*, more sentence completions occurred, and 30% of completions included a subject contrast. Object *only* produced more 'not NP' completions and 32% unambiguous object contrasts. The presence of *only* therefore increases but does not demand contrast in following discourse material, and its position affects which arguments contrast.

In perception, neither context nor *only* dictated which argument should contrast with an ellipsis remnant (*the senator* in (2-3)). The flexibility of *only* in the production study may explain its relatively weak effects in perception: contrast between an argument and upcoming material is only one grammatically permissible way to use *only*. Finally, the interpretive effects of *only* were similar in context or in isolation, suggesting that having to infer a contrast set did not skew perceivers' interpretations.

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## Contextual Licensing of Noncanonical Word Order in Spatial Descriptions

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According to mental model theory (Johnson-Laird, 1983), when reading a sentence like *The deer is to the left of the snake*, the reader constructs an initial mental model of the described layout. When the sentence is followed by another such sentence, e.g., *The donkey is to the right of the snake*, the reader will try to integrate the new element of the second sentence, *the donkey*, into the initial model. Hörnig, Oberauer, and Weidenfeld (to appear) propose the Relatum = Given principle, according to which model integration is easier if the relatum of the second sentence (the prepositional object *the snake*) is already given within the model, while the referent of the second sentence (the grammatical subject *the donkey*) is the new element. Relatum = Given, together with the Given-New principle (cf. Clark & Haviland, 1977), predicts model integration to be easiest with the given relatum in preverbal position, although the sentence has noncanonical word order (e.g., *To the right of the snake is the donkey*). Hörnig et al. tested this prediction by manipulating givenness (relatum vs. referent of the second sentence) and word order (canonical vs. noncanonical) in German. The two sentences of a pair, which were always of the same word order, were presented one after another, self-paced by participants. Comprehension times for the second sentence were taken as indicating ease of model integration. Integration was easiest with a given preverbal relatum and most difficult with a new preverbal relatum, both of which instantiating noncanonical structures. With canonical structures, integration was of intermediate difficulty. Hörnig et al. interpreted this finding in terms of Given-New licensing of noncanonical word order, i.e., noncanonical structures are easy to comprehend, as long as they establish a given-new order.

We offer and test an alternative interpretation in terms of Poset (= partially ordered set) licensing inspired by Prince (1999). On this account, noncanonical word order is licensed if the preverbal constituent refers to a new element which is Poset related to a given element. According to our analysis, the preverbal PP as a whole (*to the right of the snake*) refers to a discourse-new place that is spatially related (i.e., Poset related) to the given place occupied by the snake. On the Poset account, in order to be licensed, the spatial preposition has necessarily to be part of the preverbal constituent. On the Given-New account, it is sufficient that the given preverbal relatum precedes the new referent. In order to evaluate the two accounts, we rerun the experiment of Hörnig et al. with spatial adverbs instead of spatial prepositions. In particular, we realized four different word order variants with spatial adverbs and crossed them with givenness (relatum vs. referent). Examples of the four word order variants with a given relatum are presented below (givenness of the referent is achieved by mentioning the donkey instead of the snake in the first sentence, e.g., *The donkey is as from the deer left* for (1)):

- (42) Der Hirsch ist von der Schlange aus links. Der Esel ist von der Schlange aus rechts.  
*The deer is as from the snake left. The donkey is as from the snake right.*
- (43) Von der Schlange aus ist der Hirsch links. Von der Schlange aus ist der Esel rechts.  
*As from the snake the deer is left. As from the snake the donkey is right.*
- (44) Von der Schlange aus links ist der Hirsch. Von der Schlange aus rechts ist der Esel.  
*As from the snake left is the deer. As from the snake right is the donkey.*
- (45) Links von der Schlange aus ist der Hirsch. Rechts von der Schlange aus ist der Esel.  
*Left as from the snake is the deer. Right as from the snake is the donkey.*

Are all of the noncanonical structures in (2) to (4) contextually licensed due to the given relatum? The critical structure is (2), with the relatum being preverbal as in (3) and (4), but the spatial adverb being sentence final as in the canonical structure in (1). On the Given-New account, (2) is as licensed as are (3) and (4). On the Poset account, (3) and (4) are licensed but (2) is not. Comprehension times for the second sentence revealed that model integration is easier with (2) as compared to (1), as predicted by Given-New. In accordance with Poset, model integration is further facilitated with (3) and (4) as compared to (2). We conclude that contextual licensing of noncanonical word order is a matter of degree. Given-New was sufficient to licence noncanonical word order. Poset, however, licensed noncanonical word order to a larger extent than Given-New did. In terms of model integration, comprehension seems to further benefit from the early availability of relational information which specifies where to add the new place to the model. Taken together, our results suggest that linguistic proposals on licensing noncanonical word order might well meet with requirements identified for mental integration.

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## Relative clause attachment in Hebrew: Free versus Construct State nominals

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Our study of Hebrew sentences containing the relative clause (RC) attachment ambiguity, see (1), reports data on attachment preferences in silent reading and on prosodic phrasings in elicited utterances. The N1-N2-RC construction is psycholinguistically significant because resolution of the ambiguity varies cross-linguistically (Cuetos & Mitchell, 1988). Where an economy principle predicts that RC should be interpreted as modifying local N2, languages differ in the likelihood that other, as yet unspecified, factors override recency to give an interpretation in which RC instead modifies N1. Beyond adding to the list of languages for which the construction is evaluated, Hebrew offers an opportunity to further refine theory development. In Hebrew, the complex nominal introducing sites competing for RC-modification takes one of two forms having identical meaning but different syntax and phonology: the Free State (FS) includes an element 'šel' (equivalent to English 'of'), while the Construct State (CS) lacks that element and any definiteness marking on N1. FS nominals place pitch accents on each noun; CS nominals, in contrast, are single phonological words and place a pitch accent on N2 only. If prosody projected in silent reading influences ambiguity resolution (Fodor, 2002), attachment differences are predicted within Hebrew, because a phrasing break internal to the complex nominal is grammatical in FS but ungrammatical in CS.

Attachment preference data were gathered with an offline questionnaire (N=60 native speakers; N=24x4 targets), using silently read materials designed to factorially manipulate nominal type (FS, CS) and RC length (1, 3 prosodic words). Phrasing data (judgments, instrumental measures) were based on utterances elicited with a variant of Bradley et al.'s (2003) "Post-to-Times" protocol, see (2). The elicitation always gave RC a restrictive reading, and disambiguated for N2-modification, uniformly (N=10 native speakers; N=8x4 targets).

An interaction is evident in the attachment preference data, see (3),  $F(1,56)=11.97$ ,  $F(1,20)=5.43$ . Nominal type has an effect differing in magnitude across RC lengths: FS lowers attachment substantially with short RC,  $F(1,56)=52.08$ ,  $F(1,20)=53.86$ , but markedly less (though still reliably) with long RC,  $F(1,56)=17.10$ ,  $F(1,20)=15.54$ . The phrasing data support an account of this outcome cast in prosodic terms, turning on the availability in FS (cf. CS) of the N1][N2 phrasing break. Note that Lovrić (2003) shows that this prosody forces attachment low. In FS utterances (but not CS), we find that an N1][N2 phrasing is adopted with some regularity with short RC, but that the alternative N2][RC phrasing predominates with long RC.

(1) ha-'ohadim he'ericu 'et (ha-)me'amen (šel) ha-mit'agref še-paraš.  
the-fans admired ACC (the-)coach (of) the-wrestler who-retired

(2) ha-'ohadim he'ericu 'et (ha-)me'amen (šel) ha-mit'agref.  
the-fans admired ACC (the-)coach (of) the-wrestler

eize' mit'agref?  
which wrestler

ha-mit'agref še-paraš (le'axar ha-taxarut).  
the-wrestler who-retired (after the-fight)

(3) Attachment preference data (% N1 Attachment)

	CS	FS	
	56.7	28.7	RC1
	62.5	48.1	RC3

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## Relative clause attachment in Hindi: Effects of RC length and RC placement

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Studies of the relative clause (RC) attachment ambiguity have identified it as the only construction processed differently cross-linguistically, suggesting that components of human sentence processing are language-specific. Speakers of some languages (e.g., Spanish (1a)) are more likely than speakers of others (e.g., English (1b)) to interpret the RC as a modifier of the complex NP's head, thus violating an otherwise universal parsing preference for local attachments. We report data demonstrating that Hindi resembles Spanish, and examine how within the language both RC's length and RC's placement modulate overall preference.

In Hindi, the construction differs from standardly studied cases (e.g., Spanish, English) in that the complex NP is head-final and a participial RC precedes it, (2a) (as in Japanese; Kamide & Mitchell, 1997). Hindi grammar additionally allows a finite RC to appear post-nominally, (2b), where it still can modify either of the two host nouns.

Various studies have confirmed that RC's length modulates attachment preference, long RCs being more likely than short ones to modify the complex NP's head, an effect usually interpreted prosodically: in the standard cases (Spanish, English, etc.), long RCs are likely to be preceded by a phrasal break. This major discontinuity at RC's left edge prompts syntactic realignment: a "high" attachment to the non-local head (Fodor, 2002).

Added length to a Hindi participial RC might similarly increase the likelihood of a phrasal break, now at RC's right edge. Such breaks should promote "high" attachment interpretations. But post-nominal RCs might be uniformly separately phrased. If so, attachment preference should not vary based on their length (Hemforth et al., submitted). N=60 Hindi native speakers read N=24x4 ambiguous target sentences, (2a,b), each followed by a question probing RC's interpretation, (2c). Target materials combined factorially the manipulations illustrated: RC's Length (short/long) and RC's Placement (participial/post-nominal). The data (expressed as percent attachment to the complex NP's head, "naukaraanii") reveal a Length x Placement interaction. In line with findings in other languages, participial RCs are interpreted as attached to the complex NP's head: 61% for long, 53% for short. In contrast, post-nominal RCs are invariably interpreted as attached to the complex NP's head noun, regardless of RC's length, at a rate of 93%.

The results are consistent with Fodor's Implicit Prosody Hypothesis. More generally, these results provide further support for the view that human parsing decisions are driven by all available sources of linguistic knowledge, not merely structural constraints.

### Examples

- (46) a. Alguien pegó a la criada de la actriz que estaba en el balcón.  
 b. Someone hit the maid of the actress who was on the balcony.
- (47) a. kisii-ne (balkonii para khaRii) caaye pii rahii us abhinetrii-kii us naukaraanii-ko maaraa  
 someone-erg (balcony on standing) drinking tea was that actress-K that maid-ACC hit  
 b. kisii-ne us abhinetrii-kii us naukaraanii-ko jo (balkonii para khaRii) caaye pii rahii thii maaraa  
 someone-erg that actress-K that maid-ACC who (balcony on standing) drinking tea was aux hit  
 c. caaye kaun pii rahii thii? (a) abhinetrii (b) naukaraanii  
 tea who drinking was (a) actress (b) maid

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## Interpretation of pronouns in VP-ellipsis constructions in Dutch agrammatism

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Reuland (2001) proposes the following hierarchy of levels at which reference can be established: Syntax<Semantics<Discourse. The syntactic dependencies are the most economical and block the less economical ones, semantic and discourse-dependencies. Our previous findings (Ruigendijk, et al. in press) show that this hierarchy is disturbed in agrammatism: syntax is "weakened" and no longer blocks the establishment of dependencies at other levels. For non-brain-damaged speakers, it has been demonstrated that semantic dependencies are less costly than discourse-dependencies (Frazier and Clifton, 2000, among others).

We investigated how is the economy hierarchy in agrammatism is different with regard to the semantic and discourse level from that in the unimpaired population?

We investigated patients' comprehension of pronouns in VP-ellipsis:

(1) Bill touched his dog and John did too [e].

This sentence has two possible interpretations representing the focus of our study - SEMANTIC interpretation (bound variable) - pronoun is treated as a variable assigned reference locally (in the first conjoint local NP Bill and in the second NP John) and DISCOURSE-interpretation (coreference) - pronoun is assigned a discourse referent in the first conjunct (NP Bill) then the whole VP is copied in the second conjunct.

Subjects: 6 agrammatic patients; 8 non-brain-damaged adults (for now).

Materials: Picture selection task; 3 conditions; 10 items per condition; 30 fillers

In the first half of the experiment patients were presented with the following conditions:

TARGET sentence: De jongen raakt zijn hond aan en de man doet dat ook.  
 The boy touches his dog and the man does that too

BOUND VARIABLE ONLY (BVonly)

Picture1: boy touching boy's dog and the man touching man's dog (bound variable); Picture2: boy touching boy's dog and man touching grandfather's dog; Picture3: filler. (If the bound variable interpretation is available Picture1 should be chosen; otherwise they could chose action related filler - Picture2 or an unrelated distracter Picture3)

COREFERENCE ONLY (COonly)

Picture1: boy touching boy's dog and the man touching boy's dog (coreference); Picture2: boy touching boy's dog and man touching grandfather's dog; Picture3: filler. (If the coreference interpretation is available Picture1 should be chosen; otherwise they could chose action related filler - Picture2 or an unrelated distracter Picture3)

In the second half of the experiment they could choose between the two possible interpretations:

BOUND VARIABLE vs. COREFERENCE (BVCO)

Picture1: bound variable interpretation; Picture2: coreference interpretation; Picture3: filler.

### Results

BVonly and COonly percentages correct; BVCO percentage bound variable picture chosen:

	BVonly	COonly	BVCO
Aphasics	76.6	65.0	83.3
Controls	96.3	90.0	62.5

The agrammatic patients score significantly above chance in BVonly and are at chance in COonly conditions. Their overall performance is worse than the controls. Unlike the controls, agrammatics prefer bound variable interpretation above coreference.

### Discussion

\* The hierarchical order between semantic and discourse-dependencies is the same in agrammatism as in non-brain-damaged adults.

\* Unlike controls, agrammatics show a preference for the bound variable interpretation. The processing considerations (e.g. cheaper dependencies are preferred over the more expensive ones) play a more important role for them than for controls, for whom even the dependencies at a higher level of the hierarchy are equally accessible.

In combination with previous results, we claim that the brain damage in agrammatic aphasia results in a decrease of processing resources and consequently in a selective weakening of the syntactic machinery and affecting all other levels that heavily rely on syntax.

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## The on-line establishment of hyperonymic anaphorical relations

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The influence of the context in which an utterance is encountered is of fundamental interest for the understanding of language comprehension. Contextual information is particularly important in the resolution of anaphorical relations, i.e. in establishing and maintaining reference throughout the discourse. Typically, the resolution of anaphoric expressions during on-line comprehension is examined using personal pronouns (e.g. Osterhout & Mobley, 1995; van Gompel & Majid, 2004). However, there are also other means of establishing (felicitous) anaphoric relations, for example by the use of hyperonyms (e.g. 1).

- (1a) *Oskar fragt sich, wer den Karpfen gestohlen hat.*  
Oscar asks himself who the carp stolen has  
'Oscar is wondering who stole the carp.'
- (1b) *Dann erfuhr er, dass der Junge den Fisch/Karpfen gestohlen hat.*  
then heard he that the boy the fish/carp stolen has  
'Then he heard that it was the boy who had stolen the fish/carp.'

In a study using event-related potentials (ERP's), we contrasted the processing of anaphoric referential expressions (*carp* in 1b) with that of anaphoric hyperonyms (*fish* in 1b). While in a neutral context ('Oscar is wondering what happened. '), the two variants of (1b) do not differ from one another at the position of *fish/carp*, there are clear differences between the two in the anaphoric context provided by (1a). Thus, the repetition of the referential expression (*carp*) gives rise to a reduction of the N400 component between 300 and 500 ms post critical word onset (in comparison to a neutral context), while the same effect is delayed by approximately 70 ms in the case of the anaphoric hyperonym (*fish*).

On the one hand, these results indicate that the integration of a nominal constituent is eased by the availability of an anaphoric relationship, as reflected in the reduced N400. Moreover, and perhaps more importantly, the ERP effects give a precise indication of the time course involved in the processing of a hyperonym-hyponym relationship at the sentence level. It thus appears that the activation of the concept 'carp' – and thereby the ease of integration of the corresponding noun phrase in the target sentence – is delayed by approximately 70 ms because this is the time required by the comprehension system to identify the new nominal element 'fish' and establish its hyperonymic relationship with the antecedent concept 'carp'. These results therefore suggest that semantic relations such as hyperonymy are immediately used in the establishment of anaphorical relationships, thereby easing the integration of arguments at the sentence level. Nonetheless, these processes are constrained by the structure of the mental lexicon and the semantic relationships encoded therein.

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## Immediate interpretation of bound variable pronouns, or If a listener hears a pronoun...

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Previous studies of pronoun interpretation have shown that pronouns immediately activate all and only grammatically possible antecedents (Nicol 1988). These studies used referential NPs as antecedents, thus the relationship between the pronouns and the potential antecedents could have been either binding or coreference. We report an experiment where we investigated bound variable pronouns in so-called donkey anaphora. Donkey anaphora are pronouns bound by an explicit (1a) or implicit universal quantifier ((1b), roughly: Every time/In every situation where a farmer owns a donkey...) . We wanted to test whether donkey pronouns reactivate their antecedents (Q1), and if so, what material is reactivated (Q2).

- (1a) Every farmer who owns a donkey beats it.  
(1b) If a farmer owns a donkey, he beats it.

Donkey pronouns have been analyzed in various ways. For instance, Elbourne (2001) has recently proposed to treat them as definite descriptions ("the donkey" in (1)) with the noun remaining unpronounced. By contrast, Heim (1990) argues that they include complex material; e.g., the pronoun "es" (it) in (2) may "contain" as much as "the (glass of) water the waiter serves to the actress..." We refer to this as the "extended antecedent" (EA), as opposed to the "direct antecedent" (DA) "(a glass of) water".

- (2) Wenn ein Kellner einer Schauspielerin ein Glas Wasser serviert, ist es mit einer Limone garniert.  
if a waiter(Masc) an actress(Fem) a glass water(Neut) serves, is it(Neut) with a lime garnished.  
"If a waiter serves a glass of water to an actress, it is garnished with a lime."  
(3) Bevor der Kellner der Schauspielerin ein Glas Wasser serviert hat, wurde es mit einer Limone garniert.  
before the waiter(Masc) the actress(Fem) a glass water(Neut) served has was it(Neut) with a lime garnished  
"Before the waiter served a glass a water to the actress, it was garnished with a lime.is an ambiguous sentence.."

Sentences like (2) were presented in a cross-modal priming experiment. To test whether bound variables reactivate their antecedents (Q1), we presented probes semantically related to DA. We also included probes semantically related to EA (in this case, to "actress"), since reactivation of the extended antecedent may be taken as evidence that the EA is represented at the position of the donkey pronoun (Q2). Both types of related probes were compared to probes unrelated to anything in the sentence.

To ensure that any facilitation for EA is necessarily due to the semantics of the donkey pronoun, there was a systematic gender mismatch between the pronoun and the EA phrase we tested. Furthermore, the experiment included non-quantificational counterparts to (2) like (3), where no priming is expected for EA under either Heim's or Elbourne's account, while the DA may still be primed.

We found significant priming for the "direct antecedent" at the position of the donkey pronoun, compared to an earlier control position, both in the donkey- and the non-quantificational sentences. Furthermore, there was also significant priming at this position for the "extended antecedent" in the donkey sentences, but not in the non-quantificational ones.

The results show that bound variable pronouns are interpreted immediately. Immediate interpretation is not limited to finding the gender-matched antecedent for the pronoun, but also includes deep semantic processing of the "content" of the pronoun. We will discuss the implications of these findings for semantic theories of donkey anaphora, as well as for the processing of bound variable pronouns and of anaphora in general.

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### In some cases case processing is difficult

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In some artificial grammar studies ERP effects were reported that typically occur in native speakers of natural languages (ELAN, LAN, P600) related to structural violations (Friederici et al., 2002; Hoen and Dominey, 2000). However, it is known from studies in second language processing that analogous components are often not found if the second language is learned late (Weber-Fox and Neville, 1996). It was hypothesized that restricted vocabulary size as used in artificial grammar experiments might facilitate the development of nativelike ERPs. In a first study testing this hypothesis in natural speech processing Mueller et al. (2004) used a miniature language based on Japanese (Mini-Nihongo). MiniNihongo allows the direct comparison of processing characteristics of native and highly trained participants.

Mueller et al. (2004) measured ERPs related to case and word category violations and reported differences between natives and trained participants with respect to anterior negativities and to the N400 effect, which were both absent in learners. However, as the sentences presented in this first experiment were all in canonical word order it remains unclear if differences between learners and natives are attributable to task related linear processing strategies of the learners.

The present ERP study aimed at fostering hierarchical processing procedures by using both possible word orders of Mini-Nihongo. Test sentences were either in canonical or scrambled order and were correct or contained a word category or a case violation. As case markers have a high informational content if scrambling is possible we expected the emergence of an N400 effect in native participants and in learners. Participants were Japanese native speakers and the same group of learners as in the Mueller et al. (2004) study.

The results for native participants are similar to the previous study (Mueller et al., 2004). Word category violations elicit an early anterior negativity followed by a P600 and case violations elicit an N400-P600 pattern for both word orders. Learners displayed similar ERPs as in the previous study only in the word category violation, namely an early centroparietal negativity followed by a P600. Case violations elicited an N400-like negativity and a P600 in canonical sentences but only a P600 in scrambled sentences. The emergence of the negativity in learners illustrates that case information is used in the same time window as in natives at least in canonical sentences. The lack of the negativity in scrambled sentences is interpreted as evidence for speech segmentation difficulties with respect to processing of consecutive vowels.

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## Shallow semantic processing of spoken utterances

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During reading, a full semantic analysis of each word is not always carried out. Some words receive 'shallow processing' with respect to meaning (e.g. Ferreira et al., 2002; Sanford 2002). This paper investigates shallow processing in listening. Sturt et al. (in press) demonstrated that focus influences the depth of semantic processing, using a text change detection task. Participants read short pieces of text, which are presented twice in succession, and were asked to detect whether a word had changed from the first presentation to the second. Changes were to semantically similar or dissimilar words. Both focus and the semantic relatedness influenced correct detection, and these factors interacted. The effects of processing load upon semantic processing have also been investigated (Sanford et al., 2003). Load was manipulated by use of either a noun phrase or a personal pronoun as the subject of a nested relative clause (Warren & Gibson, 2002). There were main effects but no interaction when the embedded verb was the locus of change. We repeated these studies using auditory presentations. In experiment 1, focus was manipulated via prior context.

Experiment 2 examined the effects of referential load. In both, semantic distance was manipulated. The focus manipulation supported Sturt et al., showing a significant interaction, with fewer change detections in unfocused items when the target word changed to a semantically similar word. The load manipulation replicated earlier findings, with main effects of load and semantic distance but no interaction between these two factors. The results show the usefulness of the change detection paradigm for speech processing, and strengthen the idea that load and focus alter depth of processing in different ways. We present two simple models of these effects.

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### Abstract Categories or Limited Scope Formulae?

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Where do functional syntactic categories come from? At least two answers are current in the literature: a) they develop from innate syntactic features; b) they develop from local, lexically-specific, co-occurrences. Using data from 21 2-year-olds' use of Determiners in English, we argue that there is no evidence for b). Determiners are a particularly interesting locus for the controversy about the sources of syntactic categories because they are functional categories and are thus more removed from thematic roles than are the lexical categories of Nouns, Verbs, Adjectives/Adverbs, and Prepositions.

To evaluate hypotheses about the origins of syntactic categories, it is necessary to develop behavioral criteria to determine whether a child's grammar includes a category. In an analysis of speech from 6 English-speaking 2-year-olds, Valian (1986) developed distributional criteria for the categories Determiner, Adjective, Noun, Preposition, Noun Phrase, and Prepositional Phrase. Among the criteria for Determiners were the requirement that they not be the sole content of an utterance, not be sequenced, and occur only before Nouns and Adjectives. By these criteria, all children showed good evidence of Determiners.

But, Pine and Martindale (PM, 1996) and Pine and Lieven (PL, 1997) have argued, with such distributional criteria one could attribute categories to children who in fact have only lexically-specific knowledge about acceptable word pairs. PM proposed an "overlap" test which the 7 2-year-olds they observed failed: children did not use both \*a\* and \*the\* before Nouns and after predicates at the same rate as adults; instead, children appeared to restrict \*a\* to some Nouns or predicates and \*the\* to others. PL used an overlap test with other children and drew the same conclusion. On the basis of these findings, these authors concluded that children's early Determiner usage is best characterized as being based on "limited scope formulae" such as "*that's a X*" or "*where's the X*?"

We agree with the idea motivating the overlap test: if children have the category Determiner, they should use a range of Determiners with the same nouns. If 2-year-olds pass that test and Valian's criteria, we can confidently attribute Determiners to them. We developed a more rigorous implementation of the overlap test, one which avoids the methodological and sampling errors in PM. We demonstrate – with 21 2-year-olds – that children pass a correct formulation of the test. When we introduce appropriate sampling of tokens, we find that children – even those below MLU 2 - use multiple determiners with most of nouns they produce. As soon as children produce combinatorial speech, they show evidence of abstract categories. Lexical specificity does not dominate children's early speech. Our conclusions from children's productions converge with comprehension data from even younger children.

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## Extending Wundt's Principle for incremental processing

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Language production is a complex task, and despite limited resources, humans can speak fluently at a constant rate. The means to achieve this performance is incremental processing; i.e., utterances and sequences of utterances are not planned completely in advance but are generated on the fly. Particularly suited for incremental processing are cascaded architectures. They consist of processes that are arranged in a fixed sequence, so that the output of one process is the input to its successor. This parallel processing of a sequential information stream is, together with the accompanying strict unidirectionality of the information flow, characteristic of incremental processing.

As a principle for cognitively adequate incremental processing Levelt (1989: 26) proposes Wundt's Principle: *Each processing component will be triggered into activity by a minimal amount of its characteristic input.* (Input/output is characteristic if a process can operate on the information, e.g. a phonological process cannot use syntactic information.) I propose the following extension: *Each processing component will be triggered into activity by a minimal amount of its characteristic input and produces characteristic output as soon as a minimal amount of output is available.* (Guhe 2003: 82) This extension is in contrast to other principles put forward in the literature. For example, it contradicts principles that reason about the 'when-to-say'. In the context of a language production system that generates self-repairs Kilger & Finkler (1995: 9), for example, state: 'In order to both fulfill the time constraints and avoid overt repair incremental output production should be used to utter succeeding parts of the sentence [i.e. after the initial output increment] as soon as necessary [...] rather than uttering them as soon as possible.' This means, for improving the quality of the output and for reducing the number of self-repairs the output is not generated immediately but only after a component-internal quality assessment. Levelt's original formulation affords both possibilities.

With respect to computational complexity this difference is important. Extended Wundt's Principle has the advantage that processing is fast and requires few resources, e.g., no resources are spent on reasoning about 'when-to-say'. There is various empirical support for the principle. For example, Bock et al. (2003) show in an eye-tracking study that the content to be verbalised is selected early and the utterance then follows the established pattern. Repp & Sommer (2003) show that in generating elliptical expressions, decisions about the generated constituents are made rapidly. INC (the *incremental conceptualiser*, Guhe 2003) is a model of the first component in Levelt's (1989) language production model that operates according to the proposed processing mechanisms. INC generates preverbal messages (semantic structures) for observed motion events. Comparing INC's output with recorded verbalisations of the same scenes supports the cognitive adequacy of Extended Wundt's Principle.

Although Extended Wundt's Principle accounts for fast output by basing the output on partial information, early-generated outputs must often be changed in light of subsequent inputs. Furthermore, some of these changes cannot be avoided principally, cf. Guhe & Schilder 2002. I propose two mechanisms to alleviate this problem:

- (9) specialised *increment buffers* that temporarily store results of incremental processes (increments) so that the writing process can still access these increments and is able to change them
- (10) *indirect feedback*, which is feedback that is not realised as direct transmission of information from a process to a preceding one in the cascade, but the process giving feedback alters a memory that it shares with the process receiving feedback. Such a shared memory can be one of the specialised buffers or a general memory structure like working memory. A modification of the later process affecting operations of the earlier process is indirect feedback. Indirect feedback has the advantage that the earlier process does not need to evaluate the feedback explicitly. This means, no resources are spent on processing the information that would be given by a direct feedback. Processing indirect feedback is simply part of the standard way of processing the information present in a shared memory.

Both mechanisms preserve the strict unidirectionality of the information flow, which is desirable, because mechanisms like direct feedback or revision-based processing are more costly in terms of resources.

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### The relationship between perception and production in L2 categories.

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The aim of the present study is to explore the relationship between the ability to perceive L2 phonological contrasts and the ability to produce them. There are just few studies (see Flege 1995 or Flege, MacKay and Meador 1999 among others) that have addressed this issue and the results have not shown a reliable pattern. More precisely, we assess whether there is a correlation between the mastery in perceiving a L2 vocalic contrast and the mastery in producing it properly. To this end we compare the performance of two groups of participants that vary on the degree with which they master one specific contrast of the vocalic Catalan system /e-ɛ/. The first group of participants had Catalan (n= 20) as their first language while the other had Spanish as their L1 and Catalan as their L2. To assess their ability to perceive the contrast /e-ɛ/ three different tasks were administered to all participants: categorization (Pallier et al., 1997) , gating task (Sebastián-Gallés and Soto-Faraco, 1999) and lexical decision tasks (Sebastián-Gallés and Bosch, 2003). In order to maximize the variability, the group of participants that had Spanish as L1 and Catalan as L2, was split in two according to their performance in the above-mentioned perception tasks (e.g. Good Perceivers (n= 17); Poor Perceivers (n= 20)). These two samples of Spanish dominant speakers plus that of the Catalan native speakers were asked to perform a picture naming task in Catalan with 16 picture names contained the vowels /ɛ/ and 17 contained the /e/.

The picture naming performance was digitized and two Catalan phoneticians evaluate the extent to which each word was pronounced with the correct Catalan pronunciation. An overall "pronunciation accuracy score" (PAS), was calculated for each participant and for both vowels by averaging the PAS given to each word (0: strong foreign accent; 5: Perfect Catalan pronunciation). No differences were found for the /e/ vowel between groups. With regard to the /ɛ/ vowel, native speakers of Catalan had a close to perfect PAS (4.9). More interesting is the PAS for the two groups of Spanish dominant speakers. For the Good Perceivers group, the accuracy score (4.2) was higher ( $p < 0.001$ ) than for the Poor Perceivers (3.1). The correlation between the production and the 3 perception tasks was significant. The correlation increased according to the difficulty of the perceptual tasks:  $r = 0.513$  for the categorization task,  $r = 0.618$  for the gating task and  $r = 0.635$  for the lexical decision task, all the correlations were statistically significant ( $p < 0.001$ ). It seems that when very restrictive criteria for perception tasks are applied, a very clear relationship between perception and production can be established.

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## Plausibility and Recovery from Garden Paths in Second Language Sentence Processing

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Second language learners have been found to be sensitive to subcategorisation and thematic information in L2 ambiguity resolution (e.g., Frenck-Mestre & Pynte, 1997; Felser, et al., 2003), and to show garden path (GP) effects with local ambiguities (Juffs & Harrington, 1995, 1996). Little is known, however, about the role of plausibility information during L2 sentence processing, or how L2 learners recover from GPs on-line. We investigated these questions in a word-by-word self-paced reading study with 25 advanced Greek-speaking learners of English and 24 native speaker controls. Materials included complement [1] and adjunct clause [2] constructions containing temporary subject/object ambiguities. All experimental sentences were followed by a comprehension question. The initial verbs (read/play) were matched for subcategorisation preferences between Greek and English to control for potential L1 transfer effects, and the plausibility of the NP as a direct object (DO) was manipulated:

- |                        |  |       |
|------------------------|--|-------|
| (1) Complement Clause: | The man read the book (girl) had upset very many people.   |       |
| (2) Adjunct Clause:    |  | While |
|                        | the band played the song (beer) pleased all the customers. |       |

Contrary to the native speakers, the learners showed strong effects of plausibility for both sentence types. Implausible DOs took longer to read than plausible DOs in both [1] and [2], indicating processing difficulty when the initial analysis of the ambiguous NP as a DO led to an implausible semantic interpretation. This effect extended to the disambiguating segment following the post-verbal noun (e.g. had in [1], pleased in [2]).

For the sentences containing a complement clause, a delayed reanalysis effect was observed on the segment following the disambiguating auxiliary, which elicited shorter reading times in the implausible than in the plausible condition. This suggests that the learners recovered from the initial misanalysis more easily if the post-verbal NP was implausible as a direct object. For sentences containing pre-posed adjunct clauses, on the other hand, no effect of reanalysis was observed on any segment. Moreover, the learners were significantly less accurate in answering the comprehension questions in the plausible compared to the implausible condition. No such difference in accuracy was observed between the plausible and implausible complement clause items.

Taken together, our results suggest that (i) L2 learners are strongly influenced by plausibility during L2 sentence processing, and (ii) only in sentences containing a complement clause was GP recovery successfully achieved on-line. The observed asymmetry between the two sentence types is predicted by theoretical accounts which assume that the parser initially adopts a DO analysis, but reanalysis is less costly when the reinterpretation of the NP as subject does not require a change of clause (e.g., Gorrell, 1995).

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## Bilingual gaze patterns: attempted eye contact is associated with code switching

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This study looks at a very narrow slice of non verbal behavior, gaze, and seeks to find a pattern of gaze in bilingual speech production. Bilingual speech, which we define as speech by a speaker using, or capable of using 2 languages, is set apart from monolingual speech, at least, in its potential to include the phenomenon of code switching. Like Poplack (1980) we define code switching as "the alternation of two languages within a single discourse, sentence or constituent".

Kendon (1967) postulated some functions of gaze; regulatory, monitoring and cognitive. These functions apply to monolingual interactions but could they be applied to bilingual interactions?

Are there gaze patterns that can be detected in bilingual speech? Is there any specific gaze pattern associated with code switching? We predicted that there would be increased gaze on the part of the speaker accompanying a code switch.

In this study four dyads composed of English (L1) – French (L2) bilinguals participated in a cooperative communication task based on the Map Task of Brown, Anderson and Yule (1984). In this task an instruction giver directs a follower to draw a route through landmarks on a map. These landmarks are our target words. Landmark names are written in L1 on both maps. Participants are instructed to use L2 for the task. This maximizes the likelihood of code switching. Each dyad performs the task twice, alternating roles of instruction giver and follower.

Each target word was isolated and coded for code switching and visual contact on the part of the speaker. The proportion of visual contacts was calculated both to code switched target words and to non code switched target words for each of the eight participants when they were both instruction givers and instruction followers. Data for the eight participants was analyzed.

The data were analyzed using a two by two repeated measures analysis of variance (ANOVA) with two levels of Instruction Direction (i.e., giver vs. follower) and two levels of Code Switch Status (code switched vs. non code switched). Our main finding shows significantly more visual contacts for code switched target words (.465) than for non code switched target words (.269).

These results are consistent with our hypothesis that code switching is associated with increased eye contact in bilingual speech. Further research is necessary to determine the function of this bilingual gaze pattern.

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## A dual-task approach to investigating the connection between working memory (WM) and sentence comprehension

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The role of WM in language processing has long been of interest in cognitive psychology and psycholinguistics (e.g., Carpenter, Miyake, & Just, 1994; Gathercole & Baddeley, 1993). A number of studies have addressed the issue of whether individual differences in WM affect how readers process temporarily syntactically ambiguous sentences, with conflicting results (e.g., Caplan & Waters, 1999). The experiment to be presented approached the issue of WM and parsing differently, namely by employing a dual-task paradigm, to test if experimentally disrupting a part of WM affects sentence processing. It has been suggested that short-term phonological storage plays a role in comprehension, esp. of complex sentences. If this is the case, processing temporarily syntactically ambiguous sentences should be affected by a concurrent articulatory suppression task (AS) intended to interfere with short-term phonological storage. The present experiment tested this hypothesis with German subject- versus object-relative clauses. Previous research has established that subject-relatives are easier to read than object-relatives in English (e.g., King & Just, 1991; Müller, King, & Kutas, 1997), but see findings for Dutch by Mak, Vonk & Schriefers (2002). In English, the verb (the region for which the greatest effects occur) is at the end of the clause in object-relatives but not in subject-relatives, so the processing differences might reflect wrap-up processes rather than a preference for subject-relatives. However, the same preference has been found in German where this possible confound does not exist since the verb is at the end of the clause in both subject- and object relatives. The German sentences used in the experiment reported here differed only in the clause-final auxiliary which was marked for number, disambiguating the temporarily ambiguous clause as either a subject-relative clause, or an object-relative clause. During a word-by-word self-paced non-cumulative reading task, 48 participants silently read 24 critical items (plus 48 distractor sentences) while they carried out a concurrent task which was either Articulatory Suppression, or Tapping as a control task. The results showed that reading was slower under AS than tapping, and that the difference in processing difficulty for subject- versus object-relative clauses was not affected by having to carry out AS. The results suggest that parsing is an automatic process that is not dependent on short-term phonological storage. Implications of this apparent contrast with findings from sentence comprehension performance in patients with short-term memory problems reported in the literature will be discussed.

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## Can audiovisual speech stimuli modulate the classically known 'language-related' ERP components?

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Language processing is not only restricted to written information or auditory tokens. One of the most frequent situations we are encountering in every day's life is the face-to-face conversation, involving the processing of both visual and auditory speech information. Visual speech information, i.e. speechreading, plays a key role in our subjective perception of auditory inputs and watching a speaker's lips while listening to speech in noisy environment enhances intelligibility (Sumbly & Pollack, 1954; Walden, Prosek, Montgomery, Scherr, & Jones, 1977). However, some discrepant audiovisual (AV) speech dubbing can give rise to confusing or illusory percepts, even in situations with perfectly audible acoustic signals (Dodd, 1977; McGurk & MacDonald, 1976).

The cerebral processes involved in the fusion of bimodal speech information are far from being clearly known, and many studies took advantage of the excellent temporal resolution of electrophysiological techniques to pinpoint the early psychological and neural events underlying AV speech processing, notably by contrasting conditions of congruent and non-congruent dubbing; (Callan, Callan, Kroos, & Vatikiotis-Bateson, 2001; Klucharev, Möttönen, & Sams, 2003; Lebib, Papo, de Bode, & Baudonniere, 2003; Möttönen, Krause, Tiippana, & Sams, 2002; Sams et al., 1991). Yet, the processing of AV speech information should also involve many levels of highly complex analysis (phonological, semantic, etc.), distributed over time, and rapidly integrated for a coherent comprehension. The question arises, then, whether AV speech inputs can modulate electrophysiological brain responses (ERPs) known to reflect 'late' (i.e. endogenous) cerebral processes.

In a series of 3 experiments, we examined the modulation of late ERPs components to congruent and non-congruent AV speech stimuli; non-congruent dubbing either generated AV speech illusions (i.e. the McGurk effect) or not.

The electrophysiological results indicated that stimuli categorized as incongruent AV percepts by the subjects were associated with the presence of a N400-like response, whose amplitude was modulated by the 'degree of discrepancy' between the visual and the auditory speech inputs. This first result bring further support to the assumption for the existence of a cerebral system underlying 'semantic processing' *latu sensu*.

For the incongruent dubbing generating AV speech illusions, electrophysiological responses displayed a modulation in amplitude for a late positive component, the P600, as compared to those elicited by congruent audiovisual speech stimuli sharing the same auditory information. This result is in accordance with recent findings showing that the P600 reflects cerebral *repair* and *reanalysis* processes (Friederici, 1995; Friederici, 2002). Moreover, the result indicates that this brain response could occur in the absence of the subject's awareness, suggesting that the detection of the non-coherence between the bimodal speech inputs for those illusory stimuli results from a non-conscious process.

In addition to the theoretical implications these results suggest, they should open new perspectives for future psycholinguistic studies.

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## Perception Influences Production and Vice Versa: Evidence for Connecting Links between the Two Modalities

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In our work we examined the interplay between speech production and comprehension. In particular we investigated the influence of ongoing processing in the one domain on simultaneous performance of a task in the other domain.

In a first study, we looked at the influence of speech comprehension on the word form encoding levels of speech production. In a picture-word interference study participants performed the respective tasks while hearing phonologically either begin- or end related or unrelated distractors presented at three different SOAs (-150, 0 & +150 msec. after picture onset). To control for effects arising at higher levels of processing we included control tasks for the semantic level (animacy classification) as well as for the syntactic level (grammatical gender classification). Whereas there were no effects on the semantic and syntactic classifications, facilitation was found on picture naming for the begin- and end related condition at different SOAs. These results support the existence of a sublexical form route and a lexical form route from the comprehension to the production system. The sublexical route is assumed to cause facilitation by preactivation of the segments while the lexical form route is assumed to cause cohort competition for selection in the presence of a begin related distractor.

The second study examined the influence of ongoing speech production on a sublexical comprehension task. For that we modified the external standard phoneme monitoring paradigm in a way that picture primes were presented followed by the auditorily presented word in which participants had to monitor for the target phoneme. In one condition the picture names also contained the target phoneme while in the other condition this was not the case. SOAs were chosen on the basis of their being before and after the estimated availability of phonological information in the production system (+300 & +600 msec. after picture onset). To make sure that participants actually encoded the picture names, on some trials (indicated by hearing a beep instead of a word) participants had to perform a task on the picture (internal monitoring or picture naming). There was no effect at the early SOA but a large facilitation effect for the condition in which the picture name contained the target phoneme at the late SOA. This supports the assumption of a sublexical route from production to comprehension, causing a preactivation of the respective segments.

## Pauses as indicators of sentence planning revisited

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This study explores the planning of syntactic structures through clause embeddings in spontaneous speech. Syntactic properties and temporal data are examined. The psycholinguistic literature from the seventies established correlations between pause time and unrefined linguistic units without taking into account syntactic properties such as the level of integration (e.g. Hawkins 1971, Goldman-Eisler 1972...). We revisit this field exploiting more accurate syntactic criteria and instrumental tools.

Twenty French speaking adults involved in a narrative and in an expository task were recorded<sup>1</sup>. The signal was digitalized and silences exceeding 250 ms were identified as pauses. Filled pauses were also collected. Each pause was coded according to its position: matrix clause initial, before or after the grammatical delimitator of the embedded clause. Pauses are assumed to correspond at least partially to planning activity.

Concerning syntactic properties, we especially selected factors likely to be interpreted in terms of processing cost. Each type of clause embedding (noun clause, adverbial clause, relative clause ...) is characterized in terms of 3 main criteria:

[A] The degree of syntactic embedding: Subcategorization (1), Modification (2), and Pseudo-embedding (3). Since they are selected by the lexical properties of the matrix verb, subcategorized clauses are predicted to give rise to less planning time.

- (1) Je pense que c'est un problème
- (2) Le problème dont je parle est réel
- (3) il doit pleuvoir puisque tout le monde a un parapluie

[B] The depth of embedding (up to 7 degrees in our data) which is expected to correlate with planning.

[C] The location of the embedded clause which can be left-branched, center-embedded or right-branched. The latter is assumed to be easier to process (Yngve 1960), and hence needs less time to be processed. By contrast, center-embedding is difficult to parse (Frazier 1985, King & Just 1991, Gibson 1998, Hsiao & Gibson 2003...)

[A] The degree of syntactic embedding shows no significant effect for matrix initial pauses (presence and duration), while embedded clause initial position is significantly more often filled with a pause in pseudo-embedding ( $F(1,434)= 21,61$  ;  $p<.0001$ ) and pauses are significantly longer ( $F(1,434)= 17,1$  ;  $p<.0001$ ).

[B] Sentence initial pauses are longer for sentences including one or two degrees ( $F(2,611)= 6,868$  ;  $p<.0001$ ), as opposed to deeper embeddings leading to more local embedded clause initial planning ( $F(2,611)= 10,303$  ;  $p<.0001$ ).

[C] Sentence initial pauses reveal no significant effect while center-embedded clause initial position is more often filled with a pause ( $F(3,214)=8,654$ ,  $p<.0001$ ) and more interestingly, the pause is longer ( $F(3,214)= 5,462$ ,  $p=.0012$ ).

In sum, contrary to previous findings, provided refined syntactic criteria are used, it is possible to establish a correspondence between pauses and syntactic structures, and more generally, between language product and its process.

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<sup>1</sup> Funding for this research was made available from the Spencer Foundation (Chicago, Illinois, USA), "Developing literacy across Genres, Modalities and Languages", Ruth Berman, Principal Investigator.

## Early grammatical category effects during lexical processing for syntactic construction

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We will discuss results from several related investigations of lexical access in language production that focus on syntactic classes and their interaction with the generation of sentence structures. Earlier work by Pechmann and Zerbst (2002) reported grammatical category effects in naming performance in a picture-word interference task. Grammatical category information was not activated when subjects produced bare noun descriptions of simple objects. But, a robust effect appeared when the response procedures required speakers to produce target words embedded in syntactic frames. Follow-up experiments explored this effect using parallel tests conducted in German and in English (Pechmann, Garrett, & Zerbst, in press). We demonstrated first that compilation of a simple NP would yield grammatical class effects in picture word interference experiments, and further, that these effects appear in the same time frame as that generally observed for semantic processing. A significant feature of the comparison across languages is that the effects emerge in German and English with very similar activation profiles. On these grounds we can rule out the possibility that the syntactic effects first reported by Pechmann and Zerbst actually depended on syntactic gender activation rather than major categorial constraints. Grammatical gender constraints are lacking in the English language version of the experiments. More generally, these major grammatical category effects are distinguishable from any lexical semantic values of distractors used (as indicated by the lack of interference in the bare noun version of the tests). This affirms the need to distinguish any general semantic correlates of grammatical category from processes triggered by the integration of lexical content in phrasal environments.

Two further observations concern the time course of processing. The results showed activation of syntactic information in the same time frame as that normally observed for semantic distractors. Additional work by Pechmann & Zerbst (in press) directly compares semantic, syntactic, and phonological distractors and confirms an early emergence of syntactic constraints. The three distractor types were tested in two coordinated experiments at several successive time frames. In both experiments, syntactic activation preceded semantic activation. Semantic and syntactic activation were subsequently contemporaneous and continued to be significant at probe points for which significant phonological activation appeared. This was followed by the fading out of syntactic and semantic activation prior to full phonological activation. The appearance of syntactic interference at a point prior to semantic interference may reflect either a task specific maintenance of the syntactic frame used across successive stimulus presentations, or it may reflect very early conceptually driven grammatical encoding steps. The pattern overall suggests a significant degree of concurrence in the elaboration of the three processing types. Research in progress extends these findings to other grammatical category contrasts (e.g., verb distractors).

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## Intrinsic and Extrinsic Influences on Disfluency Production

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Natural spoken language is full of disfluency. Brennan and Schober (2001) estimate that about 10% of utterances contain repetitions, false starts, hesitations, filler terms (uh, um) and other disfluencies. This poses two interesting problems for research into natural language production: why are disfluencies produced, and what factors influence the production of different types of disfluency?

Answers to these questions have largely relied on corpus-based analyses (e.g., Clark & Fox Tree, 2002); in the research literature to date there has been a lack of experimental work to directly examine the factors that underlie natural disfluency production. In this paper we present two controlled experiments designed to elicit naturalistic speech and to determine the circumstances in which disfluencies are produced. Both experiments were based on the network task (Oomen & Postma, 2002), in which participants describe the route taken by a marker through a visually presented network of objects. In experiment one, we manipulated the intrinsic properties of objects to be described (i.e., those properties internal to the language system) by means of lexical frequency; in experiment two, linguistic properties of objects were kept constant and their extrinsic (i.e., non-linguistic) accessibility was manipulated via visual blurring.

In each case, participants named 18 "accessible" and 18 "inaccessible" objects in the course of describing the routes through six networks of eight objects each. Descriptions were recorded and later examined for occurrences of disfluency immediately prior to the target object names.

The results of Experiment 1, in which intrinsic accessibility was varied, clearly demonstrate an increase in overall disfluency (8.83% vs. 1.97% of object mentions) in cases where the objects named were low frequency. Moreover, the six disfluency types identified exhibited different distribution patterns between low- and high-frequency items (with "the" pronounced "thee" and "uh" showing the largest differences). Experiment 2 is currently underway.

A comparison of disfluency types and rates where accessibility is manipulated intrinsically and extrinsically will allow us to begin to determine precisely the circumstances under which disfluencies occur in natural speech.

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## Effect of pitch and timbre relations in the processing of unattended speech

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This study addresses the question of speech processing under unattended conditions. Dupoux et al. (2003) have recently claimed that unattended words are not lexically processed. The authors asked participants to perform a lexical decision task on a target word which was presented to the right ear. At the same time, they presented a repetition of the word (a prime) in the left ear which was embedded in a sentence and temporally compressed in order to avoid attentional switches toward the unattended message. The priming effect was used as cue of the unattended message processing. They found no priming effect and concluded that unattended messages are not lexically processed. We test their conclusions with a different paradigm in which we tried to control attentional switches without degrading the prime and using different voices in the two messages.

Participants had to detect a target word belonging to a specific category presented in a rapid list of words, in the attended ear. In the unattended ear, concatenated sentences were presented, some containing a repetition prime presented just before the target word (the end of the prime was synchronised to the start of the target). In Experiment 1, we used different pitch voice for the attended and unattended messages. We found a significant priming effect of 22ms (Experiment 1), for category detection in the presence of a repetition prime compared with an unrelated prime. This priming effect was not affected by whether the right or the left ear received the prime (Experiment 2a and 2b). The purpose of Experiment 3 was to see if priming could still be obtained when attention was more explicitly controlled. We wanted to be sure that participants' attention was not directed to the prime. We used the same procedure as in Experiment 1 except that we asked participants to perform a second task. As before, they had to detect the target in the attended message but they also had to remember a word in the attended message during each trial which was presented just before the target word (in the same time as the prime). The word that they had to remember was marked by a loud and low pitch tone presented in the attended ear. We found a significant priming effect of 24ms. In Experiment 4, we found that the priming effect was affected by the pitch range difference between the attended and unattended messages: we found a priming effect of 32ms when the pitch range was different (attended message  $f_0 = 140\text{Hz}$  or  $180\text{Hz}$ ; unattended message  $f_0 = 180\text{Hz}$  or  $140\text{Hz}$ ) but not when the pitch range was the same. In Experiment 5, we investigated the effect of the timbre difference (vocal tract) on the priming. We found a priming effect of 24ms when the timbre was different even if the pitch range was the same. Finally in Experiment 6, we tested the effect of a third message on the unattended message processing. We added backward speech in the same ear as the attended message. The pitch range and the timbre were different for each message. We found a significant priming effect of 16ms, which was smaller than in the original condition.

This research shows that unattended message processing is possible (Experiments 1 and 2) and does not need attentional resources (Experiment 3). This result is not consistent with Dupoux et al. (2003) conclusion. This discrepancy of results may be due to the degradation of the prime used by the authors and the use of same pitch for the attended and unattended messages. We suggest that unattended messages can be processed at least at a phonological level (the target and prime were acoustically very different). This processing might occur at a lexical level because in Dupoux et al. (2003), no priming effect was found with non words, which are not related to any lexical representation. This processing depends on the pitch (Experiment 4) and timbre (Experiment 5) difference between attended and unattended messages but does not require a silent environment (Experiment 6). This can be explain by the ability of the auditory system to perceptually organise each incoming sounds. Which part of the signal is from the attended message and which from the unattended message is less distinct when they have the same pitch and the same timbre. Our results are consistent with past studies showing that pitch and timbre are useful grouping cues which improve the ability to track a sound source over time and to organise speech sounds (Darwin & Hukin, 2000a; 2000b).

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## First Words and Small Worlds: Flexibility and proximity in normal development

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If work in psychology has clearly brought to light conceptual flexibility in the categorisation of objects, which led to a re-questioning of the traditional conception of categorisation which considers rigid and discontinuous categories, it is not yet really the case in linguistics and psycholinguistics. We defend the idea of semantic flexibility which constitutes a linguistic counterpart to psychologists' advances on categorisation (Clark, 1993, 2003; Tomasello, 2003). Currently, the metaphor which consists in bringing closer distinct entities by substituting one for the other, is still considered primarily as a linguistic deviance while at the same time it could be the linguistic guarantee of the relevance of the categorial flexibility phenomenon brought to light by psychologists (Le Ny, 1979; Barsalou, 1989; Hofstadter, 1995) linguists and philosophers (Wittgenstein, 1953; Lakoff & Johnson, 1980; Bianci 2001). Our objective is to bring to light an analogical categorisation of verbs which determine metaphor production. For this purpose, we restrict our study of the verb lexicon, a field still under-exploited (Bernicot, 1981; Tomasello 1992, Tomasello & Merriman, 1995, Bassano, 2000) and adopt a linguistic and psycholinguistic approach of 'metaphoric' verbal utterances produced by adults and young children. Our objective is to validate a categorization of the verbal lexicon by semantic proximity and to propose an associative computational model of it.

In order to underline that flexibility constitutes an "ergonomic cognitive principle" implemented from the beginning of the acquisition of verbs (Gentner, 1981; Gentner & Boroditsky 2001; Duvignau, 2002, 2003, Duvignau & al., 2004) and in language dictionaries' lexicon structures, we compare verbal "semantic approximations" of 2 to 3.5-year-old children:

- (1) I undress the orange
- (2) It is broken the book

and a semantic inter-verb proximity which can be found, though implicitly, in the definition networks of language dictionaries. The computational model that we develop establishes similarity between verbs (Watts & Strogatz, 1998; Love, 2000; Resnik & Diab, 2000) by considering their respective 'global' positions in a graph of dictionary which is a 'small world' (Gaume & al. 2002; Gaume, 2003, 2004).

Our approaches to the verbal lexicon highlights a categorization of verbs by semantic proximity both in children's and adults metaphoric productions. It suggests allotting the status of lexical relation to the verbal metaphor as 'semantic proximity interdomains' and underlining the fact that "To say what a thing is, is to say what it is like". According to us, the study of this semantic flexibility could be also crucial for the study of pathological development -Asperger syndrom.

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## Distributional information and word frequency effects in grammaticality judgements

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As well as binary grammatical/ungrammatical judgements, native speakers' make fine-grained, lexically-driven distinctions between the acceptability or 'naturalness' of novel phrases that models of language processing should be able to account for. Most native speakers of British English will judge (a) as more natural-sounding than (b) in the following examples:

- (1a) High winds and strong currents made navigation difficult  
 (1b) Strong winds and high currents made navigation difficult

- (2a) The conference was hosted by the university  
 (2b) I was hosted by my cousin

Gradient acceptability obtains even when phrases are novel. The graded perception by native speakers has recently been explained in terms of constraint violation (e.g. Sorace and Keller, in press). However, the acquisition of constraints has not been adequately explained. Statistical models linking acceptability judgments to linguistic experience offer a theoretical solution. Two classes of models are compared: simplicity-driven learning (e.g. Chater, 1999; Onnis, Roberts & Chater, 2002; Roberts, Onnis & Chater, in press) and distance weighted averaging algorithms (e.g. Lapata et al, 2001; Lee, 1999).

Distance weighted averaging models use distributional information (e.g. collocative statistics): inferences about words in novel contexts are based on the occurrence of similar words in those contexts. Simplicity driven learning uses word frequency to decrease the acceptability of non-occurring phrases comprised of very frequent words. Word frequency is widely implicated in the processing of individual words; there is some evidence that it is also implicated in processing combinations of words (Alario et al, 2002; Theakston, 2004). We compared these models using a forced choice task. Model predictions were computed for 1,000,000 adjective-noun pairs. Participants were asked to judge which of two novel phrases, differing only in terms of an adjective-noun pair, was a more natural sentence of English. We found that a) strongly distributionally predicted phrases were preferred to weakly distributionally predicted phrases, b) this effect disappeared when the frequency of component words was controlled for, and c) when distributional effects were controlled for, participants preferred phrases comprised of less frequent words. These results are at first glance contradictory: they appear to indicate that word frequency is responsible for the (positive) effects of distributional information, but that word frequency itself operates in the opposite direction. We suggest that an inverted U-shaped effect of word frequency may explain these effects: novel phrases increase in acceptability as the frequency of the component words increases. However, after some inflection point is reached, learners begin to suspect that they are constrained not to cooccur and acceptability declines. In this way constraint learning is therefore a direct result of linguistic experience.

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## Psycholinguistic and Corpus Investigations of Verbal Event Structures

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Lexical semantic representations for verbs of three classes are investigated: manner of motion (MOM) verbs (e.g., "run"), inherently directed motion verbs (e.g., "arrive"), and appearance verbs. The representations are assumed to be predicate decompositions, specifically event structures (e.g., Rappaport-Hovav & Levin, 1998) that express syntactically relevant meaning. The event structure for MOM verbs, x(ACT), shows one entity engaging in an activity. Arrive and appear verbs' structures show an entity changing from one location to another: x(BECOME IN LOCATION).

The event structures for arrive and appear verbs are more complex than the structure for MOM verbs because their structures include a location and a change to that location by the entity engaging in the verbal event, whereas the structure of MOM verbs includes neither. This differential complexity was demonstrated empirically in three ways: compared to arrive and appear verbs, lexical access is significantly faster for MOM verbs, as shown by lexical decision response times; short-term memory is significantly better for MOM verbs, as shown by response times for yes/no recognition; and sentence comprehension is significantly faster for MOM verbs, as shown by sentence reading times.

The simpler event structure of MOM verbs results in shorter sentence comprehension times only with sentences that do not express a change of location (e.g., 1 and 2 below). With sentences that do express a change of location (e.g., 3 and 4 below), the information conveyed about the MOM event becomes as complex as the information conveyed by the appear and arrive verbs' structures. Accordingly, reading times for MOM sentences slow relative to arrive and appear sentences such that they are no longer significantly shorter, as shown by mean reading times:

- 1) MOM verb: The students traveled by bus. 1942 ms
- 2) arrive verb: The students arrived by bus. 2161 ms
- 3) MOM verb: The students traveled to Italy. 1952 ms
- 4) arrive verb: The students arrived in Italy. 1984 ms

For all the experiments, the verbs of the different classes and the sentences using them were matched on possible confounding variables such as length, imageability, the verbs' and the other words of the sentences' frequencies of usage in English, the sentences' plausibility ratings, etc.

The experimental results in themselves and in convergence with the results of corpus studies of naturally produced sentences give strong support to event structure lexical representations, and in so doing, endorse psycholinguistic and corpus data as incisive evidence with which to build linguistic theory.

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## Comprehenders Use Event Structure to Develop Discourse-Level Representations

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Current views of event structure (in particular, telicity) assume either that it is lexically encoded (Levin & Hovav-Rapaport, 1995; Hale & Keyser, 1993) or that it is compositional (Folli, 2001; Borer, 1994). Theories of comprehension have adopted one or the other of these views: O'Bryan et al. (2004) emphasize lexical encoding of telicity (see also McDonald et al., 1994), while McElree and others (McElree et al., 2001; Traxler et al., 2002; Pinango et al., 1999) have investigated the compositional properties of telicity and the structural coercion of meaning.

We present evidence from a variety of sources that telicity is not a fixed lexical property of verbs but rather a compositional property that is represented at the level of the sentence (or discourse). Four kinds of evidence support this view:

1. Corpus evidence shows that the telicity value of a verb or predicate is easily modified ("coerced") by the discourse context and hence that telicity is not an inalienable property of a verb or predicate.
2. Linguistic evidence shows that few, if any, verbs are exclusively telic or atelic. This evidence includes judgments (N=55) on the acceptability of verbs with phrases such as in an hour vs. for an hour, showing that verbs that seem to be telic based on their semantics do not differ in preferences for these phrases, though "atelic" verbs prefer for-phrases (cf., Vendler, 1957; Dowty, 1979; Tenny, 1994).
2. Evidence from self paced reading experiments shows that verb subcategorization affects processing of garden path sentences but verb telicity does not. Two experiments with reduced relative garden path sentences varied preposition, object specificity, subcategorization, and acceptability with in/for-phrases, and included initial verbs traditionally classified as telic or atelic that were matched for frequency and plausibility. Subcategorization had immediate effects, but under no condition was the garden path smaller for telic than for atelic verbs, nor did telicity and object specificity interact.
3. Evidence from probe recognition experiments shows that telicity plays a role at the level of discourse representation. Two experiments varied acceptability of in/for-phrases, subcategorization, object specificity, perfectivity, and target position. Verb telicity influenced probe recognition times and errors (cf. Magliano & Schleich, 2000), particularly when the direct object was specific (a suitcase vs. suitcases).

The conclusion that telicity is primarily a compositional rather than a lexical property is in accord with recent studies in theoretical linguistics, e.g. Borer (1994) and Folli (2001).

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## Competition during the processing of relative quantifier scope

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Much sentence-processing research has concentrated on parsing; often focusing on whether alternative analyses of an ambiguity are selected through a process of competition or principled structural analysis. We investigated sentence *interpretation*, by examining the processing of relative quantifier scope. Quantifiers (e.g. 'each', 'every', 'a') indicate how many entities should be represented in a reader's discourse representation. Sentences containing two or more quantifiers can be ambiguous (e.g., 1 can involve one or many interviews).

- (1) The celebrity gave an interview to every reporter.

To interpret (1) unambiguously, readers must establish relative quantifier scope, with one quantifier taking wide scope over the other thereby determining how many entities or events are to be represented. In considering factors that influence this process, two theoretical positions emerge:

*A competition-based account:* loup (1975) proposed a quantifier hierarchy, ranking their tendency to take wide scope (e.g., 'each' and 'every' are more likely than 'a' to take wide scope), and a grammatical hierarchy ranking the tendency for NPs to take wide scope (e.g., indirect objects are more likely than direct objects to take wide scope). Following Kurtzman and MacDonald (1993) processing difficulty should occur when the hierarchies impose conflicting demands.

*A reanalysis-based account:* Fodor (1982) claimed that quantifier characteristics interact with the linear order in which quantifiers occur in a sentence. In (1), linear order stipulates that 'an' takes wide scope (as it appears first), but quantifier characteristics require that 'every' takes wide scope. Therefore readers might instantiate a single interview at 'an', but reanalyze to include multiple interviews on encountering 'every', incurring a processing cost.

We report two eye-tracking experiments comparing dative (e.g., 2 & 3) and double object (e.g., 4 & 5) sentences.

- (2) The celebrity gave<sub>1</sub> /an in-depth interview to every reporter from the newspaper, but<sub>2</sub>/ [the interview(s) was/were]<sub>3</sub>/ not very<sub>4</sub>/ interesting.<sub>5</sub>  
 (3) The celebrity gave<sub>1</sub> /every in-depth interview to a reporter from the newspaper, but<sub>2</sub>/ [the reporter(s) was/were]<sub>3</sub>/ not very<sub>4</sub>/ interested.<sub>5</sub>  
 (4) The celebrity gave<sub>1</sub> /a reporter from the newspaper every in-depth interview, but<sub>2</sub>/ [the reporter(s) was/were]<sub>3</sub>/ not very<sub>4</sub>/ interested.<sub>5</sub>  
 (5) The celebrity gave<sub>1</sub> /every reporter from the newspaper an in-depth interview, but<sub>2</sub>/ [the interview(s) was/were]<sub>3</sub>/ not very<sub>4</sub>/ interesting.<sub>5</sub>

Experiment 1 manipulated quantifier order ('a' or 'every' first), grammatical order (indirect or direct object first) and whether NP-anaphor continuations (e.g., 'the interview was/the interviews were') were singular or plural. Experiment 2 substituted 'each' for 'every', as it is claimed to have stronger scope-taking properties (e.g., loup, 1975; Beghelli & Stowell, 1997).

Scope processing effects at the ambiguity (Region 2) were consistent with a competition-based account: first pass and total reading times were elevated when loup's hierarchies imposed conflicting demands. Other total time effects were consistent with Fodor's account, with longer reading times when 'a' was first. Whereas Fodor attributed this effect to reanalysis, we argue that it is consistent with competition between linear order and quantifier characteristics. Differences between 'each' and 'every' did not modulate these effects. A preference for singular NP-anaphor continuations at Region 3 was unaffected by other factors. We conclude that relative quantifier scope is computed on-line through competition between alternative analyses, but may not be a prerequisite for NP-anaphor resolution.

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## Syntactic Priming in Comprehension

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A common intuition suggests that people have less difficulty processing sentences like (1) if they have recently processed similar sentences, but little hard evidence supports this intuition.

(1) The defendant examined by the lawyer turned out to be unreliable.

In fact, there is little general evidence for any effects of grammatical repetition on comprehension. Thus, we conducted four eye-movement monitoring experiments in which participants read prime-target sentence pairs that maintained or changed grammatical form. In the first, sentences like (1a) and (1b) would be followed by either (2a) or (2b)

(1a) The defendant/ examined/ by the lawyer/ turned out to be unreliable. (Reduced)

(1b) The defendant/ examined/ the bloody glove/ during the recess. (Main Verb)

(2a) The doctor/ examined/ by the specialist/ had a large mole. (Reduced)

(2b) The doctor/ examined/ the patient/ who had a large mole. (Main Verb)

"/" marks indicate where the sentences were segmented for analysis. The first region is the "verb" region, the second region is the "NP/PP" region. Sentences were rotated across lists to counterbalance for length and frequency, and so that every target sentence also served as a prime sentence. In Experiment 2, the initial verb/past participle changed between the prime and target sentence; but otherwise the design was the same. In Experiment 3, full relative and reduced relative primes were compared, with the verb/past participle remaining the same across prime and target. In experiment 4, reduced relative, full relative, and passive primes were compared (as in *The patient was examined by the doctor who drove a red car*).

Experiment 1 showed that potentially ambiguous reduced-relative sentences were processed more easily if they were immediately preceded by another sentence of the same form using the same ambiguous verb (see Table 1). Experiment 2 showed no comparable effects when the sentence form was repeated but the verb was not (See Table 2). In the third experiment, full relatives primed reduced relative targets as much as reduced relatives did. In the fourth experiment, reduced relatives were more effective as primes of reduced relatives than were passives, which produced little or no priming.

The four experiments suggest the following:

1. Verb-specificity effects suggest that grammatical information is largely localized to individual verbs during comprehension.
2. Equivalent priming for full and reduced relatives show that verbatim repetition and/or recovery from misanalysis during processing of the prime are not necessary.
3. Lack of priming from the passive construction suggests that repetition of the prepositional phrase is not sufficient for priming to occur (or at least is less effective than repetition of the entire relative-clause structure).

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