



Twenty-Fifth Annual CUNY Conference on Human Sentence Processing

March 14–16, 2012
CUNY Graduate School and University Center
365 Fifth Avenue • New York, NY

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Splendid Abstracts Review Panel

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**The 26th Annual Conference on Human Sentence Processing
will be held at the University of South Carolina, Columbia SC
CUNY2013 dates: Thursday, March 21 – Saturday, March 23
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**Dianne Bradley, Eva Fernández, Janet Dean Fodor
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■

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Jerrold J. Katz Young Scholar Award

Named in memory of our friend and distinguished colleague, the Jerrold J. Katz Young Scholar Award recognizes the paper or poster presented at the Annual CUNY Conference on Human Sentence Processing that best exhibits the qualities of intellectual rigor, creativity, and independence of thought exemplified in Professor Katz's life and work. Any first author of a presentation, who is pre-doctoral or up to three years post-PhD and not yet tenured, is eligible for consideration. The amount of the award is \$500.

Previous Recipients

2011 RECIPIENT WILL BE ANNOUNCED AT THE CONFERENCE

Adriana Hanulíková (Max Planck Institute for Psycholinguistics) for her paper entitled "When grammatical errors do not matter: An ERP study on the effect of foreign-accent on syntactic processing," presented at the 23rd Annual CUNY Conference on Human Sentence Processing, New York NY, March 2010. Hanulíková's coauthors were Merel van Goch and Petra van Alphen

Adrian Staub (University of Massachusetts, Amherst) for his paper entitled "The timing of garden path effects on eye movements: Structural and lexical factors," presented at the 22nd Annual CUNY Conference on Human Sentence Processing, Davis CA, March 2009.

Gunnar Jacob (University of Dundee) for his paper entitled "An inter-lingual garden-path? L1 interference in L2 syntactic processing," presented at the 21st Annual CUNY Conference on Human Sentence Processing, Chapel Hill NC, March 2008. Jacob's coauthor was Roger P.G. van Gompel.

T. Florian Jaeger (University of Rochester) and Neal Snider (Stanford University), jointly, for their paper entitled "Implicit learning and syntactic persistence: Surprisal and cumulativity," presented at the 20th Annual CUNY Conference on Human Sentence Processing, La Jolla, CA, March 2007.

Scott Jackson (University of Arizona), for his paper entitled "Prosody and logical scope in English," presented at the 19th Annual CUNY Conference on Human Sentence Processing, New York, NY, March 2006.

Sachiko Aoshima (American University), for her paper entitled "The source of the bias for longer filler-gap dependencies in Japanese," presented at the 18th Annual CUNY Conference on Human Sentence Processing, Tucson, AZ, March–April 2005.

Andrew Nevins (Massachusetts Institute of Technology), for his paper entitled "Syntactic and semantic predictors of tense: An ERP investigation of Hindi," presented at the 17th Annual CUNY Conference on Human Sentence Processing, College Park, MD, March 2004. Nevins's coauthors were Colin Phillips and David Poeppel.

Britta Stolterfoht (Max Planck Institute of Cognitive Neuroscience), for her poster entitled "The difference between the processing of implicit prosody and focus structure during reading: Evidence from brain-related potentials," presented at the 16th Annual CUNY Conference on Human Sentence Processing, Cambridge, MA, March 2003. Stolterfoht's coauthors were Angela D. Friederici, Kai Alter, and Anita Steube.

John Hale (Johns Hopkins University), for his paper entitled "The information conveyed by words in sentences," presented at the 15th Annual CUNY Conference on Human Sentence Processing, New York, NY, March 2002.

Award Fund

To make a contribution to the Jerrold J. Katz Fund, please send a check made out to "CUNY Graduate Center (Sentence Processing Conference)" to the address shown below. It would be helpful if you were to write "Jerrold J. Katz Fund" in the memo line of the check.

Dianne Bradley (Katz Award Fund)
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Grammars and Parsers: Toward a Unified Theory of Language Knowledge and Use

The special session at this year's conference is supported by a grant from the National Science Foundation.

For 25 years the CUNY Conference series has focused on central issues in psycholinguistics, embracing a full range of empirical methodologies and theoretical perspectives in linguistics, psychology, computer science, and cognitive neuroscience. Responding to a remarkable acceleration of recent research developments in all of these contributing disciplines, the special session will showcase current models of how language knowledge and language processing interrelate. This fundamental question underpins all empirical and theoretical studies of sentence processing. Is it possible to embed a grammar, as devised by linguists, as a working component of a processing mechanism for language comprehension or production? Or is it a mistake even to suppose that 'linguistic' grammars might articulate with processing in such a fashion? To achieve a comprehensive understanding of how the human brain is capable of this most distinctively human activity, a sure sense is needed of the interplay between language knowledge and use. The special session also marks a broadening of the traditional focus of research on syntactic processing to include the processing of semantics (sentence meanings) and prosody (the melody and rhythm of spoken sentences).

Six invited speakers will address these topics and the special session will be rounded out with related presentations selected from submitted abstracts. Collectively, these presentations will both deepen and broaden the questions that will occupy the psycholinguistics community in coming years.

Lyn Frazier (University of Massachusetts, Amherst)

Mark Steedman (University of Edinburgh)

Ivan Sag (Stanford University)

Sandiway Fong (University of Arizona)

Cristiano Chesi (IUSS-Pavia & Università degli Studi di Siena)

Noam Chomsky (Massachusetts Institute of Technology)

Colin Phillips (University of Maryland, College Park)

The conference will welcome a new generation of young scientists into the international psycholinguistics community by supporting students' participation with reduced registration fees and travel support. Publication of a volume containing the contributions of the invited speakers and related submitted presentations will make the benefits of this special occasion available to a wider audience.



Program

9:00 a.m. – 8:30 p.m. ▪ Proshansky Auditorium

Registration desk open from 8:15 a.m., with light breakfast available

Session 1	9:00 a.m. to 11:00 a.m. chaired by Gita Martohardjono (CUNY Graduate Center)	
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Program for Thursday, March 15

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Registration desk open from 8:15 a.m., with light breakfast available

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9:00 a.m. – 6:30 p.m. ▪ Proshansky Auditorium

Registration desk open from 8:15 a.m., with light breakfast available

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Wednesday, March 14 Paper Abstracts

Two interpretive systems for natural language?

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The desiderata for a theory of language interpretation include at least the following: explaining how humans compute the meaning of novel sentences, including implausible ones; characterizing the incrementality of interpretation; accounting for how interpretation processes relate to conscious awareness; explaining the existence and nature of widespread context effects, characterizing the complexity profile of interpretation (e.g., why DE contexts are more complex than non-DE contexts) and accounting for semantic illusions. The field of psycholinguistics is making successful forays into various aspects of interpretation, e.g., semantic 'coercion,' compositionality, scalar meanings, focus and the role of alternatives, implicatures, presupposition, counterfactual contexts, and the rapid impact of various types of stereotypical knowledge, to give only a few examples. I will argue that we also need to recognize the existence of two distinct systems for pairing form and meaning. One is the familiar type-based system that operates whether a sentence has an interpretation that describes a plausible real world situation or an implausible one. The other is token-based and involves the interpretation of repaired utterances, producing plausible meanings only; it depends on details of particular utterances as well as an implicit knowledge of the performance systems. Understanding the 'performance pairing' of form and meaning removes the need for the grammar to explain certain puzzling linguistic facts, and it helps to explain certain semantic illusions.

Incremental and predictive discourse processing based on causal and concessive discourse markers: A visual world study

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Discourse processing; Negation processing; Eye-tracking; Visual world paradigm; German

While there is some evidence that (marked or unmarked) causal discourse relations are processed incrementally (Traxler et al. 1997; Kuperberg et al. 2011), the time-course of comprehending concessive discourse markers (e.g. nevertheless) has not yet been investigated. Given that concessives are often defined as negative causals (e.g. König & Siemund, 2000), the time-course of processing of concessives and negations may be similar. Interestingly, Ferguson et al. (2008) found that counterfactual negated discourse information is not used incrementally but has a delayed effect on comprehension.

We examined whether this is also true for concessive discourse markers by investigating the time-course of processing causal versus concessive discourse markers in German within a visual-world experiment. In particular, we examined the stepwise integration of information from discourse context (causal/concessive marker) and grammar (gender marking) for predicting a target referent. Participants were exposed to 60 trials (20 items, 40 fillers), each consisting of three spoken sentences and a static scene (Ex.1). The second sentence always identified a **category** (e.g. 'keyboard instruments'), matching two of the depicted objects (piano and organ). Two other objects in the scene belonged to another category (the counter category, wind instruments: saxophone and trumpet). The third sentence began either with a causal or a concessive **connector** (within-participant factor) and included the gender-marked **pre-target** noun region (ein reduziertes, 'a reduced'), preceding the target noun (causal: piano, concessive: saxophone). Target nouns were always congruent with the preceding discourse. All items and half of the fillers were followed by a comprehension question ('Does Tom think consider buying a keyboard instrument?'), which participants answered by button press (YES/NO).

Eye-movement data (N=32) reveals that when the **category** was uttered, participants inspected the two objects matching this category (piano and organ) more frequently than the other objects, independent of conditions. In the causal condition, these objects were still looked at most often when the **connector** was uttered; in the concessive condition, however, participants inspected the two objects of the counter category most often in this region (saxophone and trumpet). This reveals that the concessive marker was immediately interpreted. Note that the connector could not be interpreted before subject and verb were presented (kauft sie, 'she buys'), meaning that the region provided limited time for interpretation. Interestingly, in the **pre-target** region, there were significantly more looks to the target object (causal: piano, concessive: saxophone) than to any other object, in both conditions, revealing that information from both the connector and the gender marking was rapidly processed and used for predicting the target, also in the concessive condition. However, while response times in the comprehension questions did not differ across conditions, accuracy was significantly lower in the concessive condition (78%) than in the causal condition (84%; $\chi(5) = 11.17$; $p < .05$).

These results clearly reveal that both causal and concessive discourse markers were integrated rapidly into on-line comprehension and, together with gender marking, gave rise to the prediction of the target noun. The finding that accuracy of question answering was worse in the concessive than the causal condition additionally suggests that processing was rather shallow, causing a late cognitive burden for global interpretation. We suggest that the differences between our and Ferguson et al.'s (2008) results are due to the type of negations investigated.

(Ex.1) Frau Weber sucht ein Geschenk für ihren Mann. Er könnte neue [Winterkleidung gebrauchen.]_{category}
[Deswegen/Dennoch kauft sie voll überzeugt]_{connector} [einen hochwertigen]_{pre-target} Schal/Sonnenhut.
 'Mrs. Weber is looking for a present for her husband. He needs new [winter clothes.]_{category} **[Therefore/However,**
 she buys entirely convinced]_{connector} [a high-quality]_{pre-target} scarf/sun hat. '
 [depicted: scarf (Schal: masc.), warm hat (Mütze: fem.), sun hat (Sonnenhut: masc.), trunks (Badehose: fem.)]

Ferguson et al. (2008). Eye-movements and ERPs reveal the time course of processing negation and remitting counterfactual words. *Brain Research* 1236: 113-125.

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Presuppositions and projection in processing

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Presupposition projection; Semantic/pragmatic processing; Eye-tracking; Reading; Acceptability rating; German

Introduction. Presuppositions are a component of meaning displaying distinct behavior from asserted content. They are not affected, for example, by embedding under negation: *Tina danced again* and *Tina [didn't [dance again]]* both presuppose that Tina danced before, i.e., they can only be uttered felicitously in contexts that support this presupposition. While presuppositions and their projection behavior have been studied thoroughly in theoretical terms, little is known about their processing. Using eye-tracking in reading, we investigated two issues based on German *wieder* ('again'). First, we looked at the time course of presupposition processing by testing for processing costs of unsupported presuppositions. Secondly, we tested whether embedding *wieder* under negation affected this mis-match effect.

Methods. We used a 2x2 design with **Felicity** and **Firstword** (*wieder* vs. *nicht*) as factors, as illustrated below. Version (a) of the target (*wieder* in scope of negation) is felicitous in **C1**, but not **C2**, and vice versa for (b). 24 4-tuples consisting of two target versions and two contexts were created. 32 subjects, split into 4 groups, read 24 items with counterbalanced conditions, intermixed with 48 filler items, while being eye tracked. Based on similar self-paced reading experiments (Schwarz 2007), increases in reading time are expected for sentences in contexts that are inconsistent with the presupposition.

Results. Analyses focused on the reading times on the verb following {*wieder nicht*}, since the presupposition of *wieder* crucially relies on the verb of its clause. Standard reading measures were calculated for statistical analyses. Their means are presented in table 1. The primary result is an interaction between **Firstword** and **Felicity** on various reading measures: for (b) (unembedded *wieder*), reading times on the verb were significantly higher in the infelicitous condition. For a) (embedded *wieder*), there was no corresponding simple effect of **Felicity**.

Discussion. The results are important for our understanding of presupposition processing and also have theoretical implications. First, there is an ongoing theoretical debate about whether presuppositions are introduced semantically (e.g., Heim 1982, 1990) or pragmatically (Simons 2001, Schlenker 2009). Given parallel debates about scalar implicatures (Bott and Noveck 2004), pragmatic generation of presupposed content might be expected to give rise to processing delays. The immediate processing effect of unsupported presuppositions reflected in our results (in particular in the first fixation and regression proportion measures) thus is more consistent with a semantic account. Secondly, the interaction between **Firstword** and **Felicity**, together with the absence of simple effects for the *nicht wieder* conditions, suggests that the presupposition of *wieder* is not immediately available in processing when embedded under negation, presumably because of the additional complexity involved in presupposition projection. A follow-up rating study confirmed that that subjects indeed perceive a mismatch for the embedded context, which rules out an explanation based on a potential alternative local presupposition interpretation (where it *is* affected by negation). A processing delay for embedded presuppositions that project seems most consistent with theories that posit explicit operations on levels of representation in the computation of global interpretations (van der Sandt 1992).

C1: *Tina went ice skating for the first time last week with Karl. The weather was beautiful, and they had a great time.*

C2: *Tina wanted to go ice skating for the first time with Karl last week. But the weather was miserable and they gave up on their plan.*

Target: Dieses Wochenende war Tina {(a) nicht wieder / (b) wieder nicht}

This weekend, was Tina not again again not
Schlittschuhlaufen, weil das Wetter so schlecht war.
ice skating because the weather so bad was

Table 1: Selected Reading Measures	<i>wieder nicht</i>		<i>nicht wieder</i>	
	Fel	Infel	Fel	Infel
First Fixation (ms)	173	185	171	171
Go-Past (ms)	253	327	282	258
Reg. Prop. (%)	15.2	31.3	15.2	16.1

Sig. interactions: Go-past, total ($p < .01$), regression proportion ($p < .05$); marginal: first fixation, regression duration ($p < 0.1$) **Simple effects of Felicity** for *wieder nicht* conditions: Go-past, total time, first fixation, reg. duration ($p < .01$), reg. prop ($p < .001$)

Convergence of speech rate: Interactive alignment beyond representation

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Speech rate; Alignment; Dialogue; Corpus analysis; English

It has long been known that conversational partners tend to align on common ways of talking about the world, not only in choice of syntactic structures or referring expressions (Pickering & Garrod, 2004), but also in manner (Giles et al., 1991). Alignment in both of these areas has received considerable theoretical attention, however while accounts of the alignment of representations have considered the linguistic mechanisms responsible (for example Pickering and Garrod's, 2004, *Interactive Alignment account*), theories of the alignment of performative aspects of conversation, such as speech rate, have largely tended to limit their scope to motivational explanations (most notably in *Accommodation theory*; Giles & Powesland, 1975).

One exception to this trend has been Wilson and Wilson's (2005) oscillator model of turn-taking. In order to explain high coordination in turn-taking (in particular the very short intervals between turns) they propose that endogenous oscillators in the brains of conversational partners, representing their readiness to speak, have their frequencies determined by each others' speech rate. As these oscillators become entrained (as partners align on speech rate) turn-taking should become more closely coordinated, resulting in more seamless turn-taking. A crucial prediction of this model is therefore that as interlocutors' rates converge, the amount of variance in their turn-intervals should decrease (as each partner become more accurate at predicting turn endings, and timing their responses accordingly).

By establishing the articulation rate in syllables per second of each conversational turn across 128 dialogues between 64 participants from the Map Task Corpus (Anderson et al., 1991), we were able to demonstrate that the speed at which interlocutors spoke converged as each dialogue progressed. Moreover, speakers' articulation rates were related to their interlocutors' articulation rates in the previous dialogue turn, suggesting that the mechanism by which dialogue rates converged appeared to be local priming, shown to also occur in monologue by Jungers and Hupp (2009). While these finding of convergence via local priming would be consistent with Wilson and Wilson's (2005) oscillator model, further analyses found no evidence for the prediction that the amount of variance present in turn-intervals would vary as a function of the extent of rate convergence between partners.

In absence of support for this important claim of the oscillator model, but with evidence for priming of speech rate in dialogue and in monologue, we suggest that the interactive alignment account may extend beyond *what* is said, to *how* it is said. Specifically, we propose an account where the alignment of rate comes as a consequence of the use of production systems during comprehension (Pickering & Garrod, 2007). Finally, our analyses provide a demonstration of the strength of sophisticated modelling techniques for investigating fine-grained linguistic phenomena within dialogue.

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Cost and implicature in word use: Testing predictions of a game-theoretic model of alignment

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Implicature; Game theory; Referential alignment; Interactive dialog; English

Previous work shows that joint communication tasks yield alignment of referring expressions, highlighting the role of interlocutors' experience of shared common ground in establishing convention (Brennan & Clark, 1996; Horton, 2008; Pickering & Garrod, 2004). Less well-established, however, are predictions regarding which form-meaning mappings interlocutors will converge on. To address this, we evaluate alignment in contexts where interlocutors' common ground includes the costs of producing particular forms. Our predictions stem from game theory, a formalism for modeling players' reasoning about communication based on knowledge of the costs/rewards of particular moves and players' understanding that such knowledge is shared (Jaeger, 2008; Lewis 1969).

A game-theoretic model predicts that the use of an otherwise ambiguous form can convey meaning if an unambiguous form is costly and alternative meanings can be conveyed at low cost. In other words, a listener who knows the relative costs of unambiguously referring to X (high-cost) or Y (low-cost) may reason that a speaker using a low-cost ambiguous word X-or-Y intends to convey X, or else she would have used the low-cost word Y. For example, the word 'some' can be used literally to refer to some and possibly all entities ("some fish swim" is true even if all fish swim) or to some-but-not-all entities ("some children are girls"). The literal meaning of 'some' is therefore weaker and conveys less information than 'all'. Its meaning is strengthened from some-possibly-all to some-but-not-all through implicature—i.e., a speaker obeying the maxim of Quantity and intending to convey the more informative meaning 'all' would have used the stronger form, but since the speaker didn't say 'all', the some-but-not-all meaning is favored. A game-theoretic account of 'some' reasons that the implicated some-but-not-all meaning is conveyed given the availability of the low-cost word 'all' for the alternative stronger meaning. To test whether cost-based pragmatic inferencing applies beyond a fixed lexical host like "some", we measure alignment in a communication game with superimposed costs/rewards for production/comprehension.

Participants took turns as Sender and Receiver, naming and identifying 6 objects with 8 words: 3 tree objects and 3 flower objects; 6 unambiguous names and the ambiguous generics "tree" and "flower" (see below). On each turn, the game highlighted one object for the Sender, who then incurred a point cost for communicating a word to the Receiver. If the Receiver correctly identified the intended object, both players earned points and the roles were reversed. Ambiguous words were low-cost. The absolute value of the point costs is less important than the relative ranking of the different signals' costs. Each category contained either one high-cost unambiguous word (Study 1) or two relatively costly unambiguous words (Study 2). Games continued for 20 minutes (~60 trials) unless the pair converged on a form-meaning mapping that permitted low-cost and effective communication.

As predicted, the successful use of ambiguous words reflected the costs of the unambiguous words: Pairs that converged did so with mappings involving low-cost generic words (e.g., "tree") that referred to items with costly unambiguous names (e.g., pine tree). Across trials, high-cost items yielded more ambiguous words produced (mixed-effects model: $p < 0.001$) and successfully understood ($p < 0.001$). Even with more similar costs (Study 2), most pairs converged, though some settled on a convention whereby the generic referred to the second-most-costly item. To rule out a trial-and-error strategy for finding an efficient alignment without recourse to pragmatic inference, we confirmed that Receivers inferred, more often than chance, that the high-cost object was intended when Senders *first* communicated an ambiguous word ($\chi^2 = 7.26$, $p < 0.007$). These results contrast with work demonstrating ambiguity avoidance in the presence of referential competitors (Arnold & Griffin, 2007), by instead pinpointing how pragmatic inference about cost licenses the use of otherwise ambiguous words. Our results are in keeping with existing models of communicative efficiency (Genzel & Charniak, 2002; Levy & Jaeger, 2007) which highlight how production choices reflect the growth of speaker-listener common ground, though such models have not been applied to calculable implicatures regarding referring expressions like the ones that arise here.

Study 1: one high-cost item per category; Study 2: two more-similarly high-cost items per category

Objects (presented as images): apple tree, palm tree, pine tree, rose, daisy, tulip

Unambiguous words (Study 1/Study 2 point costs in parentheses, separated by '/'): "apple tree"(60/80), "palm tree"(120/135), "pine tree"(250/170), "rose"(60/80), "daisy"(120/140), "tulip"(280/165)

Ambiguous words: "tree" (80/80), "flower" (80/80)

Factors that contribute to the use of perspective in referent identification

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Perspective taking; Visual world paradigm; Individual differences; English

Successful comprehension requires keeping track of how a speaker's knowledge differs from one's own. However, there has been some controversy over the extent to which addressees consider a speaker's knowledge-perspective on-line. One view holds that maintaining the distinction between one's own knowledge and an interlocutor's is inherently cognitively taxing. In support, perspective information sometimes appears to be ignored [1] and lower levels of executive function correlate with decreased use of perspective [2]. A second view holds that perspective use in communication is a fundamental human faculty [3] and has immediate influences on referent resolution [4]. This view predicts perspective use should be pervasive and need not be cognitively taxing, but might be influenced by enduring personality traits (such as autistic tendencies). A third view is that socio-cultural influences determine perspective-taking difficulty. [5] found that, unlike American participants, Chinese participants almost never failed to use the speaker's perspective in a referential communication task. They argued that Chinese culture places greater emphasis on collectivism and interdependence, which facilitates consideration of others' perspectives.

The present work investigates the mechanisms of perspective use by examining the contributions of cognitive, socio-cultural, and personality factors in a referential identification task. In three experiments, American college students followed a speaker's instructions to pick up a target object (*Pick up the cup*) among three mutually known items while their eye-movements were recorded. A fourth object was also present, but only known to the addressee. This privileged object was either identical to the target object (competitor) or unique (control). Perspective use was defined as the average number of fixations to the control object minus fixations to the competitor in response to the referential description.

In Experiment 1, participants completed three additional assays: (1) a test of inhibitory control, (2) a measure of cultural interdependence, (3) a measure of social aptitude (the Autistic Spectrum Quotient). Despite a broad range of cultural interdependence scores, there was no relationship with perspective taking. Intriguingly, cognitive and personality measures were both correlated with perspective use: greater inhibitory control and greater social aptitude were each associated with increased perspective use. Post-hoc analyses revealed that these factors contributed to perspective use during different phases of the study. The effect of inhibitory control was driven entirely by first half of the experimental session ($r=.32$, $p < .01$), while the effect of social aptitude was driven entirely by the second half ($r=.4$, $p < .001$).

One explanation is that cognitive resources are necessary to acquire perspective-relevant information in a novel communicative setting. Once the procedure for extracting this information is rehearsed, there is no special difficulty maintaining the speaker's perspective and social aptitude holds sway. Experiment 2 tested this directly by manipulating cognitive load during the perspective task. Consistent with Experiment 1, cognitive load decreased perspective use only during the first half of the study and social aptitude predicted perspective use only during the second half. Experiment 3 replicated the design of Experiment 2 using language to establish mutual knowledge. The effects of cognitive load were diminished in this case, perhaps because language is a more precise means of conveying and assessing others' knowledge.

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Workshop: Practical data analysis techniques for reading studies

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Eye-tracking; Reading; Parafoveal preview; Spillover

The methodology of eye tracking during reading is a useful tool for investigating the cognitive processes involved in text comprehension. In addition to allowing for a relatively natural reading environment, eye tracking can provide us with insight into the time course of processes like word identification, semantic access, and syntactic integration. The data that are involved in eye tracking studies can be intimidating to researchers who are new to this methodology. Fortunately, over the past few decades, great strides have been made in creating specific operational definitions for dependent measures that can be extracted from eye tracking data. The goal underlying the definitions of these measures, e.g., First Fixation Duration, Gaze Duration, Regression Path Duration, is to provide us with evidence of the occurrence of various cognitive processes associated with reading.

This workshop will serve to provide instruction on practical techniques for retrieving these dependent reading measures from eye tracking data. The workshop will include discussion of defining areas of interest, filtering and cleaning fixation data, changing and expanding areas of interest to investigate, e.g., parafoveal preview and spillover effects, and ultimately extracting these specific reading measures from the eye tracking data.

The processing of backward sluicing

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Online clausal ellipsis resolution; Sluicing; Word-by-word moving window; English

Backward Sluicing (BwS) e.g., (1a), is a construction in which a clausal-ellipsis ([SΔ]) in an embedded wh-interrogative precedes the antecedent-clause ([SANT]), providing the content of [SΔ]. In BwS, the parser must find the antecedent-clause for the ellipsis, and “recover” the content of the elided clause from the antecedent. This study aims to uncover the mechanism behind this online ellipsis resolution process. We specifically show: the parser’s active search for the antecedent clause drives the active search for the licensing verb of wh-phrases, like in wh-filler-gap (WhFG) dependency formation as in (1b), but, unlike WhFG, this search is not constrained by islands.

There are two possible scenarios for online clausal-ellipsis resolution: the parser waits until the end of the sentence to choose the appropriate antecedent clause, or the parser actively searches for the antecedent clause whereby the closest clause to the ellipsis site is taken as the antecedent. Wh-dependency processing in BwS can tease apart these hypotheses since, like WhFG dependency, BwS involves wh-phrases that must be licensed by a verb, which itself must be contained in the antecedent clause. Thus if the antecedent clause is found, so is the licensing verb. The first experiment tests these hypotheses utilizing the plausibility manipulation paradigm ([1]). 40 participants read the sentences in (2) in a moving-window study: we compare BwS against WhFG dependency, where semantic congruency of verbs and wh-phrases are manipulated. We find a main effect of plausibility: verbs in (2a/b) are read significantly slower than verbs in (2c/d) (P 's<.05). Thus, like WhFG dependency formation, the parser connects wh-phrases with their closest licensing verb, suggesting the parser actively searches for the antecedent clause.

The second experiment tests the island sensitivity of this search process. Islands have been debated between grammatical accounts ([2,3,4]) and processing-based accounts ([5,6]). If storage of the wh-filler and the processing of the resource-demanding intervening element induce island effects, the parser should not try to connect the wh-phrase to the licensing verb in an island during BwS processing due to processing-overload. Conversely, if the parser computes grammatical constraints related to BwS, the parser may search for the licensing verb inside an island because sluicing is insensitive to islands ([7,8,9]). Employing the plausibility paradigm again, we manipulate plausibility of verbs inside a relative clause island in subject position and compared BwS and WhFG in terms of semantic congruency:(3). We find an interaction of dependency type and congruency; incongruent verbs are read slower than congruent verbs in the BwS condition ((3a/c)) but no such differences in WhFG conditions ((3b/d)) (P 's<.05). Thus, the results suggest that the parser employs an active search strategy while ignoring islands in sluicing conditions.

In summary, processing of BwS, like WhFG, employs active search for licensing verbs, which is motivated by the active search for the antecedent clause of ellipsis, while BwS processing is different from WhFG processing since BwS processing ignores islands. This finding argues against the processing-accounts of islands since they do not predict the plausibility effects, which is the mark of dependency formation, in the island domain.

- (1) a. I don't remember which writer [SΔ], but [SANT the editor notified a writer about a new project]
b. I don't remember which writer the editor notified __ about a new project.
- (2) a./b. Incongruent: I don't remember which book {, but/∅} the editor notified the publisher about {a new book/___}...
c./d. Congruent: I don't remember which writer {, but/∅} the editor notified the publisher about {a new book/___}...
- (3) a./b. Incongruent: I don't remember which book {, but/∅} [RC the editor who notified the publisher about some science book had recommended {a new book/___} to me.
c./d. Congruent: I don't remember which writer {, but/∅} [RC the editor who notified the publisher about a fiction writer had recommended{a new writer/___}to me.

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Adjunct islands and the finiteness effect

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Island constraints; Sentence acceptability; Experimental syntax; English

Do adjunct islands exhibit the finiteness effect seen in *wh*-islands (1) and subject islands (2), in which extraction from non-finite clauses is more acceptable than from finite clauses [1, 2, 3]? There are two issues at stake: First, if adjunct islands lack the finiteness effect, as has been traditionally thought, then a unified explanation for these three islands (whether in grammar or processing terms) seems improbable [4]. Second, if finiteness in embedded clauses is the sort of small processing difficulty that accumulates with others and results in larger island effects in *wh*- and subject clauses [2, 5], then it should have this effect in adjunct clauses too. These questions are explored in a series of three experiments.

Experiment 1: Participants (N=189) judged acceptability of sentences with a 7-point scale. Materials were *wh*-questions involving extraction out of 5 types of adjuncts, both clausal and non-clausal. Crucially, 2 of the types were finite and non-finite temporal adjunct clauses, as in (3). Participants saw 4 tokens of each type (Latin square design, randomized order, 1:2 experimental/filler ratio). Extraction out of non-finite adjunct clauses (mean rating = 2.28) was rated significantly higher ($p < .001$) than extraction out of finite adjunct clauses (mean rating = 2.01), suggesting that under careful experimental conditions, a finiteness effect emerges also for adjunct islands. The question remains, however, whether the effect might be due to a general preference for non-finite adjuncts independent of extraction. This is addressed in Experiment 2.

Experiment 2: Participants (N=220) used a 7-point scale to judge *wh*-questions and *yes/no* questions with finite and non-finite adjunct clauses. Participants saw 6 tokens of all 4 types, and 40 fillers (Latin square design, randomized order). Results revealed no significant effect for finiteness in *yes/no* questions (non-finite mean = 5.72, finite mean = 5.69) ($p = 0.68$), but a very significant effect in the *wh*-questions (non-finite mean = 2.38, finite mean = 2.16) ($p < 0.001$), suggesting that finiteness affects extraction out of adjuncts, not adjuncts in general. This opens the possibility that the effect here is driven by extraction alone, i.e. a general preference for extraction out of non-finite clauses. This is explored in Experiment 3.

Experiment 3: Same as Experiment 2, but with complement clauses instead of adjunct clauses (4). Results show no significant effect for finiteness in *yes/no* questions, but unlike what we saw with adjunct clauses, a slight preference for extraction out of finite (mean = 4.96) over non-finite (mean = 4.82) clauses ($p < .01$).

We reach three main conclusions: First, since adjunct islands are now seen to exhibit a finiteness effect similar to that of *wh*-islands and subject islands, the possibility of a unified explanation for these three gains plausibility. Second, the view that island effects result from the accumulation of smaller processing difficulties [2, 5] receives support from the fact that finiteness appears to be one contributor to unacceptability in all three island types. Third, this view is crucially not supported by the fact that no such contribution was detected in complement clauses. Why finiteness behaves this way remains an open question at this point.

Example sentences

- (1) a. ?What are you wondering [whether to buy _] ?
b. *What are you wondering [whether I should buy _] ?
- (2) a. ?? the niece who [being able to bake cookies for _] gives me great pleasure
b. * the niece who [that I can bake cookies for _] gives me great pleasure
- (3) a. *Who did Bill run [after calling _]? (*Judgments given are standard ones from literature.*)
b. *Who did Bill run [after he called _]?
- (4) a. What did the teacher believe [the students to know _]?
b. What did the teacher believe [the students knew _]?

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Generating contrastive alternatives: Activation and suppression mechanisms

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Focus alternatives; Pitch accent; Activation; Suppression; Cross-modal priming; English

The meaning of a contrastively focused sentence consists of two parts: 1) an asserted fact, and 2) a set of contrastive alternatives, often indicated by a pitch accent in spoken language. *The museum thrilled the SCULPTOR* (accent on *sculptor*) conveys that 1) the sculptor was thrilled, and 2) other alternatives like a painter were not thrilled (Rooth, 1985). This study proposes that comprehenders generate the set of contrastive alternatives through two mechanisms which are used in tandem: activation of contrastive and non-contrastive associates, followed by suppression of non-contrastive associates.

Inferring a set of contrastive alternatives is often necessary for carrying on a conversation, since speakers typically do not provide them explicitly. Previous research has established that comprehenders are sensitive to contrastive alternatives (Weber, Braun, & Crocker, 2006; Ito & Speer, 2008), suggesting that they are inferred upon hearing a contrastive pitch accent. However, the mechanisms comprehenders use to arrive at the proper set of contrastive alternatives are not well understood. This study examines one possibility. Because alternatives like *painter* are semantic associates of *sculptor*, they may be automatically activated; however, the same is true for *statue*, which is inappropriate as an alternative. Since only the former are contrastive, a suppression mechanism may be used to inhibit non-contrastive associates. These processes unfold in time: activation occurs first, followed by suppression (Gernsbacher & Faust 1991).

Experiments 1 and 2 used a word/non-word cross-modal priming paradigm with auditory sentences containing a prime (*sculptor*) and three types of visual targets: a contrastive associate (*painter*), a non-contrastive associate (*statue*), and an unrelated word (*register*) (Braun & Tagliapietra, 2010). Latent semantic analysis (LSA) was used to determine the association strength of contrastive, non-contrastive, and unrelated targets to prime words and to match the association strength of contrastive and non-contrastive associates item by item. Target length and frequency were also controlled (Table 1). Sentences were recorded twice: once using neutral prosody and once using focus prosody on the prime (i.e. a contrastive pitch accent on *sculptor*). To examine time course, SOA varied between experiments: Experiment 1 used a 0 msec SOA to examine initial activation of contrastive and non-contrastive associates; Experiment 2 used a 750 msec SOA to examine suppression of non-contrastive associates.

Experiment 1 provides evidence for the initial activation of contrastive and non-contrastive associates. Relative to unrelated targets, both contrastive and non-contrastive associates were facilitated in the focused and neutral conditions at 0 msec SOA. Experiment 2 provides evidence for suppression of non-contrastive associates, while contrastive associates persisted. While contrastive and non-contrastive associates in the neutral condition and contrastive associates in focused condition all continue to be facilitated, non-contrastive associates in the focus condition were no longer facilitated by 750 msec.

Together, these studies suggest a time course for the generation of contrastive alternatives. Potential candidates for an alternative set are initially activated based on mere semantic association, leading contrastive and non-contrastive associates to both become activated. Non-contrastive associates are then inhibited, generating the proper alternative set and creating an appropriate semantic representation.

Table 1: Target Stimulus Properties

	Length	Frequency	LSA
Contrastive	5.89	502.06	0.4325
Non-contrastive	5.58	665.90	0.4347
Unrelated	5.58	547.08	0.0569

Table 2: Priming of Contrastive and Non-contrastive Associates (in msec)

	Experiment 1 (SOA: 0 msec)		Experiment 2 (SOA: 750 msec)	
	Contrastive	Non-contrastive	Contrastive	Non-contrastive
Focused	24	22	23	0
Neutral	18	7	22	16

Effects of visual and discourse contexts and prosody on referential resolution

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Contrastive prosody in speech comprehension; Visual world paradigm; Japanese

Successful discourse comprehension requires constant updates of what has been discussed and reasonable anticipations for what is likely to be discussed next. Previous studies demonstrate the immediate impact of contrast-evoking prosody on the referential resolution [1, 2, 3], yet the relationship between the context-driven referential salience and the role of prosody in guiding referential resolution has not been well investigated. The present study examines how contrast-evoking prosodies in Japanese is interpreted when the visual and discourse contexts elicit changes in salience among candidates for the subsequent referential resolution.

Experimental slides presented eight animals, each holding an object. Critical slides included a trio (e.g., three gorillas holding a racket, an umbrella and a ball, respectively) a twin with two objects repeated from the trio (two raccoons with a racket and an umbrella), a singleton (a rabbit with an umbrella) and a distracter twin (two frogs with a balloon and a baseball bat). Participants followed sequential instructions (Example 1). Q1 had no particular prominence. Q2 sentences were recorded with (1) prominence on the object noun, (2) pre-focal attenuation on the object noun and prominence on the animal noun, (3) no particular prominence. If the prominence on the object evokes contrast with Q1, (1) should lead to higher fixations to the contrastive competitor (e.g., gorilla with umbrella) than (2) and (3). If the pre-focal attenuation evokes contrast on the upcoming animal, (2) should lead to higher fixations to the animal other than the competitor than (1) and (3). The mention of a trio member in Q1 was predicted to elicit three levels of salience among the Q2 candidates holding the same object (umbrella): the trio member (e.g., gorilla) should become most salient due to the explicit mention; the twin whose counterpart has the same object as in Q1 (e.g., raccoon) should be moderately highlighted; the unmentioned singleton (e.g., rabbit) should be least salient.

The eye-movement patterns revealed interesting discourse-driven attention shift and the salience-driven use of prosodic cues. During the 1s exposure to the slide before linguistic input, participants fixated the distracter twin most often and the singleton least. Then, Q1 led to immediate increase in the fixations to trio members. Upon hearing the Q2 object (e.g., umbrella), fixations to the trio competitor (gorilla with umbrella) were higher than to the Q2 target (raccoon) regardless of the prosody. However, this anticipation was stronger for (1) and (2) than for (3), suggesting that both prominence on the object and pre-focal attenuation enhanced the context-driven contrastive interpretation. Interestingly, (2) led to higher fixations to the singleton (rabbit) than (1) and (3), indicating that pre-focal attenuation directed attention to previously least attended candidate. In sum, the results suggest that the discourse context overwrites the visual-based initial referential anticipation. Prosodic cues may not only facilitate the discourse-driven anticipation but also evoke alternative referential interpretation. The time courses of fixation patterns suggest that these alternative interpretations were simultaneously available, reflecting the parallel evaluations of candidates for referential resolution.

Example 1: Q1: *raketto-o motteru gorira-wa doko?*
racket-ACC holding gorilla-TOP where
'Where is the racket-holding gorilla?'

Q2: (1) *Jaa, KASA-o motteru tanuki-wa doko?*
(2) *Jaa, kasa-o motteru TANUKI-wa doko?*
(3) *Jaa, kasa-o motteru tanuki-wa doko?*
then umbrella-ACC holding raccoon-TOP where
'Then, where is the umbrella-holding raccoon?'

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When accenting does not introduce alternatives: Discourse coherence and pronoun resolution

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Accented pronoun resolution; Coherence relations; Off-line judgment; English

Accented pronouns are usually assumed to receive a different interpretation than unaccented equivalents [1], favoring an antecedent that is less preferred for unaccented pronouns [2]. However, recent work suggests that pronoun resolution is part of a global process of establishing discourse coherence, rather than local interpretation [3]. Indeed, coherence relations modulate the degree to which accented pronouns receive an alternative interpretation [4]. The current study shows that (i) not all accented pronouns are assigned an alternative interpretation, and (ii) the availability of an alternative depends on whether it can be used to establish discourse coherence.

In three experiments, participants listened to discourses containing a linguistically ambiguous object pronoun, and answered a written question probing its referent. The (unaccented or accented) pronoun appeared in the third sentence. Coherence relations were manipulated by changing the first or second sentence. The critical measure was the likelihood of choosing the previous subject as the referent (logit transformed before ANOVA). Experiment 1 crossed ACCENT (unaccented vs. accented) with COHERENCE (Parallel (A) vs. Result (B)). For unaccented pronouns, participants preferred the previous object for parallel relations [cf. 5] and the previous subject for result relations. Crucially, while the preference changes for accented pronouns in the parallel cases (34% vs. 63%, $p < .05$), the pattern for result remained unchanged (87% vs. 83%, $p > .05$). This indicates that alternatives are not introduced by the accented pronoun itself. We propose that in the result case the potential alternative interpretation is not pursued because it would not allow establishing coherence, but both referents allow a coherent discourse in the parallel case.

These results are also consistent with the possibility that an alternative interpretation is not available when the bias to the default referent is strong. Experiment 2 crossed ACCENT with PARALLEL (Strong (C) vs. Weak (A)). However, while we observed a stronger bias for the previous object when the pronoun was unaccented (17% vs. 34%, $p < .05$), the preferred interpretation changed in both cases with accented pronoun (60% and 57%, $p > .05$). This suggests that the strength of the bias in the result case of Experiment 1 is not responsible for the lack of coherent alternatives. We also considered whether the results of Experiment 1 are due to the different syntactic position of the unmarked antecedent, which was object in Parallel and subject in Result. Experiment 3 manipulated the syntactic position of the referent with result relations, crossing ACCENT with RESULT (Subject (B) vs. Object (D)). While the interpretation of unaccented pronouns was to subjects and objects respectively, the antecedent preferences did not change for either with accented pronouns (83% vs. 77% and 31% vs. 40% respectively, p 's $< .05$). This demonstrates that result coherence relations maintain world knowledge restrictions independent of whether the bias is towards the previous subject or object.

These experiments show that accent itself does not introduce alternative interpretations for a pronoun. Instead, we conclude that the availability of an alternative interpretation depends on whether it can be used to establish discourse coherence, and accent operates on alternatives only when they are available.

- (A) Parallel** (Exp 1,2) (i) The animals were afraid to crash into each other on the dance floor.
(ii) Elephant stayed away from Bear during the cha-cha.
(iii) Then, Cat avoided him/HIM during the waltz. (34% vs. 63%; 34% vs. 57%)
- (B) Result-S** (Exp1,3) (i) The animals were afraid to crash into each other on the dance floor.
(ii) Elephant confessed to Bear about being clumsy.
(iii) Then, Cat avoided him/HIM during the waltz. (87% vs. 83%; 83% vs. 77%)
- (C) Parallel** (Exp 2) (i) The animals were afraid to crash into their clumsy friend on the dance floor.
(ii) Elephant stayed away from Bear during the cha-cha.
(iii) Then, Cat avoided him/HIM during the waltz. (17% vs. 60%)
- (D) Result-O** (Exp 3) (i) The animals were afraid to crash into each other on the dance floor.
(ii) Elephant asked Bear to stop stepping on his feet.
(iii) Then, Cat avoided him/HIM during the waltz. (31% vs. 40%)
- Q** Who did Cat avoid?

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Intonation structure and the theory of grammar

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The unbounded constructions—principally, *wh*-movement and various reduced coordinate structures—continue to present problems for standard theories of grammar, seeming to require otherwise unmotivated operations of movement and/or deletion, over and above standard semantically compositional context-free merger. Changing fashions for renaming the problem in terms of operations of copying, agreement, or “internal” merger, and related attempts to dissociate derivational structure and composition of logical form, don’t seem to help much. Perhaps something is wrong with the standard theories.

Intonation structure and its semantic reflex, information structure, have never sat very easily with standard theories of grammar. Phonologists complain that syntacticians don’t give them enough brackets to explain prosodic phrasing, and are forced to postulate extra “edges” to do so. Those with an interest in discourse semantics also complain that intonational phrases carry a semantics of topic and comment that is somewhat orthogonal to standard compositional semantic structure. Those with an interest in language acquisition wonder why English-speaking mothers carelessly expose children to such apparently syntactically misleading utterances as “(You LIKE)(the doggies)”.

The Combinatory Categorical theory of grammar turns the problem on its head. It is the intonational phonologists (and the mothers) who have grasped the relevant notion of structure. Compositional derivation is much freer than has usually been assumed. Once the grammar, including the semantics, has been reconfigured to directly reflect intonation and information structure, the problems of unbounded dependency and coordinate reduction are greatly simplified, and can be reduced to a single formally specified operation of type-dependent adjacent merger.

Wednesday, March 14 Poster Abstracts

Structurally informative prosodic cues in center-embedded and right-branching sentences

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Prosody; Sentence processing; Production; Center-embedding; English

Traditionally, difficulty of center-embedded sentences (CES) is attributed to syntactic complexity [3,6]. In such frameworks, effects of acoustic information are neglected [4]. However, acoustic information helps the parser disambiguate attachment ambiguities (e.g., high vs. low relative clause (RC) attachment) or “chunk” linear input into relevant constituents [1,5]. Therefore, it is plausible that acoustic cues also help the parser accurately analyze the complex structure of CES. Through sentence production, self-paced reading, and offline rating experiments, we attempt to describe and explain acoustic cues differentiating CES from right-branching sentences (RBS), which allows future studies to accommodate these acoustic cues into the model of processing overload.

Singly-embedded sentences are our current focus, since *multiply-embedded* sentences are often judged as unacceptable, thus are risky production stimuli for revealing optimal prosodic structure. In Experiment 1, native English speakers (N=12) read sentences aloud after presentation of short familiarizing contexts, making production more naturalistic and inducing a restrictive reading of each RC (#1). Example #1 also illustrates which locations syntactic models predict to be pre-boundary (PB) and non-boundary (NB), relative to intonational phrases. We compare relative word duration in CES and RBS in these locations (taken as evidence of prosodic breaks), in addition to comparing overall pitch contours [1,2]. By comparing relative durations of second nouns and first verbs (within part of speech, across PB/NB), we confirm the existence of strong prosodic breaks after the embedded RC in CES ($p < 0.05$) and before the RC in RBS ($p < 0.001$). There is no evidence for differing prosodic features between CES/RBS conditions in the NP1 region ($p > 0.05$), likely due to the option for a VP intonational phrase in RBS. However, N2 in CES is significantly shorter than all other nouns ($p < 0.01$), suggesting that the RC in CES is acoustically reduced compared to the matrix clause. Additionally, f_0 analysis shows RBS and CES follow strikingly similar pitch contours, except for a medial relative pitch maximum in CES without a corresponding RBS maximum ($p < 0.05$), indicating an additional pitch accent in CES.

In Experiment 2, native English speakers (N=20) read stimuli from Experiment 1 in a self-paced reading task and subsequent offline rating task. The only difference found between CES and RBS is a significant reading time slowdown at the second verb location in CES ($p < 0.05$), reflecting the complexity of the embedded structure and the parser’s attempt to resolve the embedding. However, this complexity is not reflected in the acceptability rating, where RBS and CES do not significantly differ ($p > 0.05$).

In sum, although multiply-embedded CES are notoriously less acceptable due to processing overload, singly-embedded CES do not suffer from the same overload. They do, however, have an extra pitch accent in the embedded clause and a reading-time slowdown after the embedded clause boundary. These findings are consistent with traditional syntactic processing theories (assuming the slowdown reflects complexity), but the additional accent indicates a difference in prosodic chunking that existing theories do not address. Thus, our study forms the foundation for future investigations into prosodic contributions to processing by defining the variables to be manipulated.

(#1) Context: A family-owned bowling alley was located next door to a barber shop
The owner of the barber shop got to be friends with the regular bowlers

CES:[The jolly [barber_{N1,NP1}] that [the nimble [bowler_{N2,NB}]_{NP2}] [greeted_{V1,PB}] || said good morning

CES:[The nimble [bowler_{N1,NP1}] that [the jolly [barber_{N2,NB}]_{NP2}] [greeted_{V1,PB}] || said good morning

RBS:[The nimble [bowler_{N1,NP1}] [greeted_{V1,NB}] [the jolly [barber_{N2,PB}]_{NP2}] || that said good morning

RBS:[The jolly [barber_{N1,NP1}] [greeted_{V1,NB}] [the nimble [bowler_{N2,PB}]_{NP2}] || that said good morning

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Subject encodings and retrieval interference

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Retrieval interference; Grammatical subject; Self-paced reading; English

Within a content-addressable memory approach to dependency formation [1,2], inherent properties of encodings may be used to access constituents directly, independent of the structured representation. Grammatically inappropriate encodings sharing retrieval cues may thus give rise to similarity-based interference. For instance, [3] found that Subject-verb attachment is more difficult when crossing a subject relative clause containing a lexically-filled subject position. Interference is attributed to a feature [+Subject] shared by the grammatically licensed subject and the intervening grammatically-inaccessible subject. However, theories of subject-hood make distinct predictions about which constituents might share subject-like properties. Subjects can be thought of as occupying particular phrase-structure positions [4] or being the most prominent member of argument structure [5]. The goal of this study is to test whether argument structure or positional information informs subject retrieval cues by looking at interference effects in constructions containing subjects in both nominal and clausal domains.

Syntactic research has identified parallels in the nominal and clausal domains [6,7,8], supporting a view that takes the possessor of a process nominalization (*the soldier's destruction of the village*) to be the subject of the nominal expression. Comparing nominalizations and tensed clauses, subjects differ in (i) domain of occurrence (clausal/nominal), and (ii) the Case assigner (Nom/Gen), but are both linked to the most prominent argument [9]. We tested whether the possessors in process nominalizations compete for subject-verb attachment in a self-paced reading experiment (n=40).

We crossed the position of the nominalization (Subj/Obj) with the presence of a possessor (Y/N) in a 2 x 2 design. Subject and verb were separated with a bi-clausal subject relative clause (RC) containing the nominalization as an argument of an embedded transitive verb (see materials). Lexical items were identical across conditions, modulo the possessor. Sentences with non-overt subjects served as control for depth of clausal embedding. Interference effects (increased RTs) were expected at the matrix predicate (*was mentioned*), if the possessor of a nominalization overlaps in the features contained by the retrieval cue. Nominalizations in the inaccessible embedded subject position led to increased reading times at the verb (linear mixed-effects model, +/- 21ms, MCMC p<.01), replicating [3]. However, there was no significant effect associated with the possessor. We conclude that cues for subject retrieval encode the structural domain in which the dependency is targeted.

In contrast to [3], studies of grammatical accuracy in anaphoric dependencies have suggested that grammatically-appropriate outcomes are achieved via ordered, structure-sensitive access mechanisms [10,11]. However, the properties of encodings that serve as cues for retrieval may yield grammatically appropriate outcomes, without ordered access, if cues are carefully chosen. To assess the viability of that approach, however, it is necessary to have a theory of how such cues may be identified and combined. Here we offer evidence that some, but not all, subject properties participate in retrieval for subject-verb attachment. In an on-going experiment, we are investigating ECM verbs to test whether subject retrieval cues contain information about Case in addition to position.

Materials

As predicted, the farmer who thought that ... [CONDITION]... was mentioned in the documents.

Nom:OBJ, Poss:NO ...the rebellion prompted the deliberate destruction of the village...

Nom:OBJ; Poss:YES ...the rebellion prompted the **soldier's** deliberate destruction of the village...

Nom:SUBJ, Poss:NO ...the deliberate destruction of the village prompted the rebellion...

Nom:SUBJ, Poss:YES ...the **enemy's** deliberate destruction of the village prompted the rebellion...

CONTROL ...the farmer who appears to have recorded the deliberate destruction of enemy village...

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On the processing of epistemic modals

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Epistemic modality; Implicature processing; Eye-tracking; Visual world paradigm; English

Summary. This study examines the processing of the implicature of *might* (\approx NOT *must*). Our results show that the implicature does not emerge until 800ms after *might* is heard, and hence support the view that implicature processing is delayed.

Introduction and Methods. The literature on implicatures contains both studies that suggest rapid computation of scalar implicatures (Sedivy et al., 1999; Grodner et al., 2010), and studies that provide evidence for extra processing costs in generating them (Noveck & Posada, 2003; Huang & Snedeker, 2011). The present study extends existing work by comparing *might* to *must*, and by adapting a paradigm that integrates experimental sentences into a natural discourse within a game.

The experiments employed the visual world paradigm, using a guessing game with a confederate. In critical trials subjects had full access to a visual display of 9 colored shapes, while the confederate had only partial access (two of the shapes were hidden). The shapes were arranged according to 2 rules (1), based on which the confederate had to “guess” the hidden shapes. Critical trials were scripted for maximal experimental control. The subjects’ task was to verify the guesses.

Eye movements of 12 participants were recorded while the confederate made guesses regarding the hidden shapes, which used either *must* or *might*, depending on whether the rules provided certainty about the shape in question (2, 3). Up to the location phrase (*upper right/ bottom left*), nothing but the choice of modal provided information about which of the two hidden shapes the statement was about. Guesses for *must* sentences were always correct, while guesses for *might* sentences were incorrect (but consistent with the rules) half of the time.

Results. Target advantage scores (looks to target minus looks to competitor) were computed for the experimental conditions, split by whether the guess was correct or not. The target was the shape that could be guessed with certainty, and the competitor the shape that could not be guessed with certainty. For items for which the guess was correct, eye movements for *might* and *must* pattern together with a preference for the target (i.e., the *must*-shape, which can be guessed with certainty), until 1 second after their onset. Only after that point is there a relative increase in looks to the competitor (i.e., the *might*-shape, which cannot be guessed with certainty) when hearing *might*. This is reflected in a significant interaction between time window (1st second vs. the rest of ambiguous period) and *must/might*. If the pragmatic implications of *might* were directly accessed and were part of its meaning, “might” should have blocked eye movements to the *must* shape, and triggered eye movements to the *might* shape. Our results however show a delay in selecting the *might* shape, hence suggesting that uncertainty is an implication of *might*. The delay in incorporating the ‘not *must*’ implicature of *might* is comparable in size to previous studies finding delays in implicature computation and thus provides further support for the notion that implicatures incur processing cost, based on different implicature triggers and using an experimental paradigm based on natural dialogue.

- (1) **Rules:** Rows: 3 alike shapes or all different; **Columns:** 3 same color shapes or all different
- (2) There **must be** a red square located in the upper right.
- (3) There **might be** a red square located in the bottom left.

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Missing-VP effects: Headedness does not matter

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Sentence complexity; Missing-VP effect; Self-paced reading; Speeded grammaticality judgments; German

We address the question of whether working memory constraints on sentence processing depend on the headedness of a language. The particular phenomenon we are concerned with is the so-called *missing-VP effect* which has been thoroughly documented for SVO languages (e.g., Gibson & Thomas, 1999; Christiansen & MacDonald, 2009; Vasishth et al., 2010) but is a matter of dispute for SOV languages.

Vasishth et al. (2010) investigated the missing-VP effect also in the SOV language German. They tested sentences as in (1) in a self-paced reading and an eye-tracking experiment and concluded that readers of German are immune to the missing-VP effect. Vasishth et al. (2010) hypothesize that the difference between English (SVO) and German (SOV) is experience-based, with the expectancy for the VP being higher in German than in English.

The findings for (1), in which the incomplete relative clause is located in the clause-initial topic position (specifier of CP = SpecCP) of a verb-second main clause, contrast with earlier findings for sentences as in (3) in which the incomplete relative clause is contained within the VP of an embedded verb-final clause. For (3), experiments making use of speeded grammaticality judgments yielded evidence for a missing-VP effect in German (Bader et al., 2003).

In order to resolve this issue, we ran two experiments. The first experiment investigated sentences as in (3) with a self-paced-reading procedure (24 participants, 20 sentences). In accordance with earlier studies of this construction, but in contrast to Vasishth et al. (2010), this experiment provides evidence for the missing-VP effect in German: the verbal complex of the superordinate clause (*erhalten wird*) was read about 100ms faster when VP2 was missing than when VP2 was present. In a second experiment (34 participants, 30 sentences), we used the method of speeded grammaticality judgments for directly comparing the three constructions in (1), (2), and (3). Sentences with the relative clauses in SpecCP received the highest acceptance rate among the complete sentences and the lowest acceptance rate among the missing-VP sentences.

The experimental results are supported by evidence from an ongoing corpus study of doubly center-embedded relative clauses in German. Overall, the number of doubly center-embedded relative clauses was highest for the SpecCP context (1), followed by the VP of embedded clauses (3), followed by the VP of main clauses (2). The corpus study also revealed a number of missing-VP sentences, thus showing that this phenomenon is not restricted to language comprehension but also occurs during language production.

In sum, the missing-VP effect occurs in the SOV language German in both comprehension and production, its rate being subject to the particular syntactic context. We propose that the missing-VP effect results from general constraints on working memory that are not tuned to properties of particular grammars. Instead, this effect arises because of difficulties in distinguishing between interfering attachment sites.

(1) **SpecCP:**

Der Polizist, der den Verbrecher, der die Bank überfallen hatte, ~~gefasst hat~~, wird eine Auszeichnung erhalten.
the policeman who the criminal who the bank robbed had arrested has will a award receive
'The policeman who arrested the criminal who robbed the bank will receive an award.'

(2) **VP main clause:** Vermutlich wird der Polizist, der den Verbrecher, der die Bank überfallen hatte,
presumably will the policeman who the criminal who the bank robbed had
~~gefasst hat~~, eine Auszeichnung erhalten.
arrested has a award receive

'Presumably, the policeman who arrested the criminal who robbed the bank will receive an award.'

(3) **VP embedded clause:** Ich weiß, dass der Polizist, der den Verbrecher, der die Bank überfallen hatte,
I know that the policeman who the criminal who the bank robbed had
~~gefasst hat~~, eine Auszeichnung erhalten wird.
arrested has a award receive will

'I know that the policeman who arrested the criminal who robbed the bank will receive an award.'

Agreement errors as rational encoding errors

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Rational analysis; Noisy-channel models; Agreement errors; Sentence production; English

A classic finding in the sentence production literature [1] is that mismatches in the number-marking of head and local nouns (1) lead to agreement errors, with the effect being strongest when the head-noun is singular and the local-noun is plural (e.g., "*The actor in the commercials...were...*"). We propose that this pattern of agreement errors is driven by rational misidentification of the sentence preamble: people rationally combine the likelihood of noise in the input with prior grammatical knowledge [2,3]. Agreement errors therefore result when participants infer that the intended plural marking of the head-noun has been omitted (e.g., "*the actors in the commercials*" is inferred for "*the actor in the commercials*"). The asymmetry between singular and plural head-nouns is explained by the Bayesian size principle [4]: there are more ways to randomly select a morpheme and insert it than there are ways to delete a morpheme, so deletion of the plural "s" is more likely. Comprehenders thus infer that a singular noun is more likely to have been produced accidentally than a plural noun.

Across three experiments we test two distinctive predictions of this account:

1. Additional cues to head-noun number will decrease the agreement-error rate. Multiple cues are unlikely to be present by accident; it is therefore rational to infer these cues are intended and the number-marking is correct.
2. Misidentification of the sentence preamble will lead to *repetition errors*, which will pattern with agreement errors, i.e., the most frequent error will be replacement of a singular head-noun with a plural noun.

In a modified version of the traditional paradigm, participants saw the preamble for 1.5sec and had 13sec to retype the preamble and complete it. Experiment 1 (n=40) validated the methodology, replicating the agreement error patterns reported in [1] using similar materials (4a). The results of Experiment 1 also supported prediction 2: participants were significantly more likely to pluralize the head noun in the singular-plural condition than to make the head noun singular in the plural-singular condition ($p < 0.05$). Similar effects obtained in Experiments 2-3.

Experiments 2-3 tested prediction 1 by providing additional cues to the number of the head-noun. Experiment 2 (n=60) used the materials from Experiment 1 and two indefinite conditions as in (2), in which the singular indefinite article replaced the definite article in the head-noun (see [5] for a related manipulation in Dutch). Experiment 3 (n=60) used preambles like (3), which contained either a relative clause that marked the head noun's number ("*that is*") or a reduced version with no number-marking. The rate of agreement errors was significantly lower for the singular-plural items in the indefinite condition compared to the definite condition (Expt 2), and in the full-relative compared to the reduced relative condition (Expt 3). The error rates for the indefinite condition (Expt 2) and for the full relative clause condition (Expt 3) were not significantly different from the singular-singular condition. In summary, we have provided a novel theoretical account of a classic sentence production phenomenon in terms of rational Bayesian inference, and demonstrated that its predictions are empirically supported.

- (1) **Singular/plural head x singular/plural local:** The actor(s) in the commercial(s)
 (2) **Definite/indefinite x singular/plural local:** The/an actor in the commercial(s)
 (3) **Full/reduced relative x singular/plural local:** The actor (that is) performing in the commercial(s)

(4) **Results:** Note that all analyses were performed using ANOVAs, and interactions were significant with participants and items as random factors.

(4a) **Experiment 1 agreement error rates** ($F = 8.47$; $p < 0.005$):

Plural-plural: 4% Plural-singular: 2% Singular-plural: 19% Singular-singular: 1%

(4b) **Experiment 2 agreement error rates** ($F = 5.37$; $p < 0.03$):

Definite: singular-plural: 11% singular-singular: 1%

Indefinite: singular-plural: 2% singular-singular: 1%

(4c) **Experiment 3 agreement error rates** ($F = 5.98$; $p < 0.02$):

Reduced relative: singular-plural: 10% singular-singular: 1%

Full relative: singular-plural: 2% singular-singular: 2%

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Effects of frequency, predictability, & length in a rational model of eye movements in reading

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Eye movement control; Reading; Computational modeling; Bayesian inference; Rationality of cognition; English

Eye movement control in reading is one of the best and most naturalistic examples of the adaptive deployment of linguistic knowledge for real-time comprehension. Here we present a model of eye movement control in reading as rational action, which seeks to understand reading behavior as resulting from the efficient way to achieve reader goals. Specifically, we describe empirical benchmarks for the first rational model of eye movements in reading that makes predictions for the full range of the eye movement record. Unlike E-Z Reader (Reichle et al., 2003), SWIFT (Engbert et al., 2005), and Glenmore (Reilly & Radach, 2006), the model directly optimizes its behavior to best achieve the reader's goals, here characterized as accurate and rapid identification of the contents of the text. Unlike Mr. Chips, the only previous rational model in this domain (Legge et al., 1997), the model makes predictions about not only fixation locations but also fixation durations.

In the model, readers use Bayesian inference to combine two sources of information – (1) probabilistic language knowledge (the prior), and (2) noisy perceptual input about the text (the likelihood) – to form and repeatedly update a posterior distribution over possible text contents. At each discrete time step, readers can *continue fixating* the eyes' current position to obtain more perceptual input, *move the eyes* to a position of the model's choice, or *stop reading* and end the trial. The model includes realistic physical constraints including motor error, saccade planning time, and an asymmetric visual acuity curve. Readers obtain noisy letter-identity information (with noise level dependent on visual acuity) and veridical information about word lengths and boundaries throughout the visual span. Model behavior is determined by a number of *parameters* sensitive to the probability distribution over the text at each timestep; the parameter values used in simulations are optimized for speed and accuracy given reader goals, not for fit to human eye movement data.

Simulations reveal effects of word frequency and predictability on diverse reading measures (including first fixation durations, gaze durations, skipping probabilities, and refixation rates) qualitatively reproducing monotonic effects seen in human behavior, and quantitatively provide reasonable fits to human data. An examination of the effects of word length in the model, however, yielded a more complex picture: while skipping and refixation rates were monotonic functions of word length (decreasing and increasing, respectively, as for humans), the model did not produce humanlike monotonic functions of word length on fixation duration measures, but rather a U-shaped function rising with word length between 1–4 characters, but falling with word length above that.

We hypothesized that this length effect was an artifact of the model's simplifying assumption of veridical knowledge of word length, which artificially shrinks orthographic neighborhoods – reducing the visual input necessary for word recognition – of longer words more than of shorter words. We tested this hypothesis by extending the model to include uncertainty about word length as well as letter identity. This change shifted the word-length/fixation-duration relationship exhibited by the rational model much closer to monotonic, human-like patterns.

The success of the model to derive this range of effects from principles of probabilistic inference and rational action suggests that many aspects of human reading behavior can be profitably understood as properties of efficient solutions to the problem of reading.

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How many ducks did Heidi see swimming in the pond: Altering context speech rate creates real-time expectations that can cause words to appear and disappear

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Speech rate; Prosody; Expectations; Speech processing; Visual world paradigm; English

Expectation-based approaches in which perceptual input is evaluated with respect to internally generated forward models provide compelling and increasingly influential explanations of phenomena in the perception and motor control literatures [1,2]. Similar forward-modeling approaches may also provide a promising explanatory framework for spoken language processing. Perceptual expectations can readily account for the speed of real-time language processing, listeners' sensitivity to fine-grained contextually-conditioned subphonetic variation, and rapid adaptation to speaker-specific characteristics.

From this perspective, recent studies demonstrating effects of acoustic manipulations early in a spoken sentence on the interpretation of sentence material several syllables downstream are particularly striking [3,4]. For example, manipulations of speech rate distal to the potential location of a function word affect whether listeners report perceiving it, regardless of whether it is present or absent in an utterance [3]. The distal locus of these effects suggests that they are rooted in listeners' expectations about the acoustic-phonetic realization of upcoming segments.

To provide a stronger test of this forward-modeling account, we investigated the time-course of speech rate effects on the interpretation of indefinite articles in a visual-world experiment. Participants ($n=32$) listened to utterances containing a singular or plural expression immediately followed by a sibilant-initial word [6], and selected the picture mentioned in each utterance from a display containing singular and plural alternatives. For singular expressions, two manipulations were conducted to discourage the perception of the acoustically present determiner. In the *proximal-manipulation condition*, the determiner and surrounding segments (the *determiner region*, e.g. the underlined segments in [6]) were sped up; in the *distal-manipulation condition*, the preceding and following utterance context were slowed down. Both manipulations resulted in the determiner region having a faster speech rate than the surrounding context. For plural expressions, corresponding manipulations were conducted to slow the rate of the determiner region relative to the surrounding context and thereby encourage the perception of an acoustically absent determiner.

Consistent with predictions of the forward-modeling account, effects of speech rate emerged shortly after the processing of the determiner region. Proximally- and distally-manipulated singular expressions elicited more fixations to plural pictures than unmanipulated singular expressions, whereas proximally- and distally-manipulated plural expressions elicited more fixations to singular pictures than unmanipulated plural expressions. These findings demonstrate that listeners' expectations about the acoustic realization of spoken words in context are strong enough to cause words to effectively appear or disappear during online comprehension. However, suggestive effects of the duration of the ambiguous sibilant following the target word imply that determiner perception is probabilistic, rather than all-or-none. Longer sibilants resulted in more fixations to plural pictures relative to singular pictures, demonstrating that determiner perception, whether hallucinatory or veridical, can be modulated by phonetic information encountered several syllables later. This finding suggests that listeners maintain uncertainty about previously encountered input [5].

These results set the stage for explicit quantitative tests of forward models of spoken language processing based on cue-reliability, e.g., manipulating the relative reliability of asynchronous determiner- and sibilant-based cues to examine how the strength of listeners' determiner-based expectations affects the integration of these cues.

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Common ground and interactive feedback in online language understanding: The role of attentional and executive networks

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Common ground; Feedback; Attention; Inhibition; On-line; , Eye-tracking ; English

The lack of consensus on the use of common ground (CG) during on-line language interpretation may be attributable to (a) individual differences in executive function^{1,2} and (b) cross-experiment differences in interactive feedback used to establish CG³. However, tests of individual differences typically focus on a single underlying construct, and have not addressed the specificity of the hypothesized role of executive function to CG. Further, little research tests the role of feedback, despite claims that feedback is essential to establishing CG⁴. Here we use multiple individual-differences measures to identify cognitive mechanisms underlying use of CG, and contrast two types of feedback.

Method: 48 eye-tracked participants completed a partially-scripted dialog task and two individual-differences tasks: (1) a Stroop⁵ task, and (2) the Attention Network task⁶, which includes three subscales: Orienting, Alertness, and Executive Function. The participant and experimenter sat at separate computers and viewed the same 5x3 grid from opposite perspectives. Each square contained an animal wearing an accessory. Five animals were visible to both partners (*common-ground*), five to the participant (*participant-privileged*), and five to the experimenter (*experimenter-privileged*). The task was to identify whether adjacent squares had matching animals or accessories. The experimenter periodically asked three scripted questions, which formed the conditions of interest (see EXAMPLES). On critical trials, scenes contained two critical common-ground animals of the same type but with different accessories, both with a participant-privileged animal above. Question#1 (setup) asked about a privileged ("competitor") or unrelated animal. The experimenter then repeated the participant's answer, or immediately asked Question#2. This feedback manipulation tests whether repeat-type feedback more strongly establishes CG⁴ or signals difficulty⁷. Question#3 (critical) asked about an animal above/below a "target" CG animal, and was temporarily ambiguous with the "competitor" that could have been asked about in Question#1. We hypothesized that when Question#1 asked about the competitor, participants would be more likely to fixate the target because the competitor would be CG, and thus not a good thing to ask a question about².

Results and Conclusions: The preference to fixate the target vs. competitor during interpretation of Question#3 was analyzed with mixed-effects-models. When the competitor was mentioned, participants were significantly more likely to fixate the target, well before the disambiguating word ($t=5.20$, $pMCMC<.0001$). Further, individuals with higher Orienting ($t=3.25$, $pMCMC<.01$) and Inhibition (Stroop; $t=2.26$, $pMCMC<.05$) scores were more likely to consider the experimenter's feedback. Surprisingly, high-scoring participants looked at the target *less* following repeat-type feedback, vs. continuations. **Conclusions:** These results identify candidate mechanisms underlying sensitivity to feedback in conversation and suggest that both attention-orienting and conflict-resolution support discourse processing, potentially through orienting attention to upcoming referents, and resolving competition between candidate referents. The *decreased* target preference following repeat-type feedback suggests listeners expected to be asked about this information again. These findings suggest that in some cases, the function of feedback is not to *ground* information, but rather to mark incomplete discourse segments, or information to revisit. These findings suggest understanding the role of CG in on-line processing requires consideration of interactive cues in dialog, and individual differences in the ability to use those cues.

EXAMPLE SCRIPT (Scene has two common-ground bears): **Question #1** (setup): Experimenter: *What's in the top middle?* Participant: *A pig wearing glasses.* Exp: *Pig wearing glasses* (repeat-type feedback) / (continue to Quest. #2) **Question #2:** Exp: *What's below the caterpillar that's wearing glasses?* P: *A pig wearing lipstick.* **Question #3** (critical): Exp: *What's above the bear that's wearing glasses?* P: *A cow wearing shoes.*

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Pitch trumps duration in a grouping perception task

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Prosody; Perception; Boundary perception; Phrasing; Prosodic grouping; Pitch; Timing; American English

Speech timing patterns are known to serve as critical cues for perceived prosodic grouping, making timing central to the study of how prosody encodes meaning at all levels of linguistic structure. Investigations of, e.g., the prosody of attachment ambiguities therefore focus heavily on temporal information, operationalized as objective interval duration. Experimental studies of F0 in the context of prosodic grouping are comparatively rare (cf. [7], [4] on “declination reset”, [8] on phrase-initial reset). Perceived duration, however, may differ dramatically from measured duration: Dynamic f0 in speech can lead to longer perceived vowel duration ([12], [3]), and non-speech research has likewise shown that pitch manipulations can alter perception of timing ([9], [6]). Studies on the auditory kappa effect in particular ([2], [5]), show that in sequences of tones and silent intervals, pitch differences among tones can distort perception of timing such that tones closer in pitch are also perceived as closer in time.

To determine whether pitch interacts with timing similarly in the perception of prosodic grouping in speech, we conducted a study involving a string of 3 spoken numbers, parsable as “NN-N” or “N-NN”. The AXB design (based on [10] and [9]), used 3 rise-fall, full intonational phrase (H* L-L%) versions of the word *one*, resynthesized from the same 302 ms. base recording, and shifted in 1-semitone steps. A was set as the highest, 8 semitones above B. X was chosen from 7 intermediate pitch steps, and placed at each of 10 time steps (410 to 590 ms.) after A. (The X to B interval likewise shifted, such that the two silent intervals always totalled 1 second.) 14 participants indicated whether X was grouped with A or B for 4 repetitions of 70 resulting stimuli.

A previous study [1] with identical stimuli showed that, in a non-linguistic task involving explicit timing comparison of the A-to-X and X-to-B intervals, while subject responses were based primarily on interval duration, they were modulated by relative pitch as well: As with the kappa effect in non-speech studies, closer in pitch sounded closer in time. In the present study, however, subjects received no instructions concerning the signal itself, but were told to report only which “grouping” they heard. Surprisingly, timing now affected subject responses comparatively little: where X was closest to A (e.g., 1 or 2 st. lower), subjects overwhelmingly grouped X with A, while X closer to B (e.g., 6 or 7 st. below A) cued grouping with B, interval durations notwithstanding. Timing differences affected responses strongly only for intermediate (i.e. ambiguous) pitch steps. (See partial summary in Table 1.)

These results suggest that quantification of boundary strength based only on objective duration misses powerful cues from F0. This may shed light on durational variability in related production studies: jumps in pitch across pauses may signal stronger boundaries, while steady pitch may signal a weaker boundary, in ways that current systems of categorical pitch event labels (e.g., ToBI) are not designed to capture. These results also parallel findings from duration studies characterizing boundary strength as inherently relative, and gradiently variable [11].

Table 1: Partial Results	time	pitch	1 st.	2 st.	4 st.	6 st.	7 st.
% responses of	A to X = 410 ms. (B to X = 590 ms.)		4%	7%	25%	69%	78%
“X grouped with B” for a	A to X = 470 ms. (B to X = 530 ms.)		2%	11%	49%	83%	87%
subset of time & pitch	A to X = 530 ms. (B to X = 470 ms.)		11%	11%	43%	89%	95%
steps	A to X = 590 ms. (B to X = 410 ms.)		17%	29%	61%	84%	96%

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Effects of phonological confusability on speech duration

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Speech production; Natural corpora; Confusability

When speaking, we need to balance the wish to be understood against bottlenecks resulting from the planning processes involved in language production. How speakers manage this balance is one of the central questions in psycholinguistics. Some posit that speakers merely hem to their internal production constraints while others posit that speakers strike a balance between their internal constraints and those of their listeners (audience design). Work in the intelligibility of speech has focused on if and how speakers modify their articulations so as to avoid confusion. Currently, there are two opposing findings in confusability and articulation: in scripted sentence and isolated word production there is evidence that phonological confusability (as approximated by phonological neighborhood density, NHD) results in greater vowel dispersion and longer spoken duration [1]. Conversely, in unscripted speech the conclusion has been that NHD results in shorter durations and less vowel dispersion [2] & [3]. Recent work suggests that articulatory efforts are a function of *contextual* confusability [4].

We hypothesize that language production is sensitive to *contextual* confusability and that this explains the apparent conflicts in prior work. We analyzed word durations in Switchboard as a function of three novel measures of contextualized confusability: bigram-weighted NHD (CND, i.e. $\text{forward CND}(w_i | w_{i-1}) = \sum_k p(N_k(w_i) | w_{i-1}) / (1 - p(w_i | w_{i-1}))$, where $N_k(w_i)$ is the k th phonological neighbor of w_i), number of prior neighbor mentions and distance since last neighbor.

Data: We extracted all nouns and verbs from Switchboard[5]. We excluded tokens preceding or following a speech pause or disfluency, types with fewer than 20 occurrences, types with more than 7 phonemes, tokens with missing data and tokens with absolute log duration and log speech rate z-scores > 2.5 . The final set contained 99053 tokens (542 noun and 433 verb types).

Analysis: Normal NHD and our novel measures of confusability were included in a mixed effect linear regression against log-transformed duration while controlling for expected word duration based on biphone duration averages, phoneme length, contextual log syllable per second speech rate, log frequency (in Switchboard), bigram forward and backward probability, distance in words since last mention and random by-speaker intercepts.

Results: As in [2] & [3], greater NHD reflected shorter durations ($ps < .05$), this suggests that speakers do not adjust for context neutral confusability as measured by NHD. Consistent with [4], as distance since last neighbor increased, spoken durations decreased ($ps < .05$); further, higher forward CND resulted in longer durations ($ps < .05$). Backward CND had a mixed effect on duration; more work is needed to know why.

Conclusion: While we replicate the finding that greater out-of-context NHD seems to be correlated with shorter durations (contrary to the audience design hypotheses), we also find that word durations tend to be longer if a word would (otherwise) be confusable *in its actual context* based on CND and proximity to neighbors (consistent with the audience design hypotheses). More broadly this work suggests divergence between unscripted and scripted speech patterns with regards to NHD is partially explained by contextual factors.

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Structural-frequency affects processing cost: Evidence from Chinese relative clauses

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Relative clauses; Structural frequency; Self-paced reading; Chinese

Previous work (e.g., Hsiao and Gibson, 2003) has argued that object relatives (ORs) in Chinese are processed easier than subject relatives (SRs). One explanation is that SRs have a longer distance between the head noun and its corresponding gap than ORs as Chinese relative clauses are prenominal. Another explanation is that the relatively lower structural probability of ORs compared to SRs makes ORs harder to process (Jurafsky, 1996; Hale, 2001; Levy, 2008). Yet when Chinese RCs are presented without syntactically constraining material, temporary ambiguities arise before the head noun is encountered. This makes it difficult to interpret reading times in the region preceding the head noun or at the head noun. Gibson & Wu (2011) addressed this issue using disambiguating context so that the target sentence was guaranteed to be a relative clause from the outset. They found an OR advantage, but restricted to subject-modifying RCs, presumably because of the difficulty to eliminate the temporary ambiguities in object-modifying RCs even with constraining context.

Thus, two problems exist in previous work: we do not know (a) whether the OR advantage exists in out-of-context sentences; and (b) whether the OR advantage is seen in object-modifying RCs as well. In the present self-paced reading study, we look for the OR advantage in both subject-modifying and object-modifying Chinese RCs, using out-of-context relative clauses that are completely unambiguous from the very outset of the sentence. We begin the sentence with a determiner-classifier (det-cl) sequence *na ge* (see (a)) that requires a head noun (here *guke*, 'customer'). However, the det-cl sequence is followed not by the expected noun but an adverbial phrase (e.g., *zuowan*, 'yesterday evening'); it guarantees that the following segment is a relative clause, avoiding the temporary ambiguity preceding the head noun. This manipulation is done for SRs and ORs in subject-modifying RCs as well as in object-modifying RCs (c-d).

Contrary to the predictions of Hsiao & Gibson 2003, Gibson & Wu 2011, we found an SR advantage in the pre-head region (Verb-Noun vs Noun-Verb) in both subject- and object-modifying RCs, and an SR advantage in subject-modifying RCs two words following the head noun. No other effects were found.

The SR advantage in the pre-head region can only be explained in terms of structural-frequency accounts. We cannot hang a major theoretical conclusion on the null result (the absence of any significant effect) at the head noun, but if it is real, then it could be explained by assuming that both locality and expectation-based facilitation canceling each other out (i.e., both factors could play an opposing role). However, if this were the explanation for the null result, we would have difficulty explaining the SR advantage in the post-head noun region. The post-head noun SR advantage is compatible with structural frequency account if it is a spillover effect from previous regions. An interesting question is: why did Hsiao & Gibson 2003 find an OR advantage? We believe this is partly because they used much older participants, mean=45 years (Hsiao 2002, p. 60), than other Chinese RC studies have used, with rather low question-response accuracies even for simple one-embedded relative clauses (76% in ORs, 71% in SRs; cf. 86% and 84% in our expt.). Indeed, a previously reported replication using their items found an SR advantage (Kuo & Vasishth 2006 MS) before and after the head noun. Thus, we believe that the Hsiao and Gibson 2003 results need to be validated via a careful replication (or replications) using the same items and fillers.

- (a) **Na ge** | zuowan | zou le | fuwusheng | yi dun | de | **guke** | jian guo | laoban ... (Subj-modifying SR)
det cl | yesterday.eve. | hit asp | waiter | one cl | rel | customer | see asp | boss ...
'That customer who hit the waiter yesterday evening had seen the boss before
- (b) **Na ge** | zuowan | fuwusheng | zou le | yi dun | de | **guke** | jian guo | laoban ... (Subj-modifying OR)
det cl | yesterday.eve. | waiter | hit asp | one cl | rel | customer | see asp | boss ...
'That customer who the waiter hit yesterday evening had seen the boss before
- (c) Laoban | jian guo | **na ge** | zuowan | zou le | fuwusheng | yi dun | de | **guke** ... (Obj-modifying SR)
boss | see asp | det cl | yesterday.eve. | hit asp | waiter | one cl | rel | customer ...
'The boss had seen that customer who hit the waiter yesterday evening before
- (d) Laoban | jian guo | **na ge** | zuowan | fuwusheng | zou le | yi dun | de | **guke** ... (Obj-modifying OR)
boss | see asp | det cl | yesterday.eve. | waiter | hit asp | one cl | rel | customer ...
'The boss had seen that customer who the waiter hit yesterday evening before

Listening to resumptives: An auditory study of object resumption in English

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Resumptive pronouns; Auditory stimuli; Acceptability task; English

The claim that resumptive pronouns (RPs) ameliorate island violations in English is widespread in the theoretical literature. Yet this intuition has not been substantiated by experimental work [1], [2]. We present a large-scale experiment on the acceptability of object RPs in English under several island conditions. Unlike previous experimental studies, this study uses auditory stimuli.

The experiment used a 2x3x3 factorial design: *wh*-question/declarative; adjunct islands/complex noun phrases/factive islands; island violation with a gap/island violation with RP/grammatical control (see (1)-(3) for the declarative examples of island violations). There were 540 items with corresponding comprehension questions. Participants (N=64) listened to items and rated them on a 5-point Likert scale. Replicating past reading-based findings, we found no difference in the ratings of adjunct islands with RPs as opposed to adjunct islands with gaps, no difference in the rating of complex noun phrases with RPs compared to gaps, or of factives with RPs vs. gaps (all p 's > 0.05). Post-hoc, we pursued the potential confound that many English verbs can be used in both transitive and intransitive frames without any morphological change. This means that a sentence *This is the wheel that because Mary turned ___ she moved the ball* could be interpreted as either containing a gap or as the nonsensical, but arguably more grammatical version in which Mary turns *herself*, and the ball moves. Using VALEX [3], we determined which stimuli contain verbs that are at least as likely to occur in an intransitive frame as in a transitive frame. When those stimuli were removed, the mean rating of adjunct islands with RPs became significantly better than those with gaps ($p < 0.05$). It is still lower than the rating of the grammatical controls.

The selective preference for RPs over gaps in adjunct islands but not other types of islands suggests that resumption appears for reasons other than island repair. Of the three island types considered here, the adjunct clauses are all high adjuncts and the only ones that are associated with the main predication (noun modifiers and factives are part of an argument). They are used to denote a subsidiary event related to the main event. The main and adjunct clause, can therefore be construed as part of a coherent discourse. If so, the use of resumption in adjunct clauses is similar to the use of cross-sentential anaphora ([Main clause ... [Adjunct ... pronoun_i...] NP_i ...]). Such discourse anaphora is simply impossible in the other types of clauses, and resumption is rejected there. Overall our results confirm that resumption in English does not rescue islands, thus supporting the findings in [1], [2]. This view of English resumption differentiates it from "true" resumption in languages such as Irish or Lebanese Arabic and offers further support of McCloskey's position that the two phenomena are different [4]. The adjunct island results can be accounted for in terms of discourse anaphora and performance pressures in production.

- 1) Adjunct-Island Gap: This is the metal that unless the company mines ___ there will be a shortage.
Adjunct-Island RP: This is the metal that unless the company mines it there will be a shortage.
- 2) CNP-Island Gap: This is the metal that the company that mined ___ got a government contract.
CNP-Island RP: This is the metal that the company that mined it got a government contract.
- 3) Factive-Island Gap: This is the metal that the fact that the company mined ___ devalued its stock.
Factive-Island RP: This is the metal that the fact that the company mined it devalued its stock.

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Object animacy effects in more or less transitive sentences

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Object animacy; Idiosyncratic case marking; Eye-tracking; Parafoveal-on-foveal; Self-paced reading; Event Related Potentials (ERPs); German

German verbs that assign idiosyncratic dative case to their direct objects are “less transitive” than the standard accusative-assigning verbs¹. The relationship between their arguments is not quite accurately described by the thematic role labels “agent” and “patient”, being less hierarchical than these imply². Does this difference between structural and lexical case marking verbs affect the use of another type of hierarchy, namely animacy, in parsing? Compared to “standard transitive” sentences with an animate subject/agent and an inanimate object/patient³, sentences with two animate arguments cause well-known processing difficulties in the absence of morphosyntactic cues about “who did what to whom”^{4,5,6,7}. We aimed to answer the question whether the use of animacy hierarchies interacts with the degree of transitivity of the sentences processed. We present data from reading time, eye movement and EEG measurements, comparing object animacy effects in verb-final embedded sentences with either prototypically transitive acc.-assigning or non-prototypically transitive dat.-assigning verbs. Subjects and objects are bare plural NPs without overt morphological case marking. Thus, readers have to rely on word order and semantic / lexical information in case assignment and parsing. Unlike previous studies on animacy hierarchies and case marking⁷, we used grammatical, plausible sentences:

Condition 1a/b: accusative verb with (a) inanimate or (b) animate object NP

Condition 2 a/b: dative verb with (a) inanimate or (b)animate object NP

Peter sagt, dass Studentinnen (a) Vorlesungen / (b)Professoren begeistert (1) loben / (2)applaudieren, und Ida sagt das auch.

Peter says that students-fem.pl(nom) lectures-pl(inanim,acc=dat) / professors-pl(anim,acc=dat) enthusiastically praise/applaud and Ida says that too.

“Peter says that students enthusiastically (1) praise / (2) applaud (a)lectures / (b)professors, and Ida says so, too.”

Self-paced reading times indicate differences in the effect of object animacy between verb classes, with reading times on the postverbal word (*und*) about 15 ms longer in 1(b) than in 1(a), but no difference between 2(a) and 2(b). Eye movement measures showed that the first pass reading times on the preverbal adverb (*begeistert*) were lengthened about 13 ms after animate objects, again only in condition 1. This suggests that the interplay between the two types of information starts already during preview processing in natural reading. Preliminary analyses of our EEG data suggest a more negative-going waveform in the 400-700 ms time window on the critical verb for animate compared to inanimate object sentences in condition 1, while not showing object animacy effects in condition 2. All reported effects and interactions are statistically significant. We conclude that the information on animacy hierarchies is used differently in the processing of sentences depending on the degree of transitivity of the verb. The interaction between a verb’s case assignment pattern and the animacy of its arguments causes significant behavioural and physiological effects, even when case marking is not morphologically overt. Thus, the notion of transitivity as a gradable semantic property encoded in the syntax is not only useful in describing idiosyncratic case marking patterns, but also in gaining insight into language processing behaviour.

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Integration costs on auxiliaries: A self-paced reading study using WebExp

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Integration cost; Dependency locality theory; Relative clauses; Self-paced reading; WebExp; English

Object relative clauses (as in 1b) are more difficult to process than subject relative clauses (1a) (King and Just, 1991). Dependency Locality Theory (DLT; Gibson, 2000) accounts for this effect in terms of long-distance dependencies: The integration cost at in (1a) is lower than at in (1b) because just one argument () needs to be integrated in (1a), whereas in (1b), two arguments (chairman and) need to be integrated, and the distance between and is larger in (1b).

Demberg and Keller (2008) evaluated DLT integration cost on an eye-tracked corpus of newspaper articles (Dundee Corpus; Kennedy and Pynte, 2005), and found that verbs which were preceded by nouns were read more slowly than verbs which were preceded by both auxiliaries and nouns. Demberg and Keller thus hypothesized that integration costs might not be incurred at the main verb (as predicted by DLT), but at the auxiliary, at which it should thus be possible to observe an integration cost effect. Most previous experimental studies on locality effects do not contain auxiliaries (with the exception of Warren and Gibson (2002), who found increased reading times on the auxiliary, adverb and verb in conditions with higher integration cost). The present study sought to directly investigate whether integration costs can be measured on auxiliaries.

We created 24 subject and object relative clauses with auxiliaries preceding the embedded verb, based on the experimental items from Staub (2010), see (1). We ran a self-paced reading experiment with 126 participants online, using WebExp, webexp.info, an experimental software that carries out psychological experiments over the internet.

On raw reading times, there was a significant effect of relative clause type on the determiner (SRC determiners are read more slowly than ORC determiners; a similar effect was found on the noun region in early reading time measures in Staub 2010; differences may be due to differences in SPR vs. eye-tracking), as well as significantly faster reading on the auxiliary and embedded verb of SRCs. The facilitation effect on SRC auxiliaries and difficulty effect on SRC determiners disappeared, however, when reading times were residualized with respect to the frequency of the preceding word, thus accounting for spill-over effects.

The contribution of this abstract is two-fold. We find that increased reading times on auxiliaries can be explained in terms of spill-over effects, thus not supporting the hypothesis of Demberg and Keller (2008), who suggested that integration costs might occur at auxiliaries and facilitate integration at the verb. Instead, our findings support the original predictions of Dependency Locality Theory (Gibson, 2000). Furthermore, we provide evidence for the validity of self-paced reading via WebExp, by replicating the established relative clause asymmetry result on the embedded verb. Initial evidence that timing using WebExp is sufficiently accurate for self-paced reading studies is presented in Keller et al. (2009). To the best of our knowledge, the present results are the first ones for word-by-word SPR using WebExp, as previous studies used much larger regions.

(1) a. The mathematician who [had] [visited] [the chairman] a solution to the problem.

b. The mathematician who [chairman] [] [] a solution to the problem.

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Neurolinguistic evidence for independent contributions of verb-specific and event-related knowledge to predictive processing

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Semantic processing; Neurolinguistics; Aphasia; Self-paced reading; English

Evidence suggests that comprehenders predict upcoming verbal arguments (e.g. Altmann & Kamide, 1999) and that mismatches between predicted and encountered arguments cause processing disruption (Federmeier, 1999; Speer & Clifton, 1998). However, the source of these predictions is controversial. Some argue that event-related conceptual knowledge is used to anticipate likely upcoming arguments: verbs activate event representations, which in turn activate entities that commonly participate in such events (e.g., McRae et al., 2001). Others argue that verbs' selectional restrictions underlie predictions for possible upcoming arguments: verbs impose semantic constraints on their arguments, facilitating any argument that satisfies those constraints (Boland, 2005).

The current study suggests that these two sources of argument predictions may be dissociated following brain damage. Unimpaired older adults (n=36) and adults with left-hemisphere damage and aphasia (n=11) performed self-paced reading and sentence-final acceptability judgments on stimuli from Warren and McConnell (2007). Sentences contained a critical NP (underlined in 1), which was either a plausible argument of the verb (1a), a highly implausible/unlikely but possible argument (1b), or an impossible argument that violated the verb's selectional restrictions (1c). We interpret reading times and acceptability judgments as indexing the degree of processing disruption associated with a mismatch between the encountered argument and the verb's argument prediction.

If semantic predictions are generated in the left hemisphere (e.g. Federmeier, 2007), adults with aphasia may show less disruption for prediction-violating arguments than unimpaired adults do. If argument predictions arise from knowledge about likely event participants (McRae, et al., 2001), adults with aphasia should show similar disruption in the implausible and impossible conditions, because norming indicated that these arguments were similarly unlikely. If selectional restrictions independently contribute to argument predictions (Boland, 2005), performance on the impossible and implausible conditions may differ, because only impossible arguments violate selectional restrictions.

Acceptability judgments (2) revealed a significant interaction between group and condition ($p < .05$): unimpaired adults were more likely to reject impossible than implausible arguments ($p < .05$), whereas adults with aphasia were marginally more likely to reject implausible than impossible arguments ($p = .06$). Furthermore, unimpaired and aphasic adults' rejection rates for implausible arguments did not differ, but aphasic adults rejected impossible arguments less often ($p = .05$). These results suggest that aphasia disrupts the use of selectional restrictions more strongly than event-related knowledge (cf. Myers & Blumstein, 2005). Unimpaired and aphasic adults read implausible and impossible arguments more slowly than plausible ones (3). (The fact that unimpaired older adults showed no RT differences between the anomalous conditions is interestingly different from Warren & McConnell's eye-tracking findings with young adults, but seems to be driven by the behavior of high-WM participants in the self-paced reading task; they showed little RT dissociation among conditions.) Interestingly, individual aphasic adults' reading-time patterns differed: individuals with temporal-lobe damage showed smaller reading-time differences across conditions than individuals without temporal involvement. This finding provides preliminary localization evidence suggesting that temporal-lobe areas are especially important for prediction and rapid integration of arguments. Together, these findings indicate that selectional restrictions and event knowledge may contribute independently to verbal argument prediction.

(1) Stimuli from Warren & McConnell (2007; | marks self-paced presentation regions)

- a. Maria | used | a knife | to chop | the | large | carrots | before dinner | last night. (Plausible)
 b. Maria | used | some bleach | to clean | the | large | carrots | before dinner | last night. (Implausible)
 c. Maria | used | a pump | to inflate | the | large | carrots | before dinner | last night. (Impossible)

(2) Proportion of rejections, acceptability judgment

	Controls:	Adults with aphasia:
(a)	10%	26%
(b)	89%	85%
(c)	96%	77%

(3) Mean reading times, critical noun (in msec)

	Controls:	Aph. (temporal):	Aph. (no temporal):
(a)	946	1252	1026
(b)	1042	1244	1129
(c)	1055	1333	1214

Ungrammatical interpretations of reflexive anaphors: Online or offline interference?

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Syntactic processing; Reflexive anaphors; Retrieval interference; Eye-tracking; Self-paced reading; English

Recently the processing of reflexive anaphors has generated much insight into the parser. Studies investigating the online processing of reflexives suggest that syntactic cues act as a hard constraint on antecedent retrieval, such that syntactically illicit NPs do not result in early intrusion effects [1-3]. However, this conclusion is at odds with data suggesting that interfering NPs can produce ungrammatical reflexive interpretations in offline tasks [1,4], and data that suggests the possibility of late interference effects [1]. We hypothesize that this discrepancy is only apparent, and that during routine parsing, interpretation of the reflexive is strictly structurally guided. The offline data instead reflect a strategy for answering comprehension questions when a sentence is poorly understood. Such a strategy might cause participants to draw on verbatim memory of the sentence, using the reflexive's gender features to choose between presented alternatives at test. If so, then we predict that i) incorrectly answered trials should show no plausibility-related slowdowns, reflecting poor comprehension and ii) disruption of verbatim memory should eliminate or reduce offline intrusion effects.

The present study investigates this by jointly measuring processing time and reflexive interpretation. In a moving-window self-paced reading paradigm (Study 1; $n=38$), we presented participants with 24 sentences of the form in (1) and (2). We manipulated whether the reflexive matched the main clause subject's stereotypical gender (*congruent/incongruent* gender), and the gender of the embedded subject (*interfering/non-interfering*). Each critical sentence was followed by a question about the reflexive's interpretation.

Our results confirm that there is no illusion of grammaticality for reflexive anaphors [1-3] (main effect of *congruency* in the spillover region $F(1,37) = 19.1, p < 0.001$), and no interaction of *interference* and *congruency*. Additionally, we found significant decreases in comprehension accuracy when the interfering noun matched the reflexive's gender features, as reported by [1,4]. Linear-mixed effects modeling revealed that the congruency effect was driven by reading time on correctly answered trials, as shown by a significant interaction of *congruency* and *accuracy* ($\beta = -62, se = 18, pMCMC = 0.001$). This effect was not modulated by the gender of the interfering noun. Surprisingly, there was also a significant main effect of interfering gender ($\beta = -11, se = 4, pMCMC = 0.02$), such that *interfering* conditions were read more quickly, independently of the reflexive's gender.

This pattern of results supports the first prediction of our hypothesis: incorrect trials showed no implausibility-related slowdown, suggesting that on those trials comprehenders were not constructing robust interpretations of the sentence. An in-progress follow-up study tests the second prediction of our hypothesis: disruption of verbal memory should eliminate offline interference, because comprehenders would not be able to use verbatim memory of the reflexive's gender features to respond. In Study 2, before being presented with a comprehension question, participants were asked to complete a difficult arithmetic problem to disrupt verbatim memory of the target sentence.

Together these studies suggest that offline comprehension errors do not reflect online retrieval error for reflexive dependencies. Instead, incorrect responses stem from offline interference that is driven by a superficial representation of the sentence.

1) **Congruent:** *The ballet dancer* who {**Interfering:** *Emily*/ **Non-interfering:** *John*} danced with on stage introduced *herself* to the audience.

2) **Incongruent:** *The ballet dancer* who {**Interfering:** *Emily*/ **Non-interfering:** *John*} danced with on stage introduced *himself* to the audience.

Who was introduced to the audience? **John/Emily** **The ballet dancer**

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An Alignment-based model of scan patterns during Visual World experiments

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Cross-modal perception; Visual attention; Visual world paradigm; Eye-tracking; Computational modeling; English

Linguistic processing in the context of a visual scene triggers characteristic eye-movement responses, with fixated objects reflecting, for instance, syntactic disambiguation or semantic anticipation (see e.g. Tanenhaus et al., 1995). However, existing models based on (VWP) (e.g., Mayberry et al., 2005; Roy and Mukherjee, 2005) focus on modelling phenomena such as anticipation, i.e., predicting the next word given the linguistic and visual context, rather than capturing eye-movements directly.

We present a computational model of eye-movements on a visual scene during the interpretation of a spoken sentence. The key modelling insight is that this is an alignment problem, in which objects in the scene have to be aligned with phrases in the sentence. Alignment is well-studied in computational linguistics, and a range of relevant algorithms exist. Our model consists of two stages: A Hidden Markov Model (HMM) aligns objects with phrases based on semantic roles, i.e., predicts which objects are fixated when a phrase is processed. For example, in (1), our model predicts in which order the scene objects corresponding to agent, location, target are fixated.

(1) [The boy]AGENT [will move]PREDICATE [the ball]PATIENT [in the bin]LOCATION [on the table]TARGET

A simple HMM that takes a sequence of semantic roles as input can reliably align the corresponding phrases with correct scene objects. This confirms a basic finding of VWP experiments: objects are fixated when or shortly after they are mentioned. This stage of our model is conceptually similar to Mayberry et al. (2005), who use a simple recurrent network to align words and objects. However, when syntactic or visual ambiguity are introduced (i.e., several objects can correspond to a semantic role), the HMM is prone to errors caused by variability in the data, and predicts either the correct object or its direct competitor at a given time frame, depending on the number of fixations they receive during training. We therefore extend our model to predict the probabilities with which scene objects are fixated. We apply Monte-Carlo Markov Chain (MCMC) sampling to these probabilities in order to generate sequences of fixations. This predicts human-like scan paths during VWP experiments, which models such as that of Mayberry et al. (2005) are not able to do.

We evaluate our model on three VWP datasets (Coco, 2011). The sentences include syntactic ambiguity and the scenes are referentially ambiguous, giving rise to competition between target objects and their competitors, which we can capture using the MCMC approach. The results - average similarity calculated using the Needleman-Wunsch algorithm (see e.g. Cristino et al., 2010) - summarized in the table below, indicate that MCMC sampling improves the performance considerably over an HMM baseline.

We introduced a model that predicts scan paths in VWP experiments, even in the face of syntactic and referential ambiguity. Future work includes modelling the fixation dynamics within phrases: e.g., the amount of fixations on the target increases after the onset of the noun.

Model	HMM alignment	MCMC alignment	Subject agreement
Needleman-Wunch distance	0.97 ± 0.0015	0.29 ± 0.0012	0.25 ± 0.0060

Table 1: Results for the prediction of sequences of fixated objects. Lower distance is better.

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An ACT-R framework for modeling the interaction of syntactic processing and eye movement control

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Parsing difficulty; Eye-tracking during reading; Retrieval; Surprisal; Computational modeling; Corpus study; English; German

Previous work (Boston et al., 2011) has shown that surprisal (Hale, 2001) and retrieval difficulty (Lewis & Vasishth, 2005) are significant predictors of reading time in the Potsdam Sentence Corpus (PSC). It remains an open question how such measures of parsing difficulty interact with eye movement control processes (Reichle et al., 2009). We investigate this interaction using the eye movement control model EMMA (Salvucci, 2001), a serial attention shift model similar to E-Z Reader, which is integrated in the cognitive architecture ACT-R. Several simulation studies are presented that explore the possibilities of incorporating surprisal and retrieval in an ACT-R/EMMA model. The ACT-R model interacts with EMMA by shifting attention from word to word. The model includes a post-lexical integration stage inspired by Reichle et al. (2009), that triggers short regressions on high difficulty. A baseline study evaluates the performance of the latest EMMA implementation in ACT-R 6.0 on the sentences of the English Schilling Corpus, thereby replicating the original study by Salvucci (2001) in the latest version of the ACT-R architectural environment. The model reproduces effects of word frequency for gaze duration, first fixation duration, single fixation duration, and the probabilities of skipping, one fixation, and two+ fixations (mean correlation $r = 0.96$, RMSD = 0.220). In a second simulation the same model is applied to the German Potsdam Sentence Corpus ($r = 0.89$, RMSD = 0.285). Further simulations include surprisal, retrieval, and both, respectively, and are qualitatively evaluated on data of the PSC. Retrieval values (calculated by Boston, 2011, under independently motivated assumptions of ACT-R theory) are used to define the duration of the integration stage. Surprisal was tested in different configurations: (a) modulating integration time and (b) directly integrated in EMMA's equation of word encoding time. Configuration (b) is motivated by experimental and corpus work (e.g., Boston, 2011; Vasishth & Drenhaus, 2011) suggesting that surprisal may show early effects in the eye movement record more reliably than retrieval does. Our implementation of surprisal and retrieval, although resting on simplified assumptions, enables the model to reproduce general effects of both measures on reading time as observed in the PSC data (retrieval: $r = 0.67$, RMSD = 0.156; surprisal[b]: $r = 0.81$, RMSD = 0.309). The model predictions for frequency effects improve with the incorporation of surprisal[a] (RMSD = 0.232), retrieval (RMSD = 0.200) and in a model containing both predictors (RMSD = 0.199). The overall goodness of fit for word-by-word gaze duration improves only when surprisal is included ($r = 0.45$, RMSD = 0.983, vs. for the baseline: $r = 0.39$, RMSD 0.991). This work provides a first qualitative demonstration of an integrated, flexible framework incorporating two complementary measures of parsing difficulty interacting with eye movement control on different levels. It serves as a foundational step for future work on a precise investigation of the interactions between high-level language processing and eye movements.

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Brain regions sensitive to structure in language vs. music are largely non-overlapping in the human brain

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Syntactic processing; Music; fMRI; Domain specificity; Domain generality; Pitch; Rhythm

Neuro imaging and behavioral investigations have argued for overlap in the cognitive and neural mechanisms that support structural processes in language and music (Patel et al., 1998; Maess et al., 2001; Koelsch et al., 2002; Koelsch et al., 2005; Levitin & Menon, 2003; Tillman et al., 2003; Fedorenko et al., 2009; Slevc et al., 2009), with only one recent study suggesting otherwise (Rogalsky et al., 2011). However, neuropsychology studies have revealed dissociations between linguistic and musical deficits (Luria et al., 1965; Peretz, 1993; Peretz & Coltheart, 2003). To address this discrepancy, we examined the neural locus of structural processing in language and music using fMRI in individual subjects. Each participant (n=12) was run on (1) a language "localizer" experiment that included visually presented sentences and strings of pronounceable nonwords and that has been previously shown to identify key frontal and temporal regions implicated in linguistic processing (Fedorenko et al., 2010), and (2) a music experiment with four conditions featuring different degrees and aspects of music structure (intact music, music with scrambled note pitches, music with scrambled note onsets and durations, and music with both pitch and rhythm scrambled).

Results: brain regions sensitive to linguistic structure. In each subject we defined language-sensitive regions (see Fedorenko et al., 2010, for method details) and examined the response of these regions to the music conditions. None of the regions showed a significant Intact Music > Scrambled Music effect, although some regions showed a trend in this direction. Moreover, the response to the Intact Music condition in these regions was on average below the level of the Nonwords condition.

Results: brain regions sensitive to musical structure. First, we performed a group-constrained subject-specific analysis (Fedorenko et al., 2010) to search for spatially consistent music-structure-sensitive regions across subjects, using individual activation maps for the Intact Music > Scrambled Music contrast (thresholded at $p < .001$). This analysis discovered bilateral anterior superior temporal regions, bilateral regions in mid/posterior STG/MTG, and bilateral regions in the premotor cortex and the SMA. Each of these regions was activated in at least 8/12 subjects individually (the right temporal regions were present in at least 10/12 subjects). We then examined the response of these regions to the structural manipulations of music and language. All regions showed a highly robust Intact Music > Scrambled Music effect as measured from data not used to localize the regions. The response to the Pitch Scrambled and Rhythm Scrambled conditions fell between the Intact and Scrambled conditions in all of the regions, suggesting that these regions are sensitive to both pitch and rhythm structure. However, although most of the music-sensitive regions showed a response to the language conditions, none of the regions showed a significantly greater response to Sentences than Nonwords. Moreover, the right anterior temporal region (previously implicated in musical processing; e.g., Peretz et al., 1994) and the right posterior temporal region did not respond to the language conditions more than to the Scrambled Music condition.

These data show a robust dissociation between cortical regions that are sensitive to the presence of structure in linguistic vs. musical stimuli. These results are consistent with the patient literature, but inconsistent with previous neuroimaging, ERP and behavioral studies that have argued for overlap between these two domains. We argue that the previously observed overlap effects originate not within language- or music-sensitive regions discussed above, but rather in the domain-general regions of the fronto-parietal network that have been argued to respond to a wide range of cognitive demands (e.g., Duncan, 2001).

The effect of implied speed on eye movements in a (blank) visual world

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Pragmatics/semantics; Comprehension; Eye-tracking; English

Research has demonstrated that eye movements around a static scene can be guided by pragmatic and semantic cues (among other things) within a concurrent discourse [1,2]. Moreover, similar effects have been found even when that scene is absent, with recent studies showing that under these conditions, listeners can actually update their representation of a scene based on incoming language input [3]. The fact that participants in these tasks direct their gaze to the appropriate on-screen locations supports the experiential nature of language comprehension and demonstrates that the *affordances* denoted by an object/verb influence our understanding of their use in discourse.

We report results from two 'blank screen' paradigm studies, where participants viewed a visual scene containing either a 'fast' or 'slow' object (e.g. hare vs. tortoise), then once the scene had been removed, listened to short auditory descriptions of upcoming events (e.g. 'The [object] will [verb] across the garden'). Using a blank screen paradigm allowed participants to update their *mental* representation of the object, without constraints from the static visual scene. Experiment 1 (N=24) used neutral movement verbs (e.g. 'move') to examine baseline effects of object speed on eye movements, while Experiment 2 (N=40) also manipulated verb speed (e.g. 'bolt' vs. 'saunter'). Thus, we examined how pragmatic and semantic cues interact to influence the expected distance that an object will travel by measuring the distance of fixations around a blank screen, relative to the target object.

Eye-tracking analyses focused on the first five fixations from the verb onset. Results from Experiment 1 revealed that when one's pragmatic knowledge about an object implied a 'fast' movement (e.g. a hare), participants fixated on-screen locations that were further away from the target object, compared to objects that implied a 'slow' movement (a tortoise). This effect was apparent in the 3rd and 4th fixations following the neutral movement verb (all $t_s > 2.22$, $p_s < .05$). Moreover, in Experiment 2, analyses of fixation distances revealed a significant object*verb interaction in the 1st, 3rd, 4th and 5th fixations following the verb onset (all $F_s > 3.96$, $p_s < .05$). Simple main effects showed that these effects reflected fixations that were significantly further away from the target object in the fast object-fast verb condition, compared to either the fast object-slow verb (all $t_s > 2.02$, $p_s < .05$) or slow object-fast verb conditions (all $t_s > 2.2$, $p_s < .05$). In contrast, fixation distances in the slow object-slow verb condition did not differ from the slow object-fast verb or fast object-slow verb conditions (all $t_s < 1.18$). The exact time-course of these effects will be plotted relative to evolving language input.

These results show that a combined interpretation of pragmatic and semantic cues from incoming language can influence the incremental control of eye movements around a (blank) scene. Specifically, they suggest that the fixation distance from a target object can be modulated by pragmatic knowledge about the object's likely speed of travel, as well as semantic inferences from the movement verb itself. Moreover, these results show that this dynamic updating process rapidly integrates these cues and can reduce the *representational momentum* [4] when the two cues point to an implausible outcome (e.g. a sprinting tortoise), and maximize it under plausible conditions (e.g. a sprinting hare).

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Top-down effect of syntactic category expectations on spoken word recognition

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Syntactic expectations; Top-down effects; Spoken word recognition; Phonetic identification task; English

During spoken language processing, a listener must simultaneously identify words in the speech stream and arrive at a meaningful parse of each sentence. Measures of syntactic expectations [1,2] are successful predictors of cognitive performance in parsing tasks [3,4,5]. If readers deploy such probabilistic knowledge about these expectations during parsing, then might this information also have an impact on the simultaneous task of spoken word recognition? This would indicate that the processor is integrating many sources of information from context (e.g. syntactic expectations), even at the low level of phoneme/word identification.

In a phonetic identification task, participants were presented with target words in a noun-biasing or verb-biasing context such as (1) or (2).

- (1) Tom liked the _____. [noun-biased context]
- (2) Dennis liked to _____. [verb-biased context]

They responded whether the first consonant of the target was a “p” or a “b” on each trial. The targets’ waveforms were manipulated by changing the voice-onset time (VOT) of the initial stop consonant, making some words phonetically ambiguous between a voiced and voiceless initial consonant, resulting in a *bay-pay* and a *buy-pie* continuum. The phonetically ambiguous words were also of ambiguous syntactic category (noun vs. verb). In this way, phonological ambiguity and syntactic category ambiguity were crossed: in the *bay-pay* continuum, the voiced alternate is generally a noun; in the *buy-pie* continuum, the voiced alternate is generally a verb.

Because these were crossed, the critical test of whether syntactic category expectation can impact spoken word recognition is a CONTEXT x CONTINUUM interaction. This would indicate that participants are more likely to label ambiguous stimuli such that the syntactic category of their response and the category predicted by the context are consistent. For instance, the determiner “the” sets up an expectation for a noun. Subjects who demonstrate a CONTEXT x CONTINUUM interaction will be more likely, after hearing “the,” to make a “p”-response when an ambiguous target came from the *buy-pie* continuum, but to make a “b”-response when it came from the *bay-pay* continuum.

Indeed, subjects showed the critical CONTEXT x CONTINUUM interaction ($p < 0.001$), indicating that participants responded in a way that was biased towards congruency between their response’s syntactic category and the expectation set up by the context. There was also a main effect of CONTINUUM ($p < 0.01$): subjects made more “p”-responses to ambiguous targets from the *bay-pay* continuum than to targets from the *buy-pie* continuum. This finding could be due to another top-down effect from word frequency; the more frequent word in the *bay-pay* continuum is *pay* (“p”-response), but the more frequent word in the *buy-pie* continuum is *buy* (“b”-response).

Taken together, these findings indicate that the speech processor uses information about syntactic expectations to identify words during processing. Syntactic information can potentially be a rich resource for decoding the speech stream in a noisy environment. Though sentence processing and spoken word recognition have typically been studied as separate problems in psycholinguistics (but, see e.g. [6]), an important next step is to develop models of speech processing that work in conjunction with sentence processing models in order to explain the mechanisms behind auditory language processing.

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The accent by the adjunct: Pitch accenting interacts with argument structure and previous reference in online reference resolution

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Prosody; Pitch accent; Argument structure; Reference; Comprehension; Visual world paradigm; American English

We investigated how prior reference and argument structure interact with pitch accenting to constrain online reference resolution. In prior experiments [1], accented simple noun phrases were interpreted as new words, while deaccented nouns preferentially interpreted as given.

However, other accounts [2,3] have proposed that the mapping between accenting and discourse status is indirect and mediated by argument structure. Accenting an argument licenses deaccenting its head: *king* in (1b) is new but deaccented because its argument *diamonds* is accented. Adjuncts do not license deaccenting, so *king* is accented in (2b). Moreover, while constraints on the placement of accents have traditionally been taken to refer to new versus given lexical items, production experiments [4] suggest discourse salience influences prosodic prominence even with lexical repetition controlled.

Thus, we investigated (a) whether argument structure mediates the effects of pitch accenting on reference resolution, and (b) whether this applies even without differences in lexical repetition.

We tested online interpretation of accenting using the visual world paradigm. Participants ($N=52$) followed auditory instructions to click playing cards on a computer. Each trial featured two cards of each of two ranks (e.g., two kings, two queens). A mix of two display types was used. In *argument displays*, each card differed in suit and cards were named using an argument phrase, as in (3). In *adjunct displays*, all four cards had the same fictitious suit (stars) and were described using nearby object landmarks, as in (4). An initial instruction established one referent as mentioned, as in (3a). On critical trials, a second instruction referred to an unmentioned target of the same rank, as in (3b). (Filler trials established this card was not always the target.) Using cross-splicing, we manipulated whether the head of the target was accented or deaccented.

If argument structure mediates the interpretation of accents—and does so even with lexical repetition controlled—prominence should interact with display type. In the adjunct condition, a deaccented head noun misleadingly suggests an accessible referent and should increase looks to the already-mentioned competitor. But when an argument is anticipated, deaccenting the head is always licensed and deaccented heads should not cue the mentioned competitor over the unmentioned target.

A multi-level model assessed the log odds of fixating the competitor in the time window before the disambiguating suit (e.g., *diamonds*). As predicted, accent and argument structure interacted, $t=3.23$, $pMCMC<.05$. In the adjunct condition, deaccented heads increased looks to the mentioned competitor, $t=2.51$, $pMCMC<.0001$, but no such effect obtained in the argument condition, $t=0.13$, $pMCMC=.91$.

These results suggest pitch accents are not interpreted as a direct cue to discourse status but one mediated by argument structure. This finding is consistent with offline metalinguistic judgments [2,5] and demonstrates such constraints even influence online reference resolution. Moreover, although constraints on accent placement are typically understood as referring to new versus given *words*, our results suggest similar constraints for new versus old *referents*: both the mentioned and unmentioned referents had a given head noun, but accented nouns were preferentially interpreted as referring to unmentioned referents.

(1a) Which card did you play? (1b) I played the king of DIAMONDS.

(2a) Which card did you play, and where? (2b) I played the KING by the DIAMONDS.

(3a) First click the KING that's by the HEARTS. (3b) Now click the (king/KING) that's by the DIAMONDS.

(4b) First click the king of HEARTS. (4b) Now click the (king/KING) of DIAMONDS.

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Orthographic and phonological priming during normal sentence reading

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Priming in text reading; Eye-tracking; English

In a recent paper, Paterson, Liversedge, and Davis (2009) showed inhibitory priming effects for a word when preceded by a word's orthographic neighbour. For example, "blue" was fixated for longer when "blur" appeared in the immediate prior context compared to when it was preceded by the control word "gasp": "There was a blur [gasp] when the blue lights of the police car whizzed by." This is an important finding as it suggests that during word recognition, competition between lexical candidates (e.g., "blu_" activates the competitors "blur", "blue", "blub", etc.) is resolved by suppressing the activation of the incorrect candidates, making it harder to process one of these candidates later in the sentence.

Following Coltheart et al. (1977), and an extensive literature on single-word priming effects, Paterson et al. defined orthographic neighbours as words that differed from each other by one letter, irrespective of other attributes (e.g., phonological overlap). In Experiment 1 (N = 28), we tested whether all types of overlap lead to inhibitory priming effects. We distinguished 4 types, and constructed 32 items per type:

- (1) O+P+: Orthographic + phonological overlap (rhyming):
The birds ruffled their **wings** [tails] as the **kings** watched from their palace.
- (2) O+P+: Orthographic + phonological overlap (non-rhyming):
The captain found it a **strain** [burden] to negotiate the **strait** at the end of a long voyage.
- (3) O+P-: Orthographic-only overlap:
On noticing the giant **bear** [tree] John changed **gear** and pedalled away quickly.
- (4) O-P+: Phonological-only overlap:
The husband had a big **smile** [fight] walking down the **aisle** of the local supermarket.

Results showed that only O+P+ overlap resulted in inhibition (with the rhyming condition showing an immediate inhibition effect on the target word and the non-rhyming condition on the spillover region). No inhibitory or facilitatory priming effects were found on any eye-tracking measure for the O+P- or the O-P+ overlap conditions. The lack of an effect for the O+P- condition suggests that, if an orthographic-only neighbour gets activated during the recognition of the prime word, its suppression is much less than for O+P+ overlap neighbours. Hence, phonology seems to affect the activation and/or suppression of orthographic neighbours. A similar explanation can be put forward for the O-P+ condition, though other considerations lead us to believe that non-orthographic rhymes might not be activated during the recognition of the prime.

A second experiment (N=60) examined whether the inhibition effect reduces when the distance between the prime and target word increases, as expected in most models of word recognition (e.g., Grainger & Jacobs, 1996). This was indeed the case, with inhibition found only for the "short" condition (prime and target separated by 3 words on average) but not for the "long" conditions (prime and target separated by 9 words on average, and prime and target either in 1 or 2 separate sentences). However, a significant correlation was found for the long 1-sentence condition between the Gray Silent Reading scores, which tests the level of reading comprehension, and the inhibition difference scores, with greater inhibition for the good readers. This suggests that good readers keep orthographic neighbors active for longer, and that they discard this activation at the end of the sentence.

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Expecting the unexpected: How discourse expectations can reverse predictability effects in reading time

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Discourse; Reading time; Mechanical Turk; Predictability

A growing body of work points to reduced processing difficulty when the words that listeners encounter are frequent or predictable given surrounding linguistic context (Kliegl et al., 2004; Levy 2008). Such work, however, fails to incorporate the notion that language is often used to convey new, and therefore unpredictable, information (Grice, 1975). If comprehenders expect content to be informative, one can ask whether certain contexts strengthen that expectation and, in so doing, make otherwise unpredictable material easier to process and conversely make highly predictable material difficult. While contextual support improves otherwise difficult-to-process constructions (Altmann & Steedman, 1988; Rohde et al., 2011; van Berkum et al., 1999), our study considers the opposite—whether context can increase the difficulty of material locally predictable from surrounding words, while rendering locally unpredictable (but highly informative) material easy.

In a self-paced moving-window reading-time study, we manipulated the local predictability of an instrument noun and comprehenders' global expectations regarding the informativity of upcoming material. A context sentence established global expectations for high or low informativity by characterizing an individual as either surprising or boring. The target sentence then described an activity that this individual performed with an instrument that was either highly inferable (1a,2a) or unpredictable (1b,2b). In keeping with established effects of predictability, inferable instruments were hypothesized to yield faster RTs than unpredictable instruments when readers expected low informativity (1a faster than 1b). However, when readers expected material to be informative, those same locally predictable instruments were hypothesized to be anomalously underinformative—and thus yield slower RTs (2a slower than 2b). Data was collected using Mechanical Turk, a “crowdsourcing” marketplace where workers are paid for small amounts of work. The advantage of a large crowdsourced population was that participants saw only a few items each and were unlikely to adapt to the frequent violation of their discourse expectations (#participants=110; mean #targets/participant=3.96).

The predicted interaction was observed at the final word of the sentence (mixed-effect model: $p < 0.001$). Pairwise comparisons showed unpredictable instruments being read *faster* than predictable instruments when readers expected high informativity ($p < 0.001$), whereas the opposite (numeric) pattern held when readers expected low informativity ($p = 0.12$). The fastest and slowest RTs overall were in the high-informativity condition: fastest for unpredictable instruments (*brush his teeth... knife*), slowest for predictable instruments (*chop some carrots... knife*). The predicted interaction appears numerically at the critical word. At the first spillover, predictable instruments were read faster than unpredictable instruments but only in the low-informativity condition, replicating existing effects of predictability, at least in discourse contexts that do not create strong biases for new and informative content.

These results echo evidence of listeners' sensitivity to cues signaling upcoming linguistic complexity or new information (Arnold et al., 2007; Jaeger, 2010) and work on production showing that speakers tend to mention only uninferable, unpredictable instruments (Brown & Dell, 1987). But to our knowledge these new findings are the first evidence of comprehension difficulty for material that is overly predictable from local cues. The results point to the importance of modeling comprehenders' pragmatic expectations about upcoming material—namely, their expectations about relevance and informativity.

(1) Sentence1: low-informativity expectation

My classmate Matthew is a boring person who always does things the way you'd expect.

a. Sentence2: locally predictable instrument [“don't expect surprise, don't get surprise”]

For instance, in order to chop some carrots, he was using a knife yesterday in the afternoon.

b. Sentence2: locally unpredictable instrument [“don't expect surprise but get surprise”]

For instance, in order to brush his teeth, he was using a knife yesterday in the afternoon.

(2) Sentence1: high-informativity expectation

My classmate Matthew is a surprising person who never does things the way you'd expect.

a. Sentence2: locally predictable instrument [“expect surprise but don't get surprise”]

For instance, in order to chop some carrots, he was using a knife yesterday in the afternoon.

b. Sentence2: locally unpredictable instrument [“expect surprise, get surprise”]

For instance, in order to brush his teeth, he was using a knife yesterday in the afternoon.

Repeated names, pronouns and null pronouns in Brazilian Portuguese and Italian

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Anaphora; Reference; Self-paced reading; Brazilian Portuguese; Italian

The choice of anaphor form, such as a repeated name, overt pronoun, or null pronoun is heavily influenced by antecedent salience. Gordon et al. (1993) showed that, in English, repeated names are harder to process than pronouns when the antecedent is the grammatical subject. This *repeated name penalty* (RNP) has also been elicited in Chinese (Yang et al., 1999), a pro-drop language. Gelormini-Lezama & Almor (2011) extended the RNP to Spanish, a null subject language, but also found an *overt pronoun penalty* (OPP) such that sentences with null pronouns are read faster than sentences with overt pronouns when the antecedent is salient. Almor's (1999) Informational Load Hypothesis (ILH) explains anaphor processing as reflecting a balance between discourse function and processing cost: null pronouns are least costly and are linked to subject antecedents, and therefore, heavier anaphors are expected to cause a processing delay. The present work further tested this explanation by testing the RNP and OPP in two other null subject languages: Brazilian Portuguese and Italian. Brazilian Portuguese has been subject to recent loss of its verbal morphology and some researchers have claimed that it has become a non-pro-drop language (Duarte, 1995).

We used a self-paced sentence-by-sentence reading paradigm with two-sentence discourse items and a 2x3 design with factors Antecedent Salience and Anaphor Form (see Table 1). Sentence 1 introduced two names, which appeared in subject or object position. Sentence 2 made reference to the relevant proper name (*John*) with either (a) a repeated name, (b) an overt pronoun, or (c) a null pronoun. In both languages, we found a main effect of Antecedent Salience (*Italian*: $F_1(1,37)=6.58, p<0.02$; $F_2(1,35)=7.72, p<0.01$; *Brazilian Portuguese*: $F_1(1,44)=46.90, p<0.001$, $F_2(1,35)=43.43, p<0.001$, no main effect of Anaphor Form (F 's<1) and an interaction between the two factors (*Italian*: $F_1(2,74)=13.58, p<0.001$, $F_2(2,70)=5.57, p<0.01$, *Brazilian Portuguese*: $F_1(2,88)=9.21, p<0.001$, $F_2(2,70)=9.09, p<0.001$). To explore this interaction we ran two-way ANOVAs comparing reading times of sentences containing: (a) repeated names vs. null pronouns, (b) overt pronouns vs. null pronouns. We found an interaction effect in both languages such that sentences with null pronouns were read faster than sentences with repeated names (*Italian*: $F_1(1,37)=25.09, p<0.001$, $F_2(1,35)=11.40, p<0.01$, *Brazilian Portuguese*: $F_1(1,44)=38.13, p<0.001$, $F_2(1,35)=14.60, p<0.001$) and also faster than sentences with overt pronouns (*Italian*: $F_1(1,37)=13.42, p<0.001$, $F_2(1,35)=6.30, p<0.02$, *Brazilian Portuguese*: $F_1(1,44)=10.12, p<0.01$, $F_2(1,35)=36.65, p<0.001$), when the antecedent was in subject but not in object position.

These results indicate that the RNP and the OPP occur in Brazilian Portuguese and Italian. The OPP in Brazilian Portuguese is interesting because of the high frequency of overt pronoun use in this dialect. This shows that the processing cost associated with anaphora in reading is not a mere reflection of general production patterns. Instead, in line with the ILH, we propose that the extra semantic features of repeated names and overt pronouns, relative to null pronouns, impose an unnecessary cost when the antecedent is salient.

Table 1.

		Antecedent Salience	
Sentence	Anaphor Form	Subject	Object
S 1		<i>John met Mary.</i>	<i>Mary met John.</i>
S 2	Repeated Name	<i>John found her sad.</i>	
S 2	Overt Pronoun	<i>He found her sad.</i>	
S 2	Null Pronoun	<i>(Null) found her sad.</i>	

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Different processing dynamics for metaphor and metonymy

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Figurative language; Metaphor; Metonymy; Speed-accuracy trade-off; Italian

Figurative language is a wide label comprising different types of meanings departing from what is literally said, among which are metaphor and metonymy. For a long time grouped together indiscriminately, different types of figurative language are now undergoing a more fine-grained inspection. While metaphor has been extensively described in pragmatic terms as a case of broadening and narrowing of the lexical concept, metonymy seems rather to require a conceptual shift [1]. There are also hints in the direction of additional grammatical processes in the resolution of metonymic expressions, especially for what concerns anaphoric reference and semantic type shifting [2;3]. When it comes to processing, psycholinguistic evidence suggests that metaphor is more costly than non-figurative language, but doesn't elicit differential processing speed [4;5]. Evidence on metonymy is sparse [6] but other types of semantic shift (such as event-type shift, i.e., logical metonymy) are known to produce differences in processing speed with respect to control expressions, as a consequence of semantic composition [7].

In this experiment we aimed at describing the processing dynamics of metaphor and metonymy by employing Multiresponse Speed-Accuracy Trade-Off (MR-SAT). If metaphor can be described by conceptual broadening and narrowing while metonymy can be described as conceptual shift and/or grammatical processes, then we would expect the time-course of the two phenomena to vary. Participants performed a sensibility judgment task on utterances including figurative, literal and anomalous expressions. Figurative expressions included both nominal metaphors, where a noun is the vehicle for the metaphorical meaning (1a), and referential metonymies, where proper names of people are used to refer to objects (2a). Both types of figurative expressions were rated as equally meaningful in a previous norming study. Each type of figurative expression had its own set of literal and anomalous counterparts (metaphor set in 1; metonymy set in 2).

Fits of the time-course functions showed that both metaphorical and metonymical meanings resulted in lesser availability (lower asymptotic accuracies) than their literal counterparts. Metonymy also exhibited slower processing speed (later intercept), but metaphor did not. These results replicate previous findings for metaphor [5] and support the idea that metaphorical comprehension results from conceptual elaboration that lowers the likelihood that an appropriate interpretation is found, but is not associated with variation in the time-course profile. With respect to metonymy, we also found differences in asymptotic accuracy. More interestingly, the time-course profile obtained is similar to what was found for syntactic reanalysis, specifically case reanalysis [8]. A possible explanation for our findings is the animacy violation produced by metonymic referents with respect to the argument structure of the verbs, which might force the processor to revise its expectations in order to reach an appropriate interpretation.

Collectively, this study suggests that metaphor is based on conceptual elaboration, while metonymy entails a combination of conceptual processing and grammatical reanalysis. The results also add to our understanding of metonymy, up to now mostly confined to logical metonymy, and offers new insights for a taxonomy of figurative language based on the combination of linguistic-pragmatic distinctions and experimental evidence.

(1) Example of a triple used in the metaphor set (Original Italian; English translation in brackets)

a. Metaphor: *Quelle ballerine sono farfalle* (Those dancers are butterflies) / b. Literal: *Quegli insetti sono farfalle* (Those insects are butterflies) / c. Anomalous: *Quelle bottiglie sono farfalle* (Those bottles are butterflies)

(2) Example of a triple used in the metonymy set (Original Italian; English translation in brackets)

a. Metonymy: *Quello studente legge Camilleri* (That student reads Camilleri) / b. Literal: *Quel giornalista intervista Camilleri* (That reporter interviews Camilleri) / c. Anomalous: *Quel cuoco cucina Camilleri* (That chef cooks Camilleri)

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Advance planning and speech error production in a picture description task

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Production; Speech errors; Speech rate; Picture description task; English

Planning in production is incremental, but some amount of advance planning usually occurs as well. Thus, multiple elements are simultaneously active, which increases the chance of interference, resulting in speech errors (Garrett, 1975). Recently, Gillespie and Pearlmutter (2011; GP) suggested that subject-verb agreement errors (e.g. (1)), are more likely when a plural local noun (*pages*) is planned overlappingly with a singular head (*book*). GP argued local nouns were more likely to be planned within the scope of the head if they were semantically integrated (i.e., tightly conceptually linked, Solomon & Pearlmutter, 2004) or appeared closer in the articulated utterance. According to GP's scope of planning account, agreement errors and anticipatory and exchange errors (e.g.,(2)) should pattern similarly. In two experiments, participants described picture displays using complex subject noun phrases, as in (3), with singular head nouns and singular or plural local nouns within PP modifiers, and then completed them as sentences. Semantic integration was manipulated by varying the preposition linking the head and local nouns (3a vs. 3b). Agreement errors, morpheme ordering errors, and speech onset times (SOTs) were recorded. Analyses used mixed-effects models.

In Experiment 1 (122 participants), agreement errors were more likely when the local noun was plural than when it was singular ($t = 4.28, p < .001$). Ordering errors were too rare to analyze. Some speakers' SOTs were affected by semantic integration and local noun plurality, while other speakers' SOTs were not affected by any manipulations affecting words after the head noun, suggesting speakers varied in how much planning they completed before speech onset. Supporting GP's scope of planning account, speakers who showed effects of integration condition and local noun number in SOTs produced significantly more agreement errors, suggesting that increased advance planning increases speakers' chances of experiencing interference during agreement computation.

To follow up on SOT differences across speakers in Experiment 1, and because increasing speech rate has been shown to increase anticipatory phonological errors (Dell et al., 1997), half of the 162 participants in Experiment 2 were given instructions to speak very quickly while the remainder were instructed to speak fluently. Agreement errors were again more likely when the local noun was plural than when it was singular ($t = 5.50, p < .001$), and the mismatch effect was numerically larger in the fast condition (15.3%) than in the fluent condition (11.2%). Anticipatory morpheme ordering errors were rare (~5% of all picture description errors), but showed nearly identical patterns across instruction version. Data collection is ongoing.

Taken together, these findings support GP's scope of planning hypothesis and suggest that the degree of advance planning during sentence production affects grammatical encoding, and that agreement errors and ordering errors may be linked by some of the same underlying processing mechanisms: Speakers are more likely to experience interference when multiple elements are simultaneously prepared for production.

The book with the torn pages *ARE...

The book with the torn pages -> The pages with the torn book

- a. The apple for the pie(s) Integrated
- b. The apple near the pies(s) Unintegrated

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Coordinating lexical and structural information during language production: Evidence from semantic and structural priming

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Lexical and structural coordination; Semantic priming; Structural priming; English; Korean

Introduction How speakers coordinate lexical and structural information is a key issue in psycholinguistics. Research on English shows that lexical items can control grammatical encoding; accessible lexical items are more likely to occur in subject position, thereby impacting the structure of the sentence ([1]). This observation is closely linked to the fact that word-order and grammatical function are tightly linked in English. Effects of lexical accessibility on sentence structure further suggest that message formulation and grammatical encoding can occur in parallel in English ([2]). This raises the question of whether lexical-structural coordination in typologically different languages such as Korean is also dominated by lexical items. The present studies investigate lexical-structural coordination in Korean by comparing effects of semantic and structural priming on active/passive production and speech latencies in picture-description tasks. We report semantic priming experiments on English (n=24) and Korean (n=24), and a structural priming experiment on Korean (n=22).

Korean Based on the properties of Korean, we hypothesize that sentence structure should control lexical retrieval: In Korean—which has flexible word-order—grammatical functions are indicated by case-markers, and to assign case to a particular noun, a structural plan is necessary. Furthermore, passive and non-canonical sentences in Korean are constrained by various syntactic and semantic/pragmatic factors ([3]). This means that starting with whichever lexical item is more accessible runs the risk of hindering production. Thus, we hypothesize that Korean speakers generate a structural plan rather than proceeding with whatever lexical item is more accessible—i.e., structure controls lexical retrieval in Korean.

Predictions *If structure controls lexical retrieval*, then semantic priming (which modulates accessibility of lexical items) should not influence active/passive production. Structural priming, however, is expected to affect active/passive production and to reduce speech-onset latencies by facilitating structural planning. On the other hand, *if lexical items control structure*, semantic priming should affect active/passive production and latencies.

Results In Korean, neither semantic nor structural priming influenced the proportion of actives/passives. But *unlike semantic priming, structural priming did influence production latencies*: Passive-priming significantly reduced passive latencies (2240ms) while increasing active latencies (3046ms) (p 's < 0.1), but active-priming had no effect (actives: 2708ms/passives: 2833ms). In contrast, our findings for English, consistent with prior work, show that English exhibits semantic priming: Patient-priming reduced passive latencies compared to agent-priming (2417ms vs. 2618ms), but passives were slower than actives, which suggests that semantic priming does not necessarily promote overall structural planning.

Our results suggest that Korean speakers generate sentence structure before speech onset, whereas English speakers may proceed with whatever lexical item is available. Importantly, however, Korean speakers' structural choice was not influenced by lexical or structural accessibility. Combining our prior findings that perspective-priming influences Korean active/passive production ([4]), we suggest that (i) Korean speakers formulate sentence structure based on the relational/causal structure of even ts rather than lexical/structural accessibility, but that (ii) structural accessibility can facilitate or interfere with structural planning. This implies that—unlike English—Korean production proceeds through discrete stages of message formulation and grammatical encoding. In general, the present study shows how language-specific properties interact with production mechanisms.

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Sentence processing is “good enough”: Evidence from sentence-video matching

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Sentence processing; Language representation; Sentence-video matching

Debate exists about the depth at which people process sentences, with some people suggesting that parses are “good enough” for the task being performed (e. g., Ferreira & Henderson, 2007). We investigated the nature of syntactic representations formed in two experiments.

Experiment 1. Twenty-five native, monolingual English speakers watched captioned videos of geometric objects (circles, squares, rectangles or ovals) “chasing” each other and performed a sentence-video matching task. As shown in [1], captions were active sentences. The verbs *chase*, *flee*, *lead*, and *follow* were used because all can describe the same visual scene, albeit from different perspectives. In half of the trials, captions did not match the video because the NPS were reversed. In half the trials, the objects had 2 eccentrically placed dots (“eyes”) and in half, the dots were centered.

1a. The square is following/chasing the circle.

1b. The circle is leading/fleeing the square.

Participants were accurate (94.9% correct), with a mean RT of 2945 ms ($SE = 63$ ms). Participants were faster in conditions where the objects had eyes ($F(1,24) = 8.17, p = .009$). Verb Perspective had a significant effect, with participants faster on “front-perspective” verbs (*lead*, *flee*; $F(1,24) = 7.35, p = .012$). Performance was unaffected by Verb (Bayes Factor, $BF = 58.15, p_{null} = .98$) and Caption Veracity ($BF = 4.09, p_{null} = .80$).

Experiment 2. Twenty-four native, monolingual English speakers participated. The experiment was identical to Experiment 1 except half of the sentences were passive. Also, the verbs *guide* and *trail* replaced *chase* and *flee* because *flee* does not passivize.

2a. The square is followed/trailed by the circle.

2b. The circle is led/guided by the square.

Participants were just as accurate (95.7%) as in Experiment 1, but were 30% slower ($M = 3821$ ms, $SE = 60$ ms). Notably, their RTs were affected by Verb ($F(3,69) = 12.21, p < .001$), Voice ($F(1,23) = 29.87, p < .001$), Caption Veracity ($F(1,23) = 15.73, p = .001$), and Verb Perspective ($F(1,23) = 25.82, p < .001$), but NOT by presence of eyes ($BF = 1.72, p_{null} = .63$).

Discussion. The fact that participants were about 30% slower in Experiment 2 suggests that people may have processed sentences differently in the two experiments. The slower speed in Experiment 2 cannot be the result of a speed-accuracy tradeoff as participants were equally accurate in the two experiments. The slow speed also cannot be the result of averaging RTs of actives and passives because participants were 21% slower on actives in Experiment 2 than Experiment 1. Furthermore, it cannot be that participants in Experiment 1 (and not Experiment 2) only parsed the first noun and matched it with the trailing (or leading) object, because inclusion of perspective shift verbs would have resulted in 50% accuracy.

In Experiment 1, because all sentences had a canonical NVN structures, participants could have done a “rough” parse (e.g., Townsend & Bever, 2001). Because of inclusion of passives in Experiment 2, that strategy is inadequate and a more detailed analysis is necessary. A sentence-video matching task cannot be performed until both the sentence and the video have been processed. In Experiment 2, but not in Experiment 1, a detailed analysis may have resulted in sentence processing being the limiting factor, thus overshadowing the effects of visual parameters. Consistent with this account, in Experiment 1, both the visual parameter (Eyes) and the slightly broader linguistic parameter (Verb Perspective) had significant effects, while in Experiment 2, only the linguistic parameters (Voice, Verb, Verb Perspective, and Caption Veracity) had significant effects. Taken as a whole, these results are consistent with “good enough” models of language processing in which detailed representations are formed only when necessary.

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Question structure and ellipsis

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Ellipsis; Parallelism; Focus; Acceptability; Magnitude estimation; English

Many accounts of acceptability in ellipsis fall into one of two families. Identity-based theories place constraints on conditions licensing ellipsis. Because constraints are stated in terms of syntactic (Sag 1976; Arregui et al. 2006; Merchant 2008) or semantic identity (Dalrymple et al. 1990; Hardt 1993), such accounts emphasize recoverability, and predict antecedent mismatch effects to be limited to cases of ellipsis. By contrast, focus-based theories link well-formedness to focus structure (Winkler 2000; Kertz 2010). Ellipsis is, among other things, a focusing device: elliptical sentences are compatible with fewer interpretations than their non-elliptical counterparts. These theories crucially differ from identity accounts, predicting that mismatch effects should be observed with or without ellipsis. Here, we first present acceptability data demonstrating that neither type of theory alone can account for the pattern of well-formedness observed across ellipsis types (VP ellipsis, pseudogapping, sluicing). We propose that ellipsis-sensitive mismatch effects result not from identity requirements enforced directly on structural representations, but rather from increased complexity in the question(s) projected (in the Question Under Discussion sense). Predictions of this proposal are tested in an experiment manipulating question complexity.

Experiments 1-2 (magnitude estimation) compare pseudogapping and sluicing with VPE, showing that neither identity nor focus theories can single-handedly explain the range of data observed. As predicted by identity accounts (incompatible with focus accounts), VPE (1) and pseudogapping (2) show ellipsis-mismatch interactions (VPE: $p < .0001$; pseudogapping: $p < .01$): degradation due to mismatch is stronger with ellipsis than without. However, sluicing (3) patterns differently: while mismatch ($p < .0001$) and ellipsis ($p < .01$) independently affect acceptability, there is no ellipsis-mismatch interaction (predicted on a strict identity account).

A unifying solution in terms of question complexity. We propose that mismatch in sentences like (1)-(2) degrades acceptability by increasing the complexity of the question jointly projected by antecedent and ellipsis clauses. Ellipsis types differ in baseline complexity: VPE projects a single question with one focus (4-a), pseudogapping, a single question with two foci (5-a), and sluicing, two questions (6-a). For VPE and pseudogapping (4-b)/(5-b), mismatch increases how many questions must be projected from the surface string for the discourse to support the sentence. In sluicing (6-b), each clause projects a separate question, irrespective of structural match. Consequently, while reconstructing the elided clause based on inexact antecedents (mismatch) or by accessing discourse representations rather than surface forms (ellipsis) may contribute to complexity independently, degradation due to mismatch is not contingent on ellipsis.

The question-projection account suggests that VPE or pseudogapping can be made to resemble sluicing if embedded in similar question structures. **Experiment 3** (offline questionnaire) compares mismatch in sluicing (7-c) and VPE, with a one- or two-question context supplied for VPE (7-a)/(7-b). Despite having identical structures, the mismatch effect for VPE in two-question contexts ($\beta = -1.4$, $p < .01$) was smaller in magnitude than in one-question contexts ($\beta = -.7$, $p < .001$) (mismatch effect for sluicing was not reliable). Thus, when VPE is biased toward an interpretation where each clause answers a distinct question, acceptability is less affected by structural mismatch than when the sentence is construed as answering a single question.

- (1) a. VPE-MATCH: Cindi read *Moby Dick*, and Ed did (read *Moby Dick*), too.
b. VPE-MISMATCH: *Moby Dick* was read by Cindi, and Ed did (read *Moby Dick*), too.
- (2) PSEUDOGAPPING-MISMATCH: *Moby Dick* was read by Cindi, and Ed did (read) *Catch 22*.
- (3) SLUICING-MISMATCH: Someone read *Moby Dick*, but I can't remember by whom (it was read t_{wh}).
- (4) a. Who read *Moby Dick* b. Who was *Moby Dick* read by? Who read *Moby Dick*?
- (5) a. Who read what? b. What was read by whom? Who read what?
- (6) a. Did someone read *Moby Dick*? Who read it?
b. Was *Moby Dick* read by someone? Who read it?
- (7) a. Who was *Moby Dick* read by? *Moby Dick* was read by Cindi, and Ed did, too.
b. Was *Moby Dick* read by anyone? If so, who read it? *Moby Dick* was read by someone, but Ed didn't.
c. Was *Moby Dick* read by anyone? If so, who read it? *Moby Dick* was read by someone, but I don't remember who.

Do reflexives always find a grammatical antecedent for themselves?

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Anaphora; Retrieval interference; Focus of attention; Eye-tracking; English

Summary. A lively debate has emerged around whether locality constraints on argument reflexives [1,2,cf.12] are immediately enforced in comprehension [3-7]. In an associative memory [8,9], structurally-inappropriate but feature-compatible constituents can intrude during retrieval of prior constituents. While some relations routinely show evidence of this (agreement [6,10], subject verb attachment [11]), evidence of interference with reflexives has been more equivocal [con: 3,4,5,6; pro: 4,7]. But existing studies have focused on reflexives in very narrow syntactic contexts: usually direct objects linearly adjacent to the verb (1). Predicate-adjacent reflexives constitute a poor test for retrieval interference as the verb itself likely indexes information about its co-arguments [2]. Should this information persist in the focus of attention [8], it could block interference-generating retrieval events. Here we offer a stronger test: reflexives in prepositional object positions, (2), which are temporally separated from the verb they combine with as an argument. In an eye-tracking study with a gender match design [5], we contrasted verb-adjacent and non-adjacent reflexives. We find that verb-adjacent reflexives do not activate grammatically-inaccessible antecedents, replicating [3,5,6]. However, argument reflexives in prepositional object position do show evidence of activating the inaccessible antecedent.

Design & Results. We crossed the (stereotypical) gender match of an ACCESSIBLE antecedent, gender match of an INACCESSIBLE antecedent, and the POSITION of the reflexive in a $2 \times 2 \times 2$ design: (3)-(4). 32 items featured verbs with NP-PP/NP-NP alternations; thus the same verbs occurred in both Position levels. We counterbalanced whether the non-Theme argument was a Recipient or a Benefactive, with anaphors of both argument types requiring a local antecedent [2]. Gender stereotyping was normed to our local participant population. Theme head nouns were chosen carefully to avoid VP/NP attachment ambiguities in POSITION:NONADJACENT. Target items were combined with 96 fillers, all followed by Y/N comprehension questions. There were 48 participants. We first observed effects of gender in first-pass times on the reflexive. For POSITION:ADJACENT conditions, there was only an effect of ACCESSIBLE antecedents, with readers slowing down to mismatches ($p < .05$). However, for POSITION:NONADJACENT conditions, there was a reliable ACCESSIBLE \times INACCESSIBLE interaction ($p < .005$): readers slowed to mismatching Accessible antecedents only when the Inaccessible antecedent matched the reflexive. For INACCESSIBLE:MISMATCH antecedents, this slow-down was neutralized.

Conclusion. Argument reflexives separated from the verb clearly behaved differently from reflexives adjacent to it. For the latter, reading times were sensitive to accessible antecedents alone, a pattern which extended to re-reading time [6,cf.5]. However, non-adjacent reflexives were sensitive to inaccessible antecedents. In [6]'s ACT-R simulation, incorrect antecedents were retrieved most often in INACCESSIBLE:MATCH/ACCESSIBLE:MISMATCH conditions, exactly where our reading times were slowest. This suggests competition between two candidates which only partially match the reflexive's requirements. Supporting this idea, there were marginally higher regression probabilities for non-adjacent reflexives ($p < .10$), heightened for INACCESSIBLE:MISMATCH ($p < .10$). Why should verb-adjacent and non-verb-adjacent argument reflexives show such different patterns? In the verb-adjacent cases we propose that the reflexive has reliable, immediate information about the verb's argument structure. In the non-adjacent cases, the direct object has intervened, displacing this information from the focus of attention and necessitating an interference-prone retrieval.

(1) The pilot who scared John/Mary injured himself quite badly during the journey. [5]

(2) The pilot who scared John/Mary bought some coffee for himself after the flight.

(3) POSITION:ADJACENT

a. ACCESSIBLE:MATCH, INACCESSIBLE:MATCH/MISMATCH

The mechanic who spoke to John/Mary sent himself a package

b. ACCESSIBLE:MISMATCH

sent herself a package

(4) POSITION:NonAdjacent

a. ACCESSIBLE:MATCH, INACCESSIBLE:MATCH/MISMATCH

The mechanic who spoke to John/Mary sent a package to himself

b. ACCESSIBLE:MISMATCH:

sent a package to herself

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A Bayesian belief-updating model of syntactic expectation adaptation

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Adaptation; Sentence comprehension; Self-paced reading; Computational modeling; English

Work over the last 20 years has provided evidence that syntactic comprehension is affected by comprehenders' language experience: Structures that are more expected in their context are processed faster [1-2]. Comprehenders achieve this by integrating information from multiple cues [1,3]. Recent work further suggests that how these cues are combined into syntactic expectations can change due to *recent experience* [2,4-6]. However, there are so far no models of how comprehenders adapt to changes in the informativity of the cues that explain the observed ability to adapt syntactic expectations.

Here we develop a Bayesian belief-updating model which captures the qualitative behavioral effects found in a recent study on cue-combination and syntactic adaptation [6]. Via a Dirichlet-multinomial model, this model formalizes the following related claims: that comprehenders (a) track the co-occurrence of syntactic structures—here, sentence complement (SC) or direct object (DO) continuations, as in (1)—and cues providing information about the probability of those structures (here, the verbs and the complementizer *that*), and (b) use these *continuously updated* estimates to generate expectations about upcoming syntactic structures.

In a between-subjects, multi-visit self-paced reading experiment (pre-test session, three exposure sessions over 6 days, post-test session 2 days after last exposure session, cf.[5]), we previously investigated [6] whether comprehenders update their estimates of the probability of the syntactic structures in (1) conditioned on the verb used in the sentence and the presence of the complementizer *that*. The High Verb Reliability (HVR) group received evidence that SC-taking verbs *always* occur in sentences like (1b), while the Low Verb Reliability (LVR) group was exposed to a 50/50 mix of SC (1a) and DO (1b) continuations. For both groups, *that* occurred in 50% of all SC sentences, and was thus equally reliable across the two groups.

The basic behavioral result is that reading times changed from pre- to post-training depending on the statistics of the intervening experience, with LVR subjects relying more on the complementizer during post-training, owing to the verb having become a relatively *unreliable* cue to syntactic structure. The observed behavioral data is naturally predicted and quantitatively well-described by the model ($r^2=.3$; two free parameters) as a result of simply tracking and updating—via Bayesian inference, over the course of the experiment—the joint distribution over syntactic structures, verbs, and the presence or absence of the complementizer *that*.

The model is computationally very similar to previous modeling work on both adaptation [7] and cue combination [8-9] in perception. Moreover, the model extends these efforts by suggesting a link between adaptation and cue combination: by simply tracking the statistics of the linguistic environment, the model naturally predicts that the degree to which cues are relied upon should change according to those statistics. This model therefore provides a single computational framework for capturing two behavioral results previously treated as largely separate phenomena: syntactic adaptation and cue combination.

The framework employed here extends naturally to phonetic adaptation[10-11] and has previously been employed in vision, audition, and motor control[7-9], suggesting a potentially unifying framework for investigating adaptation and cue combination in human cognition.

- (1) Dexter believed (that) his brother...
- a. ... (DO) because they had known each other so long.
 - b. ... (SC) was a cold-blooded psychopath.

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Vowel identification shaped by phrasal gender agreement expectation

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Speech perception; Noun phrase; Gender agreement; Expectations; Phoneme identification task; Spanish

There rarely exists a clear mapping between the physical signal and our internal representations. When faced with such uncertainty, knowledge of higher-order information could be recruited to parse the signal. It has been demonstrated that the lexicon biases the identification of ambiguous phonetic segments [1,2], and small portions of a sentence replaced by noise are difficult to detect [3]. Here, we asked whether specific grammatical information might also influence low-level perceptual processes. We show that, in Spanish, phrase-level gender agreement, or the expectation of it, biases the identification of ambiguous vowels.

Sixteen noun-adjective pairs (8 masculine, e.g., *fallo tonto* 'stupid mistake'; 8 feminine, e.g., *cocina bonita* 'beautiful kitchen') were recorded by a native speaker of Spanish. Each adjective (8 total) was paired with one masculine and one feminine noun. A semantic plausibility-rating task indicated no differences between the pairs. The first (F1) and second formants (F2) of a naturally produced [o] vowel token (spliced from the recorded adjectives) were manipulated using an LPC Analysis/Reanalysis method in Praat [4], creating a 7-step continuum between /o/ and /a/. The synthesized tokens were then respliced onto the adjectives, yielding, for each adjective, a continuum from its masculine, e.g., *bonito*, to its feminine, e.g., *bonita*, form. During the experiment, participants (n=24) responded as to whether they perceived /o/ or /a/ as the adjective-final vowel either without a preceding noun (No Context) or following a noun (Masculine or Feminine). If participants use grammatical gender to bias low-level identification, we should observe more /o/ responses to the ambiguous vowels, i.e., tokens in the middle of the 7-step continuum, when preceded by a masculine noun, and fewer /o/ responses when preceded by a feminine noun.

We found a step-function identification curve in each of the three contexts, consistent with previous findings [5]. At the ambiguous steps along the continuum, in our planned comparisons, we found a reliable difference in the identification response: adjective-final ambiguous vowels in a Masculine context were more likely to be judged as /o/ than those in the Feminine context, and vice versa with /a/ judgments (step 4: $t(23)=2.27$, $p<0.05$; step 5: $t(23)=2.53$, $p<0.05$; step 3: $t(23)=1.73$, $p<0.089$). As expected, near the ends of the continuum, where the signal is essentially unambiguous, no shift was observed. Additionally, there was no main effect of Context, suggesting that the identification of the vowel was not modulated by the presence or absence of a noun alone, but instead by its gender. In a subsequent AX discrimination task, we found no effect of the preceding nominal context. We note that effects of higher-order bias, e.g., the Ganong effect, are typically reported for identification tasks; we are unaware of any similar effects in discrimination tasks.

These results indicate that phrasal-level expectation can influence vowel identification, consistent with models wherein listeners generate specific predictions [6], which can be based on morphosyntactic knowledge. We take the results to suggest that the dynamic application of higher-order linguistic knowledge to the incoming signal may be a mechanism of phrase- and sentence-level 'prediction' computations.

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Susceptibility to similarity-based interference influences judgments of long-distance dependencies

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Working memory; Similarity-based interference; Individual differences; Islands; Sentence acceptability; English

The single resource view of working memory (WM) [1] has recently been challenged by content addressable models [2,3] that make use of similarity-based interference. This research indicates that groups of subjects that differ in susceptibility to similarity-based interference judge long-distance dependencies differently. Early sentence-processing research attempting to explain phenomena pertaining to long distance filler-gap dependencies (namely islands) adopted the single resource WM model [4]. Recently, this view of islands has been challenged by the lack of co-variation of the acceptability judgments of island effects with individual measures of WM [5]. The current research uses this methodology of co-variation of individual differences with acceptability scores to demonstrate that: 1) cognitive scores co-vary with the judgments of long-distance filler-gap dependencies but not the judgments of island-violation sentences. 2) The measure that these data co-vary with is susceptibility to phonological/orthographical similarity-based interference. And 3) High-scoring individuals do not 'perform' better than low-scoring individuals on difficult to process sentences, but rather the low-scoring individuals 'perform' worse on the easy to process sentences. This mirrors results reported in ERP studies [6,7,8].

Experiment: 81 subjects who rated 32 *wh*-questions for acceptability on a 7-point scale were scored on four cognitive tasks: Flanker attention, verbal span, N-back and recall-interference (with both phonological and semantic lures). Experimental items crossed clause type with extraction distance (see examples below). High and low scoring groups were formed for each cognitive measure by median split. An ANOVA revealed an influence *only* of phonological recall-interference scores ($p = 0.002$) on the acceptability judgment data. The high phonological recall-interference group rated the difference between extraction distance conditions greater (short extraction = 5.10, long distance extraction = 3.12) than the low group (short extraction = 4.23, long distance extraction = 3.06) regardless of whether the dependency crosses an island or not.

The results presented here indicate the importance of individual cognitive differences to the judgments of sentences containing long-distance dependencies, although those differences do not co-vary with the island phenomena as expected in [4]'s account. Additionally, the data lends credence to claims that WM is better conceived as due to attentional constraints on memory processes [2,3] rather than a capacity constraint [1,4].

Further, similarity-based interference occurs over a potentially large variety lexical features [2,3]. That it was susceptibility to the phonological/orthographic (*grass~glass*), and not semantic (*jaguar~panther*) lures in the recall interference task represent an early step in narrowing these possibilities. Finally, the pattern of results presented here fits those reported in a number of ERP experiments [6,7,8] where the high and low-scoring groups perform equally on the difficult conditions, but the low-scoring groups have more difficulty in the easier conditions. This recurring pattern, now reported in two different methodologies should shape the expectations of researchers using co-variation with individual differences, and may represent some upper-bound in the ability of the parser.

Sample Materials

(1) Short-distance dependency {non-island/island}: **Who** had _ on Tuesday {assumed that/inquired whether} the decorator annoyed the carpenter when the deadline was missed?

(2) Long-distance dependency {non-island/island}: **Who** had the carpenter {assumed that/inquired whether} the decorator annoyed _ on Tuesday when the deadline was missed?

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A connectionist model of graded effects in local syntactic coherence interpretation

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Connectionist modeling; Local coherence; Visual world paradigm

Sentences can contain sequences of words that – in isolation – have an interpretation deviating from the interpretation of the global sentence context they are embedded in (see (1)). These local syntactic coherent (LSC) sequences influence both reading times (Tabor, Galantucci, & Richardson, 2004) and fixation patterns in visual-world experiments (Konieczny, Müller, Hachmann, Schwarzkopf, & Wolfer, 2009). The latter showed that in sentences like (1) participants' fixations are drawn to scenes depicting the (globally incorrect) meaning of the embedded sequence '*die Astronautin überrascht den Außerirdischen*' (the astronaut surprises the alien). These effects provide strong evidence against self-consistent parsing models and are in favor of self-organized dynamical system approaches of language processing (Tabor et al., 2004), where local transitions influence processing regardless of global consistency. We provide a connectionist (SRN) model that can account for the patterns found in the visual-world experiment. In addition, the model predicts a graded influence of part-of-speech bias of the ambiguous elements (*überrascht*) on the effects. A reanalysis of the visual-world data revealed similar bias effects in the fixation patterns.

Simple recurrent networks were trained with different combinations of training parameters for 100 epochs of 20000 sentences, generated by a simplified PCFG of German that included ambiguous elements, thus allowing various types of sentences, among them clauses resembling the materials of Konieczny et al. (2009). The networks performed better than 7-grams in long distance number agreement. However, where global (1a) and local (1b) predictions diverge maximally, as at the relative-clause verb, the networks still elicited locally coherent false alarm activations of an end of sentence (EOS) in addition to the most strongly activated correct elements. Moreover, the amount of false-alarm EOS activation was modulated by the part-of-speech bias of the ambiguous element: EOS activation was higher when the ambiguous element occurred more often as a finite verb.

To test the latter modeling result empirically, we calculated the finite-verb-bias for the ambiguous elements in Konieczny et al.'s (2009) stimuli as the tendency to occur as a finite verb (the locally coherent reading) divided by the overall frequency of the element. Linear mixed-effect modeling reveals a significant interaction of finite-verb bias with local coherence: fixations on the local scene are more likely the higher the finite-verb bias, but not in a control condition containing the ambiguous element but no LSC (2), proving the context-dependency of the effects and ruling out a purely lexical explanation (Gibson, 2006).

Our SRN-model can account for the general patterns of local syntactic coherence effects, and, in addition, predicts graded bias-effects that were approved in visual-world data. The results provide support for dynamical system approaches to language processing.

- 1) Hans, dem [die Astronautin überrascht den Außerirdischen] zeigt, sieht das Raumschiff .
 Nnom, RP_{dat} [DET N_{nom} ADV_{ambig} DET N_{akk}] V_{finite}, V_{finite} DET N_{akk} EOS
 Hans, whom the astronaut (surprised)/surprisedly the alien shows, sees the spaceship .
 '*Hans, to whom the astronaut shows the alien surprisedly, sees the spaceship.*'
 a. 6-gram prediction: EOS (and others)
 b. globally possible: V_{finite} only
- 2) Hans, dem [die Astronautin äußerst überrascht den Außerirdischen] zeigt, sieht das Raumschiff .
 Nnom, RP_{dat} [DET N_{nom} ADV ADV_{ambig} DET N_{akk}] V_{finite}, V_{finite} DET N_{akk} EOS
 Hans, whom the astronaut very (surprised)/surprisedly the alien shows, sees the spaceship .
 '*Hans, to whom the astronaut shows the alien very surprisedly, sees the spaceship.*'
 a. 6-gram & global prediction: V_{finite} (no local coherence)

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Processing of filler-gap dependencies in complex NP islands: Evidence from Hebrew

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Island constraints; Filler-gap dependencies; Processing; Self-paced reading; Acceptability judgments; Hebrew

Since Ross's (1967) work on island constraints until many current works, the unacceptability of island effects is mostly explained by violations of universal constraints on grammar. However, it has been claimed that the unacceptability of certain island violations, such as Complex NP island, can be explained by limitations on the cognitive resources associated to the processing of filler-gap dependencies. The advantage of this sort of explanation is that these processing difficulties are known to exist independently of island violations.

This paper examines whether a processing explanation of Complex NP island violations in Hebrew is empirically motivated. The prediction of this account is that by reducing processing difficulties in Complex NP islands, their acceptability should improve while reading times (RTs) of critical regions should decrease.

D(iscourse)-linking is a manipulation over the wh-element that is associated with the processing of filler-gap dependencies. D-linked wh-elements, such as *which movie*, have been shown to increase acceptability and reduce RTs at critical regions in wh-islands, superiority condition violations, and some grammatical structures. The effects of D-linking in Complex NP island was examined in three experiments.

Experiment 1 investigated whether D-linked wh-elements improve the acceptability of Complex NP Islands with extractions from complement clauses (CNPCCs). To this end, subjects participated in an acceptability judgment task and rated questions that included CNPCCs with different types of wh-elements (1a) and a parallel grammatical baseline without D-linking (1b). The results indicate that D-linked wh-elements improve the acceptability of CNPCC violations but not to the level of the grammatical baseline.

(1) (a) {*ma; eize seret*} *doron cien et ha-uvda še-hu ra'a _ be-šavu'a še-avar?*
 {what; which movie} Doron stressed ACC {the fact} {that he} saw _ {in week} {that past}?
 {What; Which movie} did Doron stress the fact that he saw _ last week?

(1) (b) *ma doron cien še-hu ra'a _ be-šavu'a še-avar?*
 what Doron stressed {that he} saw _ {in week} {that past}?
 What did Doron stress that he saw _ last week?

Experiment 2 used the same approach to investigate whether Complex NP Island with extractions from relative clauses (CNPRC) are also susceptible to D-linking. Participants rated questions such as (2) and no parallel baseline could be devised; the results show no significant effect for D-linking. This suggests that CNPRCs are not susceptible to processing factors.

(2) {*ma; eize mexonit*} *Itamar pagaš et ha-iš še-maxar _ lifney šavu'a?*
 {what; which car} Itamar met ACC {the man} {that sold} _ before week?
 {What; Which car} did Itamar meet the man that sold _ last week?

Experiment 3 used the same stimuli as Experiment 1 to investigate whether RTs at critical regions in CNPCCs are affected by D-linking. Subjects participated in an online self-paced reading experiment. This experiment shows that critical regions are read faster in CNPCC conditions with D-linking in comparison with critical regions in both CNPCC and baselines with non-D-linked wh-elements.

The results from experiments 1 and 2 strongly imply that CNPCC and CNPRC are two distinct phenomena, and I argue that the unacceptability in the case of CNPRC is due to its ungrammaticality. Results from experiments 1 and 3 show that acceptability is not correlated with speed-ups in the critical region. In fact, the actual processing of filler-gap dependencies in CNPCC violations can be even faster than in grammatical baselines while the acceptability of all CNPCC conditions is significantly lower than the acceptability of the baseline. Even though filler-gap dependencies impose a burden on the parser and lower the acceptability of sentences with CNPCC violations, this is also true for grammatical sentences. This suggests that the processing of filler-gap dependencies is unrelated to the unacceptability of CNPCC violations.

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Propositional truth-value and the comprehension of 'impossible' counterfactual worlds: Evidence from event-related potentials

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Counterfactual comprehension; Sentence truth-value; Event Related Potentials (ERPs); Spanish

Introduction: Two event-related potential (ERP) experiments addressed the role of propositional truth-value in comprehension of (Spanish) sentences about biologically or physically impossible counterfactual worlds. Counterfactuals are thought to require keeping in mind what is true and what is false [1], and pre-stored real-world knowledge may therefore intrude upon and delay counterfactual comprehension, as is predicted by some accounts of discourse comprehension [2], and has been observed with ERP and eye-tracking measures [3-4]. Impact of truth-value may thus be delayed in counterfactuals, as also claimed for negated and quantified sentences (see also [5]; but see [6]). The current hypothesis involved N400 ERP amplitude, which indexes early semantic processing costs and is sensitive to subtle variations in discourse-semantic fit [7]. If real-world knowledge briefly disrupts counterfactual comprehension, critical words in counterfactual true statements (Spanish equivalent of 'water' in "If dogs had gills, Dobermans would breathe under water without problems") should evoke larger N400s than in real-world true statements ("Because fish have gills, tunas breathe under water without problems"), while smaller than N400s to words that render both sentence types false ('poison'). In contrast, if incoming words are mapped onto counterfactual context without delay, false sentences should elicit similarly increased N400s compared to true sentences, whether counterfactual or real-world. Experiment 2 examined the contribution of the counterfactual premise.

Methods: In Experiment 1, EEG was collected (27 electrodes) while twenty native Spanish speakers read 96 Spanish sentences (design: 2(counterfactual, real-world) x 2(true,false)) word-by-word that were matched for critical word expectancy and truth-value, mixed with 120 fillers. In Experiment 2, twenty new participants read the consequences without premise ("Dobermans would/Tunas breathe under water/poison without problems"), and 120 fillers. Pre-testing confirmed that without premise, counterfactual 'true' sentences ("Dobermans would breathe under water") were rated similarly as false sentences.

Results: In Experiment 1, false sentences elicited larger N400s than true sentences ($F(1,18) = 82.2, p < .001$; based on average voltage across all electrodes per condition between 350-400 ms after word onset), for counterfactual and real-world sentences alike, there was no interaction between truth-value and sentence type ($F(1,18) = .66, n.s.$). In Experiment 2, there was an interaction between truth-value and sentence type ($F(1,15) = 7.3, p < .05$): real-world false sentences elicited larger N400s than real-world true sentences ($F(1,15) = 2.7, p = .001$), whereas counterfactual true/false sentences elicited similarly enlarged N400s ($F(1,15) = .54, n.s.$). Between-experiment analyses revealed that ERP patterns differed between experiments at anterior electrodes ($F(1,32) = 4.2, p = .049$) and at crossline electrodes (T7/8, C3/4, Cz; $F(1,32) = 3.5, p = .07$).

Conclusions: The indistinguishable N400 effects of counterfactual and real-world truth-value in Experiment 1 argue against disruptions by real-world knowledge during counterfactual comprehension, and suggest that incoming words are mapped onto counterfactual context without delay. Experiment 2 confirmed the contribution of the counterfactual premise, and, together with N400s in counterfactual false sentences (Experiment 1), suggests that the observed patterns in counterfactual sentences are not due to modal verbs. Propositional truth-value can rapidly impact ongoing semantic processing, be the proposition factual or counterfactual.

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Phrasal complexity and ellipsis

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Processing of ellipsis; Regression modeling; English

Recent research on interrogative *wh*-phrases suggests that differences in their behavior in filler-gap constructions follow from their phrasal complexity (Hofmeister 2010, Hofmeister and Sag 2010, and Hofmeister et al. In press). A *which*-NP phrase (*which player*) is richer in semantic and syntactic features, hence more complex, than a bare *wh*-phrase (*who*). Greater complexity of a filler *wh*-phrase aids its retrieval from memory when the gap is encountered. Another strand of research finds a similar effect of phrasal complexity in sluicing: *which*-NP phrases are better remnants (1) than bare *wh*-phrases (2), given the same NP correlate (a new vehicle) (Frazier and Clifton (2011)). Frazier and Clifton attribute this effect to *which*-NP phrases, but more than just the complexity of the remnant contributes to the improved acceptability of sentences like (1), because the phrase retrieved from memory is the correlate, not the remnant. In this paper I explore how the features of a remnant interact with the features of its correlate in sluicing and three further elliptical constructions. I address this issue in the context of preposition omission in these constructions.

Using data collected from three corpora of spoken American English, I develop a mixed-effects model (Baayen et al. 2008) of speakers' choices between preposition omission and preposition retention, as (3). Mixed-effects modeling permits an insight into whether complex correlates (with or without complex remnants), for example, the NP correlate and *which*-NP remnant shown in (4), favor preposition omission. I coded the data for phrasal complexity such that NPs and *which*-NP phrases were complex phrases, but (indefinite or interrogative) pronouns and bare *wh*-phrases were not (see (3)).

For sluicing, *which*-NP remnants, where the head NPs are commonly absent, only combine with complex (NP) correlates. Indeed, coupling a pronominal (noncomplex) correlate with a *which*-NP remnant seems degraded (5)-(6). This suggests that the form of *wh*-remnants is less central to the phenomenon of preposition omission than the form of their correlates.

Across all constructions, complex correlates show a significantly stronger preference for preposition omission than noncomplex correlates ($p < .002$). This preference was confirmed by a comparison (split-100 task via Amazon's Mechanical Turk) of speaker ratings for selected items from the corpus data with corpus probabilities for these data. Given that remnants with and without prepositions differ in phrasal complexity (explicitness), their distribution is consistent with the predictions of Accessibility theory (Ariel 1990, 2001) and Hofmeister and colleagues' results: a more explicit antecedent is retrieved with a less explicit anaphor, because it's easily accessible. I propose that the use of prepositionless remnants signals the availability of accessible correlates in surrounding discourse, and the use of remnants with prepositions signals low-accessibility correlates.

These results add to cross-linguistic evidence for complex correlates strongly favoring remnants realized as prepositionless *which*-NP phrases in sluicing (Vicente 2006, 2008, Szczegielniak 2008, Stjepanovic 2008, Rodrigues et al. 2009, Caha 2011, Sag and Nykiel 2011). While this preference commonly receives syntactic, and language-specific, motivation, I argue that it's best explained by appeal to memory retrieval, and hence, may be found in any language regardless of its syntax.

Examples

- (1) Britney likes this guy who destroyed a new vehicle, but she didn't reveal which vehicle.
- (2) Britney likes this guy who destroyed a new vehicle, but she didn't reveal what.
- (3) a. A: Lisa had lunch with somebody B: Who?
b. A: Lisa had lunch with somebody B: With who?
- (4) A: We have the concert in the state park. B: (In) which state park?
- (5) ?Jani was eager to live in something inexpensive but I don't know (in) which apartment.
- (6) ?Paula Abdul was replaced on American Idol by someone, but I don't know (by) which musician.

PRO beats gap, revisited: Eyetracking evidence

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Filler-gap processing; Eye-tracking; Reading; English

Several early results in the literature on filler-gap processing (Frazier, Clifton and Randall, 1983; Crain & Fodor, 1985; Clifton & Frazier, 1986) suggested that in the course of incremental comprehension, the null pronominal PRO is initially posited in preference to a gap corresponding to a previously encountered wh-filler. Using methods such as self-paced reading and RSVP, these studies found an RT or comprehension advantage for sentences like (1a) compared to (1b). These results were interpreted as suggesting that in (1b) readers initially assumed a control structure, in which *begged* is followed by PRO, then had to reanalyze upon reaching the end of the sentence. To explain this phenomenon, Clifton and Frazier (1989) suggested that in fact a gap is initially posited, but is rapidly replaced by PRO when the reader obtains evidence (e.g., from the words *to sing* in (1)) of the beginning of an embedded clause. The two current experiments used eyetracking to assess readers' on-line preference for PRO over gap, and to investigate the role of verbal subcategorization restrictions.

In Experiment 1 (N = 42), we obtained evidence consistent with the claim that PRO is initially preferred over the gap. Participants read sentences like (2a-b); the matrix verb was always either *want* or *need*. In (2a), the gap is after the embedded verb (*ask*); in (2b), the gap is earlier, after the matrix verb. There was evidence of processing difficulty in (2b) compared to (2a), in the form of highly significant reading time differences, by mixed-effects models, on both on the penultimate region (*about*; go-past time 583 ms vs. 342 ms; regressions out 17% vs. 8%) and the final region (*the textbook*; go-past time 1177 ms vs. 939 ms). Consistent with prior findings, readers initially misanalyzed (2b) as a control structure, and were later forced to reanalyze.

Previous evidence is equivocal, however, as to whether comprehenders posit a control structure even when the verb does not allow one; Crain and Fodor (1985) argued that they do not, while Clifton and Frazier (1986) found evidence for processing difficulty even when, e.g., *begged* in (1b) is replaced with *forced*. In Experiment 2 (N = 32), participants read sentences like (3a-b) and (4a-b), differing in whether the matrix verb was *help*, which allows a control complement, or *make*, which does not. There was significant processing difficulty in (3b) compared to (3a), on the final region of the sentence (*in most cases*; go past time 1662 ms vs. 980 ms; regressions out 48% vs. 31%). Notably, the difference between (4b) and (4a) in the final region was in the opposite direction (go past time 1130 vs. 1284 ms). Thus, it appears that PRO is posited only when the verb does permit a control complement. In addition, this experiment demonstrates that the PRO analysis is adopted even in the absence of the word *to* as a cue to the beginning of an embedded clause. In sum, the two experiments confirm that PRO is preferred to a gap in on-line processing, but also demonstrate the parser's sensitivity to subcategorization restrictions imposed by the verb.

1. a. Everyone liked the woman who the little child begged PRO to sing those stupid French songs for ____.
b. Everyone liked the woman who the little child begged ____ to sing those stupid French songs.
2. a. Who do you need PRO to ask ____ about the textbook?
b. Who do you need ____ to ask Tim about the textbook?
3. a. The students that the professors help PRO advise ____ graduate on time, in most cases.
b. The students that the professors help ____ graduate on time, in most cases.
4. a. The machines that the technicians make ____ operate run efficiently on solar power.
b. The machines that the technicians make ____ run efficiently on solar power.

Is reading a blog the same as reading a book?

The structure and predictive validity of self-report measures of reading habits

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Individual differences; Language related experience; Print exposure; Exploratory factor analysis; English

Many theories of language processing assign an important role to linguistic experience, but how does one actually measure an individuals' linguistic experience? A handful of self-report measures of reading exposure have previously been proposed (e.g., 1) but much is still unknown about the validity of these measures. Are all occasions of linguistic experience – from blog to novel – equivalent, or does linguistic experience consist of multiple underlying dimensions, each with different relationships with language-related outcomes? The answer to this question is crucial for measurement of individual differences, as using total scale scores when the scale actually reflects multiple underlying dimensions can mask important correlations between measures and hypothesized outcomes. In two studies, we bring a psychometric approach to these questions.

In Study 1, 217 undergraduates completed two reading habits subscales (1): Comparative Reading Habits (subjects' ratings of themselves relative to their perceptions of others) and Reading Habits (time spent reading different types of material, such as magazines and textbooks), along with 10 novel questions asking participants to rate time spent reading various online materials.

Exploratory factor analysis (EFA) on item responses revealed that these scales do not reflect a uni-dimensional underlying construct; a single-factor solution exhibited extremely poor model fit. Instead, six distinct factors emerged in the EFA, each separately associated with greater reported exposure to *specific* printed materials. These included four theoretically intriguing factors: an "enjoys reading" factor, related to relative reading enjoyment and amount of time spent reading fiction and non-fiction books; an "entertainment reader" factor, positively related to relative time spent reading, and amount of time spent reading entertainment news, online shopping sites, blogs and magazines, but *not* novels or nonfiction; a "reading difficulty" factor, negatively related to self-reported comparative reading speed and positively related to perceived relative reading material complexity and hours spent reading (required) class material such as textbooks; and a "reads for information" factor, related to hours spent reading magazine, newspaper, and nonfiction content, both in print and online. A confirmatory factor analysis positing these factors, individually indicated by items with loadings of more than .20 in the EFA, was a good fit to the data, $RMSEA = .04$, $TLI = .95$.

In Study 2, a separate sample of 85 undergraduates completed the same print exposure questionnaires, along with self-paced reading of complex grammatical constructions, the revised Author Recognition Test (1), and pronunciation of uncommon English words in North American Adult Reading Test (2). We computed item cluster scores corresponding to the factors suggested by the analysis in Study 1 by summing the items that loaded significantly on each factor.

Results suggest differential relationships between these distinct facets of reading habits and language-related outcomes. For example, "reading enjoyment" was significantly related to ART (1) performance ($r = .40$), scores on the NAART (2) scores ($r = .21$), and comprehension of complex syntactic constructions ($r = .24$), while "entertainment reading" was not significantly related to either author recognition or pronunciation, and had a trending negative relationship to complex sentence comprehension ($r = -.12$).

Taken together, these results suggest that language-related experience is multi-faceted, with different components relating differentially to aspects of language understanding, and have important methodological implications for using self-report measures of linguistic experience.

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Processing literary metaphor with and without original context: ERP evidence

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Literary metaphor; Event Related Potentials (ERPs); Italian

ERP studies on metaphor have mainly focused on everyday expressions, either familiar (“Those fighters are lions”) or unfamiliar (“Those apprentices are lions”), showing an N400 modulation driven by context expectations [1]. Almost no interest has been devoted to more creative metaphors as those found in literary works (“All the world’s a stage”). The specificity of literary metaphor is still unexplored in its neuroscientific aspects. Interesting hints come from pragmatic approaches to metaphor. The distinctive feature of literary metaphor might lay in the condensation of multiple meanings in a few words and in the vast range of non-manifest implications (“weak implicatures”). The cognitive effects achieved by such implications could be identified as “poetic effects” [2]. This study aims at (i) exploring possible distinctive ERP signatures for literary metaphor, and (ii) understanding to what extent context can affect the process. Based on previous evidence on figurative language [3;4;5], we hypothesized a biphasic pattern in response to literary metaphor, i.e., a lexical-semantic stage followed by pragmatic enrichment. The specificity of literary metaphor is expected to influence pragmatic stages of processing, rather than lexical-semantic access. Context is expected to facilitate lexical-semantic integration [1;6] but not pragmatic enrichment [3;4].

In Experiment 1, participants read a corpus of Italian literary metaphors (1a), literal phrases (1b) and anomalies (1c) presented out-of-context. In Experiment 2, another group of participants read the same set of literary metaphors (2a) and literal phrases (2b) embedded in their original context - prose and poetry - which had the same length in number of words. In both experiments, behavioral pre-tests (e.g., cloze probability) were carried out. Participants were unaware of the study goal and were asked to perform a word matching-task at the end of each trial.

In the out-of-context presentation (Exp1), literary metaphors were more costly than their literal counterparts in both early and late time-windows (P200 and LPC). The effort in lexical/semantic access required by literary metaphors was visible in the P200 modulation [7]. LPC presumably reflects pragmatic elaboration that might be related to the activation of poetic effects, as hypothesized in the theoretical literature. Surprisingly, no N400 effect was observed: literary metaphors did not elicit more enhanced amplitudes than the literal condition (while, as expected, anomalies did). In the in context presentation (Exp2), compared to controls, literary metaphors elicited an early and sustained negative effect. This is likely to index a highly demanding process of pragmatic enrichment triggered by context and is consistent with results reported for coherence construction [8] and recomputation of the discourse models [9].

Collectively, our results suggest that the specificity of literary metaphor emerges in relation to the pragmatic aspects of the comprehension process and that, crucially, context does not facilitate but rather enhances the comprehension process. This increased cognitive effort is likely to result in greater aesthetic benefits, as presumably happens in the ecological fruition of literary texts. In conclusion, this study can pave the way to a fruitful combination of literary studies and (neuro)pragmatics.

Example stimuli [Original Italian, English translation in brackets]:

Exp 1 (out-of-context): 1a) Literary metaphor: prato di velluto [grass of velvet] – 1b) Literal: trono di velluto [throne of velvet] – 1c) Anomalous: marmo di velluto [marble of velvet]

Exp 2 (in context): 2a) Literary Metaphor: Non so se veramente fu vissuto / quel giorno della prima primavera. / Ricordo o sogno? Un prato di velluto, / Ricordo o sogno? Un cielo che s’annerà (Gozzano). [I don’t know if really was lived / that day of the early spring. / Do I remember or dream? A grass of velvet, / Do I remember or dream? A sky that grows dark]. - 2b) Literal: Venti minuti appena la sua ospitata: seduta su un trono di velluto rosso e dorato, ha sorseggiato una coppa di spumante. [Her visit lasted only twenty minutes: sat on a throne of (red and golden) velvet, she sipped a bowl of sparkling wine].

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Domain restriction and discourse structure: Evidence from processing

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Domain restriction; Definite descriptions; Truth-value judgments; Visual world paradigm; English

Introduction. Assuming a uniqueness-based analysis, definites, like quantifiers, are typically interpreted relative to a contextual domain: *The professor laughed* is only interpretable when there is a unique professor. While it is clear that contextual support is needed to derive the comprehenders' actual interpretation, there are two views with respect to how domain restriction is implemented. Pragmatic Enrichment approaches (e.g., Neale 1990, Bach 1994) see it as purely pragmatic. The literal meaning of sentences is taken to be unrestricted (even if that leads to infelicity), and comprehenders are assumed to go through Gricean reasoning to infer the intended meaning. Syntactic enrichment approaches (e.g., von Stechow 1994, Stanley and Szabo 2000) assume that NPs contain covert, syntactically represented C-variables (place-holders for predicates) or situation pronouns (Kratzer 2007, Schwarz 2011) that are interpreted much like pronouns, namely via the assignment function. These approaches give rise to different expectations for the time course of domain restriction processing, assuming that pragmatic implicatures incur additional processing time. Another important question for theories of domain restriction is how discourse context affects domain selection, and the accounts differ in their options for incorporating such effects. A visual world eye-tracking study (with Truth Value Judgments), was conducted to investigate these issues.

Methods. Subjects were eye-tracked while seeing displays of five colored shapes and listening to auditory stimuli, and subsequently making truth-value-judgments. Target sentences were of the form *The circle is black/green* and were presented in three different discourse contexts (see below). Displays were varied as to whether the circle was unique or not. Contexts contained spatial PPs such as *on the top*, which provided a suitable domain restriction option for the non-unique conditions, ensuring uniqueness relative to the relevant sub-domain. This yielded a 2x3 interaction design. 36 experimental sets were presented to 36 subjects in 6 counterbalanced groups (+36 fillers). Target adjectives held either of target or competitor shapes (between-items). TVJs revealed the choice of referent in the non-unique conditions. The design allowed us to investigate the strength of the domain restriction effects in the different contexts and the time course of domain restriction choices in processing.

Results. Responses for PPFront, where the PP serves as a frame adverbial for the entire discourse, reflected a higher rate of choosing the top circle when the adjective was false of that circle, suggesting that the domain restriction effect is strongest in this context. Eye movements were analyzed during the time windows corresponding to 'circle is' and the first 1000ms after the onset of the adjective. In the initial time window, there were more looks to the competitor (green) circle in the PPPred and PPNP conditions, as reflected in a 2x3 interaction and corresponding simple effects in comparisons with PPFront in the non-unique conditions. During the adjective time-window, PPNP pattered more like PPFront when the adjective was 'green'. The latter was significantly different from PPPred, which yielded more looks to the competitor.

Discussion. Domain restriction effects were reflected in eye-movements more or less immediately during the noun-time-window. This seems contrary to the expectation of pragmatic enrichment accounts, where domain restriction is determined by (presumably costly) online pragmatic reasoning, and is thus more consistent with syntactic approaches. The differences between the various contexts furthermore reveal fine-grained effects of discourse context on choice of domain restriction. This provides further grounds for deciding between syntactic approaches to the extent that situational accounts offer a more straightforward implementation of discourse factors (discussed in more detail in the poster presentation).

(PPPred) The yellow triangle is on the top. The circle is {black / green}

(PPFront) On the top, there's a yellow triangle. The circle is {black / green}

(PPNP) The TRIANGLE on the top is yellow. The circle is {black / green} ('on the top' deaccented)

Non-Unique display

Black circle		Yellow triangle
	Blue square	
Red diamond		Green circle

Unique display (control)

Black circle		Yellow triangle
	Blue square	
Red diamond		Green square

Audience design affects classifier positioning in Chinese relative clauses: Evidence from spoken corpus and sentence-production data

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Audience design; Corpus; Word-based production; Relative clauses; Classifier; Chinese

In sentence production literature, it remains controversial whether speakers tailor their utterances to their audience ('audience design') [4,7] or plan their words according to speaker-internal constraints ('speaker-oriented') [3,5]. This study tests these two hypotheses by examining a flexible construction in Chinese, where a demonstrative+classifier (DCL) sequence that requires semantic agreement with its host head noun can occur either *before* or *after* a relative clause (RC). Using a spoken corpus and two sentence-production experiments, we investigated the distribution pattern of DCL positioning in subject-extracted RCs (SRCs, 1) and object-extracted RCs (ORCs, 2).

The speaker-oriented hypothesis posits that speakers tend to produce whatever is most accessible first (i.e., DCLs), thus buying time to plan less accessible units (i.e., bare nouns) [1,2]. This predicts no differences in DCL positioning regardless of RC types. The audience-design hypothesis posits that speakers help listeners to pre-build RC structure by providing early cues (e.g., DCLs), and to avoid situations where structural ambiguity or semantic clash occurs. This predicts an asymmetric pattern: DCLs tend to occur at the left edge of SRCs (1), but at the right edge of ORCs (2) to avoid garden-path effects (main clause vs. RC) or semantic clash (incurred by the incongruence between a mismatching classifier and a local noun, ex. 3).

We first investigated the distribution pattern of DCLs in 357 RCs extracted from a Chinese live TV-show similar to Oprah Winfrey's talk show — *Appointment with Luyu* (309,848-word). Regardless of the modifying role of RC in matrix clause or the transitivity of RC-verb, we consistently found an asymmetric distribution pattern. This, together with similar findings in written corpora [6, 8], supports the audience-design hypothesis.

We then conducted two production experiments using Paradigm software. Sentences were chunked into four parts (DCL/RC/headNoun/main-clause), each randomly assigned to four boxes in a diamond layout on a visual display. **Experiment 1** (N=42) manipulated RC types (SRC vs. ORC), with human local&head nouns modified by the same classifiers. The utterances produced by participants showed an asymmetric pattern in 444 SRCs (77.5% pre-RC DCLs vs. 22.5% post-RC DCLs; $p < .0001$), but no such asymmetries in 418 ORCs (49.0% vs. 51%). However, the asymmetric pattern emerged when examined by DCL positioning: out of 549 pre-RC DCLs, SRCs outnumbered ORCs ($p < .0001$); out of 313 post-RC DCLs, ORCs outnumbered SRCs ($p < .0001$).

Experiment 2 (N=48) used the same stimuli as Exp.1, but had animate heads and inanimate embedded nouns (ex. 3). The utterance produced by participants showed a strong asymmetry of DCL positioning by RC types: Out of 515 SRCs, pre-RC DCLs outnumbered post-RC DCLs (71.5% vs. 28.5%; $p < .0001$), out of 460 ORCs, post-RC DCLs outnumbered pre-RC DCLs (66.1% vs. 33.9%; $p < .0001$). This suggests that while participants preferred DCLs at the left edge of SRCs, animacy biased participants to put DCLs in post-RC positions in ORCs.

Taken together, the data show that DCL positions are asymmetrically correlated to RC types, and animacy configuration modulates DCL positioning. The results are compatible with the audience-design hypothesis.

- (1) Pre-RC DCL in SRC ('The girl who met the star-hunter is very beautiful.')
na-ge [RC yujian xingtian de] **nuehai** zhangde hen piaoliang
 that-CL meet star-hunter DE girl grow very beautiful
- (2) Post-RC DCL in ORC ('The girl whom the star-hunter met is very beautiful.')
 [RC xingtian yujian de] **na-ge** **nuehai** zhangde hen piaoliang
 star-hunter meet DE that-CL girl grow very beautiful
- (3) Pre-RC DCL in ORC (semantic clash)
na-kuai [RC baoan duokai de] **shikuai** diaozai dishang.
 that-CL_{stone/human} guard dodge DE stone fall ground

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**When a stone tries to climb up a slope:
The influence of perceived and linguistically induced animacy on reference**

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Perceptual animacy; Linguistic animacy; Reference; Story retelling; Dutch

Animacy has strong influences on language production. People are more likely to talk about animate entities than about inanimate entities, and animacy has been found to affect a range of grammatical phenomena, such as passivization, the dative alternation, and case marking. Furthermore, there is evidence that animacy affects the choice of referring expressions: Animate beings are more often referred to with pronouns (Dahl & Fraurud, 1996; Fukumura & Van Gompel, 2010). Animacy may be so pervasive in language because beings that, like ourselves, can act upon their environment, and have goals, intentions and mental states, are much more important to us than lifeless objects. Most linguistic studies on animacy treat these properties only implicitly, presupposing an animate entity for an animate lexical item (e.g. 'scout'), and an inanimate entity for an inanimate lexical item (e.g. 'stone'). However, we sometimes perceive inanimate entities as animate (and perhaps also the other way around). According to the perception literature, purely visual information, such as movements of simple geometric objects (e.g. a sudden change in speed), can induce a strong and immediate percept of animacy (e.g. Scholl & Tremoulet, 2000).

In the present study, we raise the question whether an entity's perceived animacy influences the way people refer to it, or whether reference is only affected by the animacy associated with lexical items. In a pilot study, we presented 12 Dutch-speaking participants with 20 animations of geometric objects. The movements of one target figure in each animation were manipulated such that they gave rise to either an animate percept (self-propelled movement; e.g. climbing up a slope) or an inanimate percept (movement caused by an external (invisible) force such as gravity; e.g. rolling down a slope). To make repeated reference possible, each animation consisted of an intransitive action of the target figure, followed by a transitive action (interaction with competitor figures) and another intransitive action. To control for agency, the target figure could be either the agent or the patient in the transitive action, which was crossed with the perceptual animacy of the intransitive actions. Each target figure was given a linguistic label, either animate (e.g. 'scout') or inanimate (e.g. 'stone'). The participants' task was to retell the animations, using the given labels for the target figure. We investigated whether the target figure was made the subject of the transitive action, and whether the target figure was referred to using attenuated expressions (pronouns and zeros) in the final intransitive action. We analyzed the data using logit mixed models.

The results suggest that linguistically induced animacy affects both grammatical function and referring expression production: There were more subject references when the label was animate (74%), than when it was inanimate (44%), $\beta = 1.45$, $p < .001$. In addition, there were more pronoun references when the label was animate (88%), than when it was inanimate (67%), $\beta = 1.63$, $p < .01$. Perceptual animacy did not have a significant effect on either grammatical function or pronoun use. However, we found effects of perceptual agency: There were more subject references to agentive figures (82% vs. 40%, $\beta = 2.54$, $p < .001$). For pronoun use, there was a significant interaction with linguistic animacy ($\beta = 2.30$, $p < .05$), the effect of linguistic animacy being larger for agents than for patients. These findings provide evidence that linguistically induced animacy is more important in reference than an entity's perceived animacy. However, effects of perceptual animacy may be more subtle and might have been masked by perceptual agency. In a follow-up study, we pretested the materials for perceived animacy and adjusted some animations to be more clearly animate or inanimate. In addition, we only had target figures that were agentive in the transitive event. Results will be presented at the conference.

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Determinants of scanpath regularity in reading

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Scanpaths in reading; Aging; Processing difficulty; Oculo-motor control; Eye-tracking; German

When people read sentences, the majority of eye movements proceed in one direction. Deviations from this default trajectory have been identified to index low-level oculo-motor constraints, high-level language processing, and age-related changes in perception and cognition. To our knowledge, there exists no study investigating how all these factors interact. We present an analysis of a comprehensive eye-tracking corpus (Kliegl, Grabner, Rolfs, & Engbert, 2004) that investigates how oculo-motor constraints, sentence processing, and aging together determine the regularity of scanpath trajectories in reading. The corpus (the Potsdam Sentence Corpus) consists of 144 simple German sentences that were read by 230 readers which differed in socioeconomic background, education, and age (ranging from 18 to 84). For the analysis, we used a measure that was recently proposed for the analysis of scanpath trajectories in reading (von der Malsburg & Vasishth, 2011). The scanpath analysis recovered effects that have previously been reported in the literature: short words, and syntactically more difficult sentences (as measured by surprisal, and retrieval difficulty) elicit more irregular scanpaths; also, older readers produce more irregular scanpath patterns than young readers. These results validate the scanpath method by von der Malsburg and Vasishth because they demonstrate that the method can recover effects that have previously been found in analyses of traditional eye-tracking measures.

Beyond these expected effects, we also found an interaction of age and the syntactic measures that has not been reported earlier: in older readers the effects of the syntactic processing difficulty are smaller than in younger readers, suggesting a shift in sentence processing strategies as readers age. This is a surprising result given earlier studies of the relation of aging and sentence processing that suggested only minor quantitative differences between old and young comprehenders (Davidson, Zacks, & Ferreira, 2003; Waters & Caplan, 2005). However, our result is consistent with the finding by Christianson, Williams, Zacks, and Ferreira (2006) that older readers may rely to a lesser degree on syntactic bottom-up information than young readers. We interpret the results in terms of shifts towards more risky and expectation-driven processing strategies on the oculo-motor level (c.f. Rayner, Reichle, Stroud, Williams, & Pollatsek, 2006) and the sentence processing level. We also consider the alternative explanation that more frequent lapses of attention in older readers followed by recognition of such lapses and subsequent corrections could cause the age differences observed in scanpath regularity (Wotschack & Kliegl, in press).

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Optional *to* and prosody

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Stress sensitivity; Syntactic reduction; Corpus analysis; American English

Numerous studies have investigated factors influencing the presence or absence of *that*, at the beginning of complement or relative clauses. These include the predictability of the clause in its context, the complexity of the clause, and various properties of the clause-internal subject NP, plus such factors as modality (speech vs. writing) and speech rate (e.g. [1], [2], [4], [5]).

In contrast, the factors influencing where the infinitival *to* will occur when it is optional remain almost entirely unexplored. One environment where *to* is optional is what we call the *do be* construction (DBC), exemplified in (1). DBC is characterized by a relative clause in the subject containing some form of *do*, followed by a copula interpreted as an assertion of identity, which is in turn followed by a verb phrase. The post-copula verb (PCV) is usually in base form (uninflected, without *to*), but infinitival *to* also occurs frequently. The forms with and without *to* appear semantically indistinguishable.

We analyzed over 1000 DBC examples from the spoken portion of the Corpus of Contemporary American English. Several factors behave as we expected, based on the analogy with optional *that*: sentences with longer subjects or longer post-copula VPs have higher rates of *to*, and *to* is more likely when the *do* in the subject is in infinitival form than when it is finite or base (arguably due to priming). But frequency of the post-copula verb is positively correlated with the occurrence of *to*, contrary to what accounts in terms of predictability would lead one to expect.

Considering prosody as a factor in the distribution of optional *to* helps to explain this surprising correlation. Specifically, avoidance of stress clash and stress lapse – that is, two adjacent syllables that are both stressed or unstressed ([3]) strongly influences whether *to* is used. Infinitival *to* is unstressed; so insertion of *to* would always either prevent clash (if the adjacent syllables are both stressed) or cause lapse (if either adjacent syllable is unstressed). The rate of *to* use is almost three times as high in environments where it prevents clash as in environments where it causes lapse. Frequent verbs tend to be monosyllabic and hence initially stressed, and the DBC copula carries some stress (as evidenced by the fact that it never contracts). Thus, in the absence of adverbs, use of *to* with frequent PCVs often prevents stress clash. When an adverb intervenes between the copula and the PCV, *to* is extremely rare; examination reveals that its use in these cases would usually create lapse rather than prevent clash. Once we included stress in our models of *to* use, the expected negative correlation with PCV frequency emerged.

Our study of optional *to* supports the processing accounts of the distribution of optional *that* put forward by Jaeger and others. In mixed models of our DBC data, prosody consistently ranks among the strongest predictors of *to*. This suggests that other studies examining the factors influencing syntactic alternations should be including prosody as well.

- (1) a. What the former colonial subject has done is (to) beat the master at his own game.
- b. All they can do is (to) say we'll try to enforce the no-fly zone.
- c. The best thing to do was simply (to) remind the reader repeatedly.

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MEG evidence for distinct sub-operations within semantic composition

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Composition; Left anterior temporal lobe; Magnetoencephalography (MEG); English

Introduction

The power of language lies in our ability to combine its basic elements to create more complex expressions. A central question in characterizing this combinatory system is whether linguistic composition is a single monolithic operation (e.g. Hagoort, 2011, Hornstein & Pietroski, 2009), or whether composition is accomplished via several distinct sub-operations, as most formal semantic theories would hold. Here we aimed to characterize the potential brain bases of these sub-operations, by employing a broad distinction between two basic composition types standardly assumed in Linguistics: the optional modification of a predicate (modification) and the satisfaction of a predicate's argument position (argument saturation) (Heim & Kratzer, 1998). Due to prior evidence that the left anterior temporal lobe engages in predicate modification (Bemis & Pykkänen, 2011, Baron & Osherson, 2010, 2011), we hypothesized that this region might specifically subserve composition of this nature. Additionally, we tested four other regions of interest (ROIs) previously hypothesized as combinatory: the left inferior frontal gyrus (LIFG) (Hagoort, 2005), the angular gyrus (AG) (Humphries et al., 2006), the ventromedial prefrontal cortex (vmPFC) (Pykkänen & McElree, 2006, 2007), as well as the right anterior temporal lobe (RATL). In order to ensure that the results were maximally generalizable, we investigated three different types of predicate modification: the composition of adjectives and nouns (e.g. 'black sweater'), of adverbs and verbs ('runs quickly'), and of adverbs and adjectives ('very funny'), and three types of argument saturation: the composition of verbs ('eats meat'), prepositions ('in Italy'), and determiners ('Bilbo's ring') with their noun arguments.

Design & Method

Target words were visually presented to 14 native English speakers during magnetoencephalography recording sessions, either in combinatory contexts (e.g. "in Italy") or in non-combinatory contexts (target word preceded by an unpronounceable consonant string, e.g. "xq Italy"). To monitor attention, in 20% of trials subjects matched the meaning of a third word to the preceding critical stimulus. Neural activity was measured from the onset of the target word (e.g. "Italy"), such that the activity elicited by combinatory and non-combinatory operations was measured at the same words. The ROI analysis was followed by a full brain analysis.

Results

Non-parametric cluster-based analyses of distributed minimum norm activity at the target words identified a significant interaction at 276-307 ms ($p < 0.05$) in the LATL, where there was more combinatory than non-combinatory activity for predicate modification but not for argument saturation. This result replicated in the full brain analysis. Analyses of sub-conditions suggest this pattern holds across sub-types of predicate modification and of argument saturation. Furthermore, there was some evidence for a more general involvement of the RATL (218-282 ms, $p < 0.01$) the vmPFC (371-401 ms, $p < 0.05$), and the AG (182-288 ms, $p < 0.005$) in composition.

Conclusion

Our results demonstrate a neural distinction between modification and argument saturation. Importantly, this distinction generalized across several instances of the rules. Thus, instead of a uniform combinatory operation, our findings suggest a finer architecture for the composition system of language, establishing a starting point for characterizing the brain bases of its sub-computations.

Familiarity and frequency disentangled: An eye-tracking corpus study with German texts

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Eye-tracking during reading; Eye-tracking corpus study; Lexical processing; Frequency; Familiarity; Retrieval

Models of eye-movement control (e.g., E-Z-Reader, Reichle et al., 2003) make detailed predictions about the influence of lexical variables on the reading process. These predictions have previously been tested on large-scale eyetracking corpora like the Postdam sentence corpus (Kliegl, Nuthmann, & Engbert, 2006) and the Dundee corpus (Kennedy, Hill, & Pynte, 2003). One established predictor for reading times is word familiarity where highly familiar words show decreased reading times (Kennedy & Pynte, 2005). Gernsbacher (1984) had subjects rate words for their subjective, “experiential familiarity”. Here, familiarity is captured by the cumulated frequency of all words sharing word n 's length and initial trigram. However, familiarity is confounded with lexical frequency: Highly frequent words tend to be also highly familiar. Does familiarity contribute anything beyond word frequency?

In an analysis of lexical variables in reading German jurisdictional texts, press releases and newspaper articles, we applied a multi-residualization technique to assess this issue. Our eye-tracking corpus consists of gaze data from 80 participants on over 16,000 words. Word length, token frequency, familiarity, and the number of nearest neighbors as measured by a Levenshtein distance of 1 were extracted from the lexical database dlexDB (Heister et al., 2011) and treated as predictors in linear mixed-effects models (with participant and item as random factors).

For first fixation durations, first-pass reading times, regression path durations and total reading times, we found an effect of residual familiarity independent of the effects of word length and residual frequency that points in the opposite direction than the effect of raw familiarity. The fact that words with a high residual familiarity (with word length and frequency partialled out) are read longer points to an effect of lexical competitors. This effect is still reliable if the number of words with a Levenshtein distance of 1 to word n is included into the model, underpinning the relevance of residual familiarity capturing other sources of variance than lexical competitors. Obviously, the beginning and the overall shape (as captured by the length) of a word are important in lexical processing during reading. If there are many similarly shaped words with the same beginning, then lexical retrieval gets harder, which could be characterized as a fan effect (Anderson, 1974). The fan consists of all other words of equal length and the same beginning as word n . If the fan is smaller, fewer competitors interfere and word n gets activated faster. Hence, lexical retrieval is easier and faster.

In analyses of lag effects, we did not find an effect of familiarity of word $n-1$, whereas we found an interaction effect of the lexical frequencies of word n and $n-1$. The frequency of word n exerts a higher influence on first pass reading times when word $n-1$ is less frequent – a phenomenon captured by Henderson & Ferreira's (1990) “foveal-load hypothesis”. This effect pattern is in line with a lexical retrieval explanation, because the early stages of lexical retrieval should already be completed when readers move on to the next word – therefore, no effect of residual familiarity of word $n-1$ is expected.

Analyses of lexical properties and their contribution to reading behavior emphasize the relevance of residual familiarity of word n . Even while reading natural texts, where semantics and pragmatics are constantly constraining the number of possible words which could be encountered next, the beginning and the overall shape of a word seem to influence reading times.

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Two stages of NPI licensing: An ERP study

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Semantic/pragmatic processing; Event Related Potentials (ERPs)

Negative polarity items (NPI) such as *ever* and *any* are known to be subject to particular semantic and pragmatic licensing conditions, but the exact nature of the licensing condition is still under debate. Using ERP recording, the current study argues that (i). there are two different kinds of licensing mechanisms: one licenses NPIs in the grammar proper, and the other licenses NPIs through inferences; (ii). it is the negativity of the licensing environment, rather than the downward entailment (DE) property per se, that licenses NPIs, contrary to the long-held assumption (since Ladusaw 1980) that DE is a fundamental semantic property underlying NPI licensing.

In a Latin Square design, native English speaking participants (n=33) read a context sentence followed by one of five target sentences (1), while ERPs were recorded. The context sentence was presented as a whole, and the target sentence word by word in the center of the screen (500ms SOA), followed by a comprehension question. Conditions (1a) to (1d) are grammatical sentences, with a different licensor in each condition: *no*, *few*, *only* and *emotive factives* such as *surprised*, *glad*, etc; condition (1e) is the ungrammatical control in which the NPI *ever* is not licensed by any licensors. The experimental items (n=150) were normed in an offline rating study before the ERP recording session (see (1)). Among the four grammatical conditions, *no* and *few* are the stereotypical DE licensors. *Only* and emotive factives like *surprise* or *glad* do not pass the standard DE test (2). It has been argued that licensors like *only* and factives license NPIs via inferences rather than in the grammar proper(3) (Giannakidou2006; Linebarger1988). All participants also finished an Autistic Spectrum Quotient (AQ, Baron-Cohen et al. 2001), which has been reported to independently assess pragmatic skills in language comprehension (Nieuwland et al. 2010).

ERP recording time-locked at the onset of the critical word(CW) *ever* showed a significantly larger posterior positivity in the 400-700ms time window on the ungrammatical condition (1e), compared to *no*, *few* and *only* conditions (ps<.05), but only for the licensor *only* that the positivity is correlated with the participants' AQ scores (communication subscale (CS) in particular,) (p<.01), such that the worse a participant's pragmatic skills, the smaller the positivity effect, suggesting licensing through *only* may be qualitatively different from *no* and *few*. The difference between (1e) and the emotive factive condition, is not significant at the CW (ps>.1). However, at the sentence final word (SFW), the ungrammatical control showed a prolonged positivity (starting from 400ms from the onset) compared to all four grammatical conditions (ps<.05); but only for emotive factives, this effect is correlated with the CS scores (p<.06) in the same direction as above.

In conclusion, based on both the time course information and the correlation between the processing of a licensor and the participants' pragmatic skills, the non-DE focus marker *only* and the emotive factives demonstrated a qualitatively different licensing effect from the DE quantifier *no* and *few*, suggesting two different mechanisms for NPI licensing.

- | | |
|---|------------|
| (1). War and Peace was such a long novel. | 1-5 rating |
| a. No Russian literature students could ever finish it. | (4.15) |
| b. Few Russian literature students could ever finish it. | (4.08) |
| c. Only Russian literature students could ever finish it. | (3.90) |
| d. Russian literature students were glad they could ever finish it. | (3.75) |
| *e. Russian literature students could ever finish it. | (2.32) |

- (2) ?? Only John came to school. → Only John came to school early.
 ?? I am surprised John came to school. → I am surprised John came to school early.

(3) || *Only John* || = $\lambda P.P(\text{John}) \wedge \neg\exists x [x \neq \text{John} \wedge P(x)]$

- a. Only John came to school. → John came to school and no other people than John came to school.
 b. "I am surprised/glad John came" could imply that "I did not expect John to come".

Thursday, March 15 Paper Abstracts

The adaptive nature of eye-movement control in linguistic tasks

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Adaptive control; Reading; Eye-tracking; Lexical decision; English

Overview. We present empirical and modeling evidence that eye-movement control in reading precisely adapts to speed-accuracy tradeoffs imposed jointly by processing architecture and task structure and payoffs. Our experiments provide participants with payoffs at different points on a speed-accuracy tradeoff continuum, and our model optimizes the same payoffs to arrive at quantitative predictions. The work extends existing models of oculomotor control in reading [1, 2] by explicitly identifying loci of strategic adaptation in saccadic control in an architecture capable of performing a simple but complete linguistic task. Architecture and payoff jointly determine predicted adaptive behavior; changes in either can change model predictions because they redefine the adaptive problem. These results extend work on rational analysis of oculomotor control and reading strategies [3, 4, 5] by providing evidence for low-level adaptation of saccadic control to task and architecture. It complements existing empirical approaches to speed-accuracy tradeoff [6] through its focus on deriving behavior as solutions to precisely defined optimization problems that include processing constraints [7].

The task. On each trial of the List Lexical Decision Task (LLDT), participants see six four-letter strings and make one decision as to whether all are words. One nonword appears in a random position in 50% of trials. Participants and model were given feedback in the form of points after each trial; participants were given cash bonuses as a function of total points.

The model and its predictions. The model receives noisy perceptual samples of the fixated string, and performs a Bayesian update of a belief distribution over possible word lists, using priors derived from frequencies in a lexicon of four-letter words. From this distribution the model derives two summary statistics: the probability that the current trial is a word trial, and the probability that the fixated string is a word. The model's decisions are conditioned on these two probabilities: at each time step, the model compares them to two strategically-chosen thresholds to decide whether it should issue a trial (manual) response or program a saccade to the next string. The structure and temporal dynamics of the visuo-oculomotor and manual subsystems are motivated by existing literature (e.g. [8]). Optimal thresholds (found via search and Monte Carlo simulation) yield predictions of faster trial RTs, shorter single fixation durations (SFDs), and lower accuracies in the speed vs. the accuracy payoffs (see table for partial summary). The model recovers and explains both skewed fixation time distributions [9] and the log frequency effect on SFDs [10, 11] as a signature of optimal policies, and furthermore predicts an attenuation of this effect in the speed condition. Many suboptimal strategies do not yield these predictions, and neither do strategies optimal under different architectural constraints (such as changing the eye-brain lag).

Experiments. 48 participants completed 200 trials of the LLDT in one of three conditions specifying per-trial points as function of speed and accuracy. Participants adapted to the payoffs as the model predicted, achieving increased speed at the expense of accuracy via a reduction in SFD accompanied by an attenuation of the frequency effect—despite many other adaptations that were in principle possible, such as changing the number of fixations or regressions or reducing mind-wandering.

	Payoff 1 (speed emphasis)			Payoff 2 (accuracy emphasis)		
	Human	Model	Model (no EBL)	Human	Model	Model (no EBL)
SFD (s.e)	224 (9.7)	221 (1.5)	199 (0.9)	250 (6.0)	252 (2.8)	203 (4.9)
Freq. effect	-3.00 (0.6)	-4.08 (0.21)	-5.9 (0.26)	-5.22 (0.62)	-5.68 (0.28)	-5.7 (0.27)
Trial RT	1373	1366	988	1713	1479	1066

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A computational model of cognitive influences on pronoun processing

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Pronouns; Discourse; Acquisition; Processing speed; Working memory load; Cognitive model; Dual-task experiment; Dutch

How do listeners process an ambiguous pronoun? The use and interpretation of pronouns depends on linguistic principles, discourse prominence (e.g., Ariel, 1990; Arnold, 1998; Grosz et al., 1995) and pragmatic reasoning (Gundel et al., 1993). This study investigates if and how more general cognitive factors such as processing speed and working memory influence referential processing.

We implemented a computational model within the cognitive architecture ACT-R (Anderson, 2007) to explain the processing of referring expressions in discourse. The processing of pronouns is simulated as two related processes. In the first process, the model uses general memory principles to build a discourse representation during sentence comprehension. The accessibility of discourse referents is represented by the activation of elements in memory. The discourse referent with the highest activation is considered as the current discourse topic and is retrieved as the referent of a pronoun. In the second process, the model evaluates whether this referent is a plausible interpretation given the speaker's choices: The model then takes the speaker's perspective, and checks whether the speaker could have intended the selected interpretation.

Our model integrates accounts of linguistics competence and plausible assumptions about cognitive processing, and is used to generate precise and testable predictions about linguistic performance. We discuss empirical support for two predictions derived from our computational simulations.

1. Adult-like interpretation of object pronouns requires sufficient speed of processing.

Our model uses perspective taking to learn that an object pronoun cannot refer to the local subject (cf. Principle B of Binding Theory; Chomsky, 1981), because a speaker would have used a reflexive for expressing a coreferential meaning (Principle A of Binding Theory). However, this additional reasoning step takes extra processing time. We have tested this prediction by presenting children, who show a Delay of Principle B Effect (a.o., Chien & Wexler, 1990), with slowed-down speech, thus giving them more time for interpretation. With slowed-down speech, their pronoun interpretation, but not their reflexive interpretation, became more adult-like (Van Rij et al., 2010). This supports the model's prediction that pronoun interpretation requires sufficient processing speed.

2. Adult-like interpretation of subject pronouns requires sufficient working memory capacity.

In our model, the activation of discourse referents is influenced by their frequency and recency of mention and the current discourse context. The current discourse context, in particular the subject of the previous sentence, receives more activation than other referents. Working memory capacity determines how much more activation this previous subject receives (Daily et al., 2001). We performed a dual-task experiment to test whether adult listeners would show difficulties in perceiving a topic shift if they have less WM capacity available. To manipulate WM load, participants performed a dual task: memorizing digits while reading stories with and without topic shift (indicated by new or same subject). WM load influenced the interpretation of stories with a topic shift, but not the interpretation of stories without a topic shift, supporting the prediction that the interpretation of pronouns in discourse is dependent on the amount of WM capacity available for interpretation.

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The role of hierarchical structure in syntactic dependency integration

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Processing complexity; Dependency integration; Locality; Regression analysis; Eye-tracking; British English

The role of the hierarchical syntactic structure has been controversial in sentence processing: while experience-based models of syntactic expectations or *surprisal* (Hale, 2001) generally rely on hierarchical sentence structure, memory-based models like the Dependency-Locality Theory (DLT; Gibson, 2000) tend to emphasize the importance of linear distance. Although DLT successfully predicts the difference between object and subject relative clauses in English (Gibson, 2000), it has problems accounting for a similar pattern in Korean (Kwon et al., 2006), where the linear distance between the verb and its object is the same in both constructions. One possible way to remedy this shortcoming of DLT is to replace linear distance by a structural distance measuring the number of syntactic nodes crossed (cf. O'Grady, 1997) when integrating the dependent(s) of a head.

We tested to what degree structural distance could replace linear distance by evaluating their relative importance as predictors for reading times in the Dundee Corpus (Kennedy & Pynte, 2005). Both distances were calculated based on dependency relations obtained from parsing the corpus with the Stanford Parser (de Marneffe et al., 2006): for each dependency relation the distance was determined as the number of words (LINEAR DISTANCE) between the head and its dependent and as the number of non-terminal nodes crossed (STRUCTURAL DISTANCE) when traversing the syntactic tree structure from the head to its dependent.

First-pass reading times were modeled using linear mixed-effects regressions with subjects and word tokens as random effects. We first fitted a baseline model with the predictors *word position*, *word length*, *unigram* and *bigram frequency* and all two-way interactions that significantly improved the model in a log-likelihood ratio test. All predictors were centered and scaled to reduce collinearity. We then added linear and structural distance as a predictor to the baseline model: while *structural distance* yields a reliably better model fit ($\chi^2(1, N=189,704) = 14.53, p < .001$), *linear distance* does not significantly improve over the baseline model ($\chi^2 = 1.02, p = .31$).

To test whether the effect of structural distance can be attributed to other measures of syntactic expectations or syntactic structure, we calculated the depth of embedding of each word and surprisal based on a non-lexicalized PCFG, and added them to the baseline model. While both predictors improved the model fit independently and together (cf. Pynte et al., 2008; Demberg & Keller, 2008), adding *linear distance* to a model with either *surprisal* or *depth of embedding* yielded no significantly better model fit (p 's $> .11$). *Structural distance*, however, was a significant predictor ($|t| = 3.4$) when added to *surprisal* and *depth of embedding*, and the resulting model is a better fit to the data than the baseline model with *surprisal* and *depth of embedding* only ($\chi^2 = 11.17, p < .001$). The model improvement still holds ($\chi^2 = 9.95, p < .01$) if structural distance is residualized by linear distance to account for possible traces of lexical information (e.g. sub-categorization) contained within the dependency structure.

These results suggest that dependency integration costs for heads are more sensitive to structural distance than to linear distance, and that structural distance could improve the empirical adequacy of memory-based models not only for Korean relative clauses, but also for English. The independent contributions of surprisal and structural distance indicate that hierarchical structure plays a role not only in the formation of syntactic expectations, but also in dependency integration.

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Structural repetition in sentence production conditioned by verb semantic similarity

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Syntactic priming; Verb semantic similarity; Sentence recall; RSVP; English

Although the tendency to reuse the syntactic structure of a previous sentence (a.k.a. syntactic priming) occurs without lexical repetition between prime and target sentences (Bock and Loebel, 1990), lexical repetition increases priming magnitude (Hartsuiker et al. 2007, for a review). Some studies show that priming is modulated by semantic factors (Cleland & Pickering, 2003; Chang et al., 2003; Griffin & Weinstein-Tull, 2003; Melinger & Dobel, 2005). However, none have shown that repetition of verb meaning in the absence of lexical repetition increases structural priming (c.f., Tooley, et al., 2009). Four experiments investigated whether semantic similarity between prime and target sentences affects the likelihood that a syntactic frame is reused. We hypothesize greater priming effect when verbs in prime and target sentences describe highly similar events (*promise-guarantee*) than when they do not (*promise-bounce*).

On every trial, participants began by reading two sentences in alternative syntactic frames presented via Rapid Serial Visual Presentation at 200ms per word [reading phase]. First sentences were either structural alternates of second sentences or were structurally different controls. Participants were then shown the first few words of sentences as cues to recall them in reverse order of presentation [recall phase] (Potter & Lombardi, 1998; Griffin & Weinstein-Tull, 2003). Thus 1st recalled sentences became primes and 2nd recalled sentences became targets (see Table 1). Experiments 1-2 examined the Double Object (DO)/ Prepositional Object (PO) alternation; Experiments 3-4 examined the Location Object (LO)/ Material Object (MO) alternation. Presentation order of these syntactic frames was counterbalanced across experiment pairs (see Table 2).

We conducted mixed-effects logistic regressions on participant responses to cues (shift/no-shift in syntactic frame) with participants and items as crossed random effects and prime type (High vs. Low similar verb vs. control) as a fixed factor. In every experiment, significantly more structural shifts were observed when verbs were highly similar across prime and target sentences relative to control sentences. Structural priming was only observed in the low similarity condition when targets shifted from DO to PO in Experiment 2. This was probably because the PO frame is overwhelmingly preferred for the verbs in Experiments 1-2. Shifts from the dispreferred DO frame to the preferred PO frame do not require an additional 'boost' from the semantic similarity of verbs between prime and target sentences.

These results provide converging evidence that syntactic priming can be conditioned by verb semantic similarity between prime and target sentences. The critical role of semantic similarity in our experiments raises the possibility that some prior reported results might also reflect, at least in part, influences of semantic similarity, since verbs with similar syntactic distributions are often semantically similar. Our results also suggest that sentence production models should incorporate a lexical-semantic component that ensures verbs closer in semantic space exert a stronger influence on the structure of subsequent sentences than verbs farther apart in semantic space.

Table 1

Exp 1	Presentation order	Condition	Sentences
Reading	Target (PO)		<i>The producer promised a large part to the actress.</i>
	Prime (DO)	1. Control	<i>Organic food is increasing in popularity recently.</i>
		2. High similarity	<i>The CEO guaranteed all employees a Christmas bonus.</i>
		3. Low similarity	<i>The ball boy bounced the player a new ball.</i>
Recall	Prime (DO)		(First few words up to verb from 1~3) _____.
	Target		<i>The producer promised _____.</i>

Table 2

Recall phase	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Prime recall	DO	PO	LO	MO
Shift in target if priming occurs	PO → DO	DO → PO	MO → LO	LO → MO

Shared argument structure among bilinguals: Evidence from sentence reading and recall

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Bilingualism; Argument structure; Sentence recall; American English; Brazilian Portuguese

This study contributes to investigations of whether language-specific syntactic structures are shared by bilinguals while processing sentences in one of their languages (Hartsuiker, Pickering, & Veltkamp, 2004). We report a case in which bilingualism influences L1 performance, focusing on an argument structure pattern that differs between Brazilian Portuguese (BP) and English: the induced action alternation of English manner-of-motion verbs. This is a causative construction applying to a particular sub-set of motion verbs (Levin, 1993), licensing sentences such as (1)—ungrammatical in BP (1') and Spanish (Montrul, 2001; Souza, 2011).

(1) The French captain marched his soldiers to the capital.

(1') *O capitão francês marchou seus soldados até a capital.

The task performed by bilinguals in L1 was a combination sentence-recall/sentence-matching procedure. Whole sentences were presented for silent reading, arranged on a single line, center-screen. A button press extinguished the sentence and prompted participants to recall orally the sentence just read. A second button press immediately revealed a new sentence on which a matching judgment was made. Materials included sentences with causative-like structure (NP-V-NP-PP) instantiating the induced action construction with manner-of-motion verbs (1), transitive change-of-state verbs like (2), and intransitive verbs (pseudocausatives) like (3).

(2) The young actresses dried their dresses at the theater.

(3) *The sad poet appeared his book after years.

Participants were BP-English bilinguals residing in the United States, with low (N=11) or high (N=12) English proficiency (assessed by a vocabulary size test). Two additional groups contributed baseline data: American English monolinguals (N=13) performing the same task with translation-equivalent materials in English; and BP monolinguals (N=10) performing a slightly different task (self-paced reading) with identical materials in BP.

Measures of total reading time (for first presentation of the sentences) and recall accuracy (omission of substantive words in the oral recall) were taken, and analyses of variance compared them across the three sentence types. For the English low-proficiency group, change-of-state materials (2) were read significantly faster ($p < .001$) and were recalled more accurately ($p < .005$) than both manner-of-motion (1) and pseudocausative (3) materials, which in turn did not differ from each other on either measure ($p > .5$). For the English high-proficiency group, reading times for the three sentence types differed reliably ($p < .001$): manner-of-motion (1) was fastest, followed by change-of-state (2), followed by pseudocausatives (3). Recall was equally accurate with change-of-state (2) and manner-of-motion materials (1) ($p > .5$), both reliably more accurate than with pseudocausatives (3) ($p < .003$). As expected, American English monolinguals showed no reliable difference in reading times or recall accuracy for manner-of-motion (1) and change-of-state (2) materials, which were both read significantly faster than pseudocausatives (3). BP monolinguals' time reading the second NP in manner-of-motion (1) and pseudocausative (3) materials did not differ ($p > .5$), whereas in both sentence types it was reliably higher than in change-of-state materials ($p < .001$).

High proficiency bilinguals departed from the grammatical restrictions of their L1 when performing our task, adjusting their performance based on their L2 grammar, suggesting that language-specific syntactic structures may be shared when bilinguals process sentences.

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Using structural priming to investigate linguistic representations underlying processing

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Linguistic representation; Structural priming

The psychology of language has traditionally encountered much opposition when it attempts to constrain linguistic theory – whether in relation to the reality of transformations (e.g., J.A. Fodor et al., 1974) or the reality of empty categories (e.g., J.D. Fodor, 1989). Because of this, it has often “retreated” into discussing issues of processing without tackling the underlying issues of linguistic representation.

Here we argue that structural priming (Bock, 1986) provides a method of addressing linguistic representation (i.e., is a form of “experimental linguistics”), as proposed by Branigan et al. (1995). A great deal of recent work has used it to determine the mechanism of language production and (to a lesser extent) comprehension. We contend that this research is also highly suggestive about linguistic representations and how they are linked, and most importantly provides a clear method for a great deal of future work on these issues.

Perhaps most importantly, the research suggests that priming is sensitive to different levels and components of linguistic representation. There is good evidence for *syntactic priming*, in studies that have systematically ruled out explanations in terms of prosody, lexical repetition, thematic repetition etc. Moreover, priming occurs between constructions that are syntactically similar but have unrelated constructional meaning, and across word-order variations in which meaning is identical. In addition, priming occurs for idiomatic constructions and constructions with inappropriate or novel verbs, suggesting that constructions are represented independently from lexical items.

However, recent research also reveals non-syntactic structural priming. For example, people tend to persist in the assignment of emphasis (topichood) to particular thematic roles, in the order of thematic roles (e.g., theme-recipient), in the assignment of thematic roles to functions (e.g., theme as direct object), in the assignment of animacy (or predicability) to grammatical functions or linear order, in the assignment of quantifier scope, and probably with an operation associated with complement coercion.

We argue that the data support the existence of a single, “shallow” surface syntactic representation, which includes grammatical function information and linear order, together with a single semantic representation that includes information about thematic roles and quantifier scope. The evidence does not support intervening levels of LF, DS, F-structure, or dominance-without-precedence. It also suggests that syntactic information is not “projected from the lexicon”.

Finally, we discuss cross-linguistic priming as evidence in the context of universality. The strength and ubiquity of such priming suggests that many constructions “count” as the same in different languages. However, priming also occurs between constructions that are different in the two languages and also supports shared semantic representations.

Overall, we argue that structural priming has only just started to investigate linguistic representation, and that it is not limited to resolving issues about processing. It provides an implicit method based on similarity between utterances that provides a useful alternative to grammaticality judgments. Among other things it is potentially able to discriminate among contentious linguistic analyses, and we briefly illustrate this with the Mandarin *bei* construction.

Early participant role commitments have their greatest impact on the integration of unpredictable role fillers

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Expectation-based sentence comprehension; Verb participant role information; Semantic similarity; Predictability

Many types of contextual constraints might affect the integration of linguistic material. Using a visual world paradigm, Bienvenue et al. (2007) and Sussman (2006) found that listeners anticipated the mention of specific instruments when they encountered verbs that semantically required (or were strongly associated with) an instrument. In sentences containing optional instrument verbs that described actions that could be done without an instrument, looks to instruments did not occur until they were mentioned. Presumably encountering verbs that require an instrument increase the likelihood that readers will anticipate a specific instrument, and do so early on. This would account for Yun et al.'s finding that instrument PPs are integrated more easily following obligatory instrument verbs than following optional instrument verbs. An alternative explanation for this finding is suggested by Roland et al. (2012), who showed that instrument PPs are more easily integrated when they are more semantically similar to other possible instruments. Verbs describing actions requiring an instrument might tend to have a much smaller, more semantically similar set of possible instruments than actions that can be performed without an instrument, which was not controlled in Yun et al. We explored whether the integration of instruments into declarative sentences is influenced by whether the presence of an obligatory or optional instrument verb leads readers make an early or late commitment to a specific instrument, when predictability and semantic similarity is controlled.

We presented sentences like (1-2), in which verbs either semantically required (jab) or merely allowed (attack) an instrument. Instrument predictability was high (sword/knife), medium (spear/stick), or low (spike/club) for online reading. Data were analyzed using mixed-effect linear regression. The dependent variable was the reading time of instrument NPs; fixed factors were the predictability of instruments (log-cloze probability), LSA semantic similarity between the target filler and the other possible fillers, and the frequency and length of target instruments; participants and items were random factors.

In addition to replicating Roland et al., Table 1 reveals that whether readers made early commitments to specific instruments interacted with instrument predictability. Readers had more difficulty integrating semantically required instruments than semantically optional instruments only when they were unpredictable. Whether readers made early instrument commitments interacted with semantic similarity and predictability. Only highly predictable instruments that were more semantically similar to other instruments were read faster, regardless of whether readers made early instrument commitments. But, only unpredictable instruments to which readers had not made an early commitment were facilitated by semantic similarity.

While early commitment to specific instruments may provide little discernable benefit when they are already highly predictable and similar to other instruments, readers apparently do make early commitments when verbs semantically require instruments. Specifically, early commitments have deleterious effects when unexpected instruments are encountered (see also Schwanenflugel & LaCount, 1988). This finding, like Roland et al.'s finding that semantic similarity influences instrument filler integration, reveals the limitations of models that propose that the processing of words should be equally difficult if their probabilities are equivalent at the point when they occur (Levy, 2008).

(1) The gladiator | jabbed | the African tiger | with | a sword/spear/spike | in | the Colosseum.

(2) The aborigine | attacked | the angry lion | with | a knife/stick/club | in | the field.

Table 1. Summary of key results

	Coefficient	S.E.	t -value
Predictability	-63.66	10.97	-5.80
Similarity	-209.55	76.30	-2.75
Predictability x Verb Type	-46.84	20.01	-2.34
Predictability x Verb Type x Similarity	-867.76	212.85	-4.08

WH agreement and the timing of the unbounded dependency formation: A Chamorro perspective on predictive licensing and interpretation

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Unbounded dependencies; Psycholinguistic fieldwork; Self-paced listening; Eye-tracking; Austronesian; Chamorro

Summary. Comprehension of unbounded filler-gap dependencies proceeds actively: gaps are predicted in particular positions before evidence that those positions are unoccupied [1,2]. This phenomenon is well-suited to probing the sources and availability of information that shapes expectations about linguistic relations. Lexically-projected information provides clues to the gap site, but it is less clear how it interacts with information available before lexical access of the verb [3-6]. Here we investigate online comprehension in Chamorro, a verb-initial Austronesian language whose system of WH Agreement provides morphological cues to the extraction site [7].

We report two major findings: (A) Chamorro, like other languages, shows active filler-gap comprehension; but only when a transitive verb is (optionally) inflected for WH Agreement are extracted constituents immediately semantically interpreted. (B) Uninflected forms show no evidence of early interpretation. Comprehenders do, however, experience difficulty comprehending extractions of non-objects, e.g. possessors, across uninflected verbs. This difficulty, we argue, suggests a garden-path [8]: comprehenders do posit gaps for (all compatible) verbs, but only actively interpret them when WH Agreement is visible morphologically. These results support a time-course distinction between formal predictions and their interpretive commitments [9].

Design & Results. Verbs in Chamorro are specially inflected to reflect the grammatical role of extracted arguments [7]. In (1), subject extraction obligatorily triggers infixation of *-um-* to the verb *lâksi*; oblique extraction also triggers special verb forms. Crucially, WH-inflection for object extractions is optional: (2a)/(2b). Moreover, possessor extraction does not trigger a WH-inflected form (3). Thus, while WH-inflection provides a direct cue to the filler's role, lack of WH-inflection could forestall active comprehension either by (a) providing a more slowly recognized signal for the object analysis; or (b) introducing the possibility of possessor extraction [3,4]. To test whether active comprehension was diminished for uninflected forms, we crossed the extractee's pragmatic plausibility as object [**±PLAUS.OBJ**] with the presence of WH-inflection [**±WH.INFLECT**]: (4)-(5). In two paradigms we probed for an anomaly effect at the verb: In **Exp. 1**, 40 participants listened in an auditory moving window paradigm [10] and judged whether sentences made sense. In **Exp. 2**, 72 participants listened passively and also made a sensibility judgement. Large 'good'/'not good' ('mâolik'/'ti mâolik') buttons were depicted on screen. Participants were recorded via webcam and their gaze later coded blind by multiple annotators.

The dependent measure was thus either listening times [Exp. 1] or looking preference to the appropriate response button [Exp. 2]. There were 12 targets and 28 non-targets, counterbalancing other factors. Experiments took place in the Northern Marianas, with all materials and interactions in Chamorro. In both paradigms we observed a main effect of **PLAUS.OBJ** and an interaction with **WH.INFLECT** at the verb, such that a disruption/preference-shift due to anomaly was only observed in WH-inflected forms. Nonetheless in the (untimed) judgments, participants systematically dispreferred possessor extractions for **-PLAUS.OBJ** extractions only.

- | | | |
|---------|--|--|
| (1) | Hâyi na sâstri lumâksi i magâgu-mu?
who L seamstress WH[NOM].sew D clothes-AGR? | "Which seamstress sewed your clothes?" |
| (2) | Hâfa na trâk (a) pinentâm-mu / (b) un penta ta'lu un biâhi?
what L truck WH[OBJ].paint-AGR / AGR-paint again a time | "Which truck did you paint over again?" |
| (3) | Hâfa na trâk un penta ta'lu sanme'nâñ-ña?
what L truck AGR-paint again front-AGR | "Which truck did you paint its front again?" |
| (4) (a) | [+PLAUS.OBJ, +WH.INFLECT]: => (2a) | "Which teacher did you paint over again?" |
| (b) | [-PLAUS.OBJ, +WH.INFLECT]:
Hâyi na ma'estru pinentâm-mu ta'lu un biâhi?
who L teacher WH[OBJ].paint-AGR again a time | |
| (5) (a) | [+PLAUS.OBJ, -WH.INFLECT]: => (3) | "Which teacher did you paint his truck again?" |
| (b) | [-PLAUS.OBJ, -WH.INFLECT]:
Hâyi na ma'estru un penta ta'lu trâk-ña?
who L teacher AGR paint again truck-AGR | |

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Turning the 'Dumb N400' into the 'Smart N400': What role-reversed sentences tell us about the time course of predictions

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Prediction; Semantic illusion; N400; Event Related Potentials (ERPs); Mandarin Chinese

Despite much recent interest in how predictive processes may underlie successful online sentence processing [1-4], relatively little is known about the time course of such processes. Meanwhile, in another corner of the sentence processing literature, increasingly many findings suggest that the N400, long thought to reflect semantic processing, can be completely 'blind' to blatant semantic anomalies. For example, most studies of 'role-reversed' sentences such as "The fox.SUBJ the poacher.OBJ hunted" in verb-final constructions show that the verb elicits no N400 effect relative to the canonical word order control, despite the obvious anomaly [7-10]. This kind of 'dumb' N400 has been taken to reflect a semantic illusion [5-8], and it contrasts sharply with the extensive evidence for 'smart' N400 effects, where its sensitivity to semantic/pragmatic anomalies is not reducible to simple lexical associations [11-13]. We propose that the smart vs. dumb N400 contrast reflects how quickly the processor generates expectations about upcoming input, and show how it is possible to turn the dumb N400 into the smart N400. These findings undermine the semantic illusion account of the dumb N400. Instead, they fit with the view that N400 effects reflect top-down predictive mechanisms rather than bottom-up interpretive mechanisms. This account also allows us to give a unified account of diverse 'dumb N400' effects elicited in contexts such as negation and quantification [14-16].

We examined the effects of role-reversals on processing profiles using the unambiguous S-O-V BA-construction in Mandarin Chinese. In Experiment 1 (ERP, n=23), we examined the effects of role-reversals in predictive (a-b) vs. non-predictive (c-d) contexts and found that, even when the verb was highly predictable given its arguments (as determined by an offline cloze task), the N400 remained blind to role-reversals, though role-reversed sentences consistently elicited a P600 effect. In Experiment 2 (eye-tracking; n=24; identical materials), we found that role-reversals led to increased first fixation durations at the target verb, and also at the preceding word. These results show that the blindness of the N400 to role-reversals is unlikely to be due to weak contextual constraint (Exp1) or to slow recognition of the anomaly (Exp2). Experiment 3 (ERP, n=24) examined whether the N400's blindness to role-reversals reflects that the processor had insufficient time to generate expectations about the upcoming verb. We manipulated the linear distance between the arguments and the verb by placing an extra phrase either at the beginning of the sentence (local (e-f)) or between the verb and its arguments (non-local (g-h)). Notably, role-reversals elicited a significant N400 effect (i.e., a 'smart N400') only in the non-local conditions, although a significant P600 effect was observed in both conditions. This suggests that when the verb appeared just 600ms after the arguments, the processor had insufficient time to generate expectations for the verb, but that 1800ms was sufficient. Taken together, our results suggest that the 'dumb N400' reflects the processor's temporarily limited expectations for upcoming words, and the within-experiment contrast in Experiment 3 provides new evidence regarding the time course for expectation generation. A similar mechanism can account for other cases of N400 blindness that have been treated as separate phenomena [14-16].

- | | |
|---|--|
| a. Low predictability – Canonical: | Yesterday, customer BA salesperson <u>complain</u> ... |
| b. Low predictability – Role-reversed: | Yesterday, salesperson BA customer <u>complain</u> ... |
| c. High predictability – Canonical: | Last night, cop BA thief <u>arrest</u> ... |
| d. High predictability – Role-reversed: | Last night, thief BA cop <u>arrest</u> ... |
| e. Local – Canonical: | <i>Last spring</i> , philanthropist BA orphan <u>adopt</u> ... |
| f. Local – Role-reversed: | <i>Last spring</i> , orphan BA philanthropist <u>adopt</u> ... |
| g. Non-local – Canonical: | Philanthropist BA orphan <i>last spring</i> <u>adopt</u> ... |
| h. Non-local – Role-reversed: | Orphan BA philanthropist <i>last spring</i> <u>adopt</u> ... |

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Grammatical knowledge vs. syntactic processing in the human brain

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Syntax; Syntactic complexity; fMRI; Domain specificity; Domain generality

Caramazza & Zurif (1976) demonstrated that Broca's aphasics have difficulty understanding semantically reversible constructions where word order is the primary cue to meaning. Subsequent neuroimaging investigations have reported activations in the posterior parts of the left inferior frontal gyrus (LIFG) and anterior insula/frontal operculum for syntactic complexity contrasts (e.g., Stromswold et al., 1996; Ben-Shachar et al., 2003). However, three sets of findings are problematic for the notion that Broca's area is the "seat of syntax". First, using a grammaticality judgment task Linebarger et al. (1983) demonstrated that syntactic knowledge is largely preserved in Broca's aphasics. Second, the ability to process syntactically complex structures has been linked to non-linguistic abilities, like general working memory (e.g., King & Just, 1991; Gordon et al., 2002; Fedorenko et al., 2006). And third, contrasts between structured (e.g., sentences) vs. unstructured (e.g., lists of words) stimuli activate brain regions that appear to be non-overlapping with the brain regions where syntactic complexity effects typically arise (e.g., Fedorenko et al., 2010). In fact, regions sensitive to syntactic complexity respond more strongly during the processing of word lists than sentences (Fedorenko et al., in prep.).

We argue that linguistic processing is accomplished by the joint engagement of two functionally and computationally distinct brain systems: i) "language regions" on the lateral surfaces of left frontal and temporal lobes that appear to be functionally specialized for linguistic processing, showing no response to working memory or cognitive control tasks (Fedorenko et al., 2011a), and ii) the fronto-parietal "multiple-demand" network (e.g., Miller & Cohen, 2001; Duncan, 2001, 2010). "Language regions" plausibly store linguistic knowledge (Fedorenko et al., 2011b), and the response in these regions appears to be a function of how closely linguistic input matches stored linguistic representations, with better matches leading to greater responses (Fedorenko et al., 2010; Bedny et al., 2011; Pallier et al., 2011). In contrast, "multiple-demand" regions are modulated by cognitive effort across a wide range of cognitive tasks (e.g., Duncan, 2001, 2010). As a result, these regions are plausibly engaged when parsing becomes effortful, e.g., when the only cue to meaning is word order (e.g., Ben-Shachar et al., 2003), when reanalysis is required after temporary ambiguities (e.g., Novick et al., 2005; January et al., 2009), or when syntactic anomalies are encountered (e.g., Kuperberg et al., 2003; Nieuwland et al., 2011).

We evaluated this proposal directly in an fMRI experiment. In each subject we functionally defined language regions (using the language localizer from Fedorenko et al., 2010) and multiple-demand regions (using a working memory task) and examined the response of each set of regions to subject- vs. object-extracted relative clause sentences. The results showed that the activations for the syntactic complexity contrast in the left frontal lobe overlap with the activations for the working memory task, and not for the language-localizer contrast. Language regions responded similarly robustly to both syntactically simple and complex sentences.

In summary, both the language regions and the domain general multiple-demand regions support linguistic processing. In characterizing the architecture of the language system, it is therefore important to distinguish between these systems, especially in the frontal lobes, where subsets of each system reside side-by-side within the region known as "Broca's area".

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Quantifying parsing complexity as a function of grammar complexity

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Syntactic complexity; Computational modeling; Narrative; English

Introduction Recent research has used measures of complexity generated by computational models to predict human processing effort as measured in behavioral and neurophysiological experiments, ([2,4,5,6,9] among others). For ostensibly practical reasons, these models often rely on simplifying grammatical assumptions. For example, many are defined over structures from the Penn Treebank II which, while an impressive annotation scheme, is still far from the grammars that syntacticians propose to account for patterns in natural language. Though there is emerging consensus that natural languages are at least mildly context sensitive ([12,14]), the dominant, if implicit assumption in both computational and psycholinguistics is that simplified context free grammars are adequate approximations for theories of processing (but cf. [7]). However, while significant research has examined the degree to which different parsing strategies match human parsing performance (e.g., [1,10,13]), the effect of grammar (even within a particular class) on estimates of processing complexity has not been systematically investigated.

Methods We directly compared the impact of grammar on estimated processing complexity for a 12 minute English narrative. We used two grammars: One generated by an automated parser ([3]) trained on Wall Street Journal corpora annotated according to the Penn Treebank 2 schema (hereafter Penn), and one manually constructed by a trained linguist in the Minimalist Grammar framework ([11]) and represented as an X-bar schema (hereafter Xbar). The XBar grammar includes head movement (making it non-context free), A and A-bar movement, left and right adjunction, vp and pp shells, and Kaynian relative clauses ([8]). The impact of grammar was contrasted against the impact of parsing strategy using two stack-based strategies: Top-Down (TD) and Bottom-Up (BU). A TD strategy builds the root node first and is fully incremental and predictive whereas the BU strategy makes no predictions at all. Rather, it waits for all daughters to be complete before projecting a mother node. For each lexical item n , we calculated the number of nodes built between items n and $n - 1$ as our complexity measure.

Results Across parsing strategies, the incremental complexity of the Penn grammar is not systematically correlated with the complexity of the Xbar grammar ($r_{TD} = 0.14$, $r_{BU} = -0.19$), suggesting that grammatical assumptions have a large impact on parsing complexity. Furthermore, we observe an interaction between parsing strategy and grammar choice such that TD and BU measures over the Xbar grammar are highly correlated ($r_{Xbar} = 0.64$), i.e., make similar predictions for human processing effort, but make very different predictions over the Penn grammar ($r_{Penn} = 0.12$).

Conclusion The degree to which parsing strategies make different predictions for human processing effort is in a large part a function of grammar choice. Indeed, in the fragment of English we considered, the impact of grammar choice matches or exceeds the impact of parsing strategy on estimates of processing complexity. This finding shows that even for a single, fixed corpus and a fixed parsing strategy, the choice of grammar is extremely important: a treebank grammar predicts different, and under some circumstances opposite, parse complexities from a standard Xbar grammar.

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Flexible processing and the design of grammar

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In this talk, I explore the consequences of letting the incremental and integrative nature of language processing inform the design of competence grammar. What emerges is a view of grammar as a system of local monotonic constraints that provide a direct characterization of the signs (the form-meaning correspondences) of a given language. This 'sign-based' conception of grammar has provided precise solutions to the key problems long thought to motivate movement-based analyses, has supported three decades of computational research developing large-scale grammar implementations, and is now beginning to play a role in computational psycholinguistics work that explores the use of underspecification in the incremental computation of partial meanings.

Thursday, March 15 Poster Abstracts

Do readers obtain preview benefit from transposed words in English?

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Parafoveal processing; Reading; Word order; Eye-tracking; English

In most languages, the word order in a sentence carries crucial information about the sentence's syntax and meaning. Despite this, whether readers always identify words in the order they are printed is still debated. Kennedy and Pynte (2008) claimed that readers can identify words out of order and maintain word order through a separate process, while Reichle, Liversedge, Pollatsek, and Rayner (2008) argued that readers always identify words in canonical order. Yang (2010) reported a gaze-contingent boundary (Rayner, 1975) experiment in Chinese in which the character order of the preview for a two-character word was manipulated so that it could be either correct or transposed. Readers obtained the same amount of preview benefit from a transposed preview as from the correct preview, as long as the transposed characters (morphemes) plausibly fit into the sentence context.

In line with these findings, Angele and Rayner (2012) found that readers obtain preview benefit from a transposed preview in English, when the transposed units were constituents of a compound word (e.g., *cowboy*). Taken together, these data point to a morphological source of transposed preview benefits within words: both constituents may be activated parafoveally, leading to facilitation once the word is fixated, with plausibility playing a significant role at least in Chinese. Importantly, in both experiments, the target was a single word, leading to it being processed as a unitary whole. The question, then, is whether transposition effects occur across two words (i.e., letter strings separated by spaces) and, if so, how plausibility contributes to the benefit a transposed preview provides.

In the present study, we used the boundary paradigm to manipulate the preview for a two-word target region (e.g. *meat rare* in "The chef cooked the meat rare for the couple"). Readers received an identical (*meat rare*), transposed (*rare meat*) or unrelated preview (*moon wood*). Importantly, both the identical and the transposed preview were plausible within the sentence context while the unrelated preview was not. If the transposed word preview provided a benefit, it might suggest that readers could identify words out of order. If this were the case, however, we would see preview benefits for the transposed preview across the whole target region. On the other hand, if the transposed preview benefit effect simply reflects the result of a parafoveal plausibility check, the effect should only appear on the first word.

Mean go-past time in the target region was shortest (522 ms) in the control condition, but also significantly shorter in the transposed condition (567 ms) than in the unrelated condition (647 ms). Separate analyses on the two target words showed that this effect originated from fixations on the first word (identical 297 ms, transposed 319 ms, unrelated 354 ms), while the second word did not show a significant difference (identical 329 ms, transposed 366 ms, unrelated 389 ms). Because the transposed preview benefit only appeared on the first word, this effect may be due to plausibility rather than identifying words out of order.

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Automatic and recruitable:**MEG evidence for an obligatory but flexible combinatory mechanism in the LATL**

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Basic combinatorial processing; Automaticity; Left ATL; Magnetoencephalography (MEG); English

Short Summary: A major goal for the cognitive science of language is characterizing the domains in which the combinatory rules of language operate. Here we used a cognitive neuroscience approach to investigate the extent to which expressions not conforming to canonical English word order engage the same combinatory mechanisms as canonical expressions. Both intuition and electrophysiological evidence suggest that basic linguistic combinatorial operations are automatic and obligatory, i.e., upon encountering the phrase *red car*, the processor has no option but to construct a complex representation from the constituent elements.^{1,2} Given this, a brain mechanism reflecting such combination should behave similarly no matter what the task demands are. Here we show that MEG activity localized to the LATL – a region hypothesized in both the hemodynamic³ and neuromagnetic⁴ literatures to support combinatory linguistic mechanisms – shows a composition effect for adjective-noun combinations whether the task requires composition or not. In contrast, when the noun and adjective are presented in non-canonical English order, e.g. *car red*, combinatory LATL activity is absent in the non-composition task, but present when the task forces composition. These results suggest that the combinatory mechanism reflected by LATL activity is automatically engaged by grammatical expressions and can also be recruited to compose ungrammatical sequences, if the task demands it.

Experiment details: Subjects read adjective-noun combinations (e.g. *red boat*, *boat red*) word by word and indicated if a following picture matched the preceding words. In the composition task, a single colored shape was presented as the test, thus encouraging subjects to construct a single, complex mental representation from the linguistic stimuli. In the non-composition task, the test color and the shape were presented separately, promoting a list-like interpretation. To maximize this contrast, each task was administered as a separate experiment to separate subjects. Within each experiment, canonical and non-canonical orderings were blocked separately and interleaved with complementary one-word trials in which the first word was replaced by a length matched consonant string (*xhl boat*, *kqzl red*). Thus, both experiments had a 2x2 design with Number of words (one, two) and Order (canonical, reversed) as factors.

Analysis & Results: Our primary dependent measure was MEG activity elicited by the second word that localized to the LATL, which has previously been linked with the mental construction of basic adjective-noun phrases.⁴ In our non-composition task, a non-parametric cluster test⁵ revealed a significant interaction from 214-255ms ($p = 0.046$) with increased activity during the processing of canonically ordered phrases compared to the one-word control and no difference between the non-canonical conditions. This result suggests that the combinatorial mechanism reflected by the LATL is automatically engaged by canonical phrases, as composition was not only not required by this task but was in fact detrimental (accuracy was significantly impaired in this condition). Contrastingly, in the composition task we observed no interaction in LATL activity but instead found a main effect of number of words (209-269ms; $p = 0.035$) suggesting that this basic combinatorial mechanism can be recruited by non-canonical linguistic processing if the task requires it.

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Verb omission errors: Evidence of rational noisy-channel language processing

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Rational analysis; Noisy-channel models; Sentence production; Self-paced reading; English

Recent work by [1,2] suggests that human sentence processing maintains uncertainty in input representations and reconciles it with prior grammatical knowledge. Here we explore the prediction of such rational noisy-channel theories that morphosyntactic production errors and comprehension garden-pathing should be inducible when context strongly biases expectations about syntactic category.

We use unambiguous NN-phrases (“The voter hope”) differing in a single morpheme from unambiguous NV-phrases (“The voter hoped”). A noisy-channel model where morphemic realization errors are possible makes four key predictions regarding the processing of such phrases. First, the Bayesian *size principle* [3,4] predicts that producers should complete NN-preambles as NV-preambles, creating apparent *verb omission errors* (1), more often than the reverse error. The NN-preamble can be produced from the NV-preamble by deleting a morpheme, whereas producing the NV-preamble from the NN-preamble requires inserting a morpheme. Because there are more ways to choose a random morpheme to insert than to delete, the posterior probability of NV given NN must be higher than NN given NV. Second, verb omission error rate should be higher the greater the NV bias of the phrase. Third, repetition errors for the preambles should pattern with other production errors: adding past or present tense morphology to NN-preambles should be more common than removing it from NV-preambles. Fourth, in comprehension, it should be possible to garden-path readers of “unambiguous” NN-preambles onto NV syntactic interpretations inconsistent with veridical wordforms, and see the behavioral hallmarks of garden-path disambiguation further downstream.

Experiment 1 evaluated the first three claims. 60 participants were given a visual presentation of the preamble for 1.5sec and had 13sec to retype the preamble and complete it (subject-verb agreement error patterns from [5] were separately replicated using this paradigm). 16 NV-biased (e.g. “The voter hope”) and 16 NN-biased (e.g. “The almond roll”) preambles were shown to participants (bias was measured by completions for the ambiguous NN/NV preamble, e.g., “The voter hopes”). Restricting to completions without repetition errors, participants were significantly more likely to complete NN-preambles as NV-sentences (see 1) than vice-versa (27 vs. 1; $p < 0.001$; ANOVAs with subjects and items as random factors). All but one of the NN-errors occurred on an NV-biased item. Finally, morphological errors in repetition occurred significantly more often for NN-preambles (12 vs. 1; $p < 0.01$).

Experiment 2 evaluated the fourth claim using self-paced reading (120 participants, 16 items, 32 fillers).

Participants read sentences which contained a modifier-noun or NV-preamble as in Experiment 1; in critical but not in control conditions, NV and NN preambles were single-morpheme-edit neighbors (2). As a result, participants should be more likely to be garden-pathed in the critical condition. At the disambiguating word (“seemed”) we obtained a significant interaction ($p < 0.05$; lmer with random slopes for participants and items), with reading times superadditively high in the critical modifier-noun condition.

Together, these experiments constitute the first results indicating that comprehenders can be biased to morphosyntactic processing inconsistent with veridical input due to context-specific grammatical prior expectations for syntactic category.

(1) NN/NV: The voter hope(d)...

Example verb omission error: The voter hope that the president will win.

Example verb insertion error: The voter hoped was that the president will win.

(2) Critical modifier-noun: The voter hope for a victory seemed naïve.

Critical NV: The voter hoped for a victory but seemed naïve.

Control modifier-noun: The national hope for a victory seemed naïve.

Control NV: Some voters hoped for a victory but seemed naïve.

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Eye-tracking evidence for implicit prosodic phrasing of unambiguous sentences

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Implicit prosody; Eye-tracking; Reading; English

The current paper describes three eye-tracking experiments investigating the representation of prosodic boundaries in silent reading. Theories of implicit prosody hypothesize that readers generate prosodic representations of silently read material (Fodor, 1998; Bader, 1998). Prior work from garden-path sentences demonstrates that readers interpret commas as implicit prosodic boundaries (Steinhauer, 2003; Hwang & Steinhauer, 2011). In spoken production, the probability of a prosodic boundary at a sentence location increases as the size of the material that has been produced (left-hand side—LHS), and the size of the material that will be produced (right-hand side—RHS) increases (Watson & Gibson, 2004; Breen, Watson & Gibson, 2010). Here, we investigated the hypothesis that, in unambiguous sentences, the presence of a comma facilitates silent reading when the size of preceding (LHS) and/or following (RHS) material increases.

In Experiment 1, readers' eye movements were recorded while they silently read sentences like those in (1), where three factors were manipulated: a) the length of a sentence-initial adverbial phrase (LHS), b) the length of the main clause (RHS), and c) the presence of a comma between the clauses. Comma presence facilitated reading, such that on both the pre- and post-comma regions (*party, we went*), early and late reading-time measures (first-pass, total-time) were shorter when the comma was present. However, there were no clear interactions with sentence length, perhaps because the sentences were generally long enough that readers imposed implicit prosodic boundaries at the critical location in all conditions.

Experiment 2 items were similar to Experiment 1, but LHS material was shortened, as in (2). We now observed two interactions of LHS length with comma presence: On the post-comma region (*we went*), go-past times were shorter after a comma only when the LHS was long ($t_{\text{interaction}}=2.24$). On the following region (*to the park*), first-pass times were *longer* after a comma only when the LHS was short ($t_{\text{interaction}}=2.18$). These results demonstrate that readers preferred a boundary after the initial adverbial phrase only when it was long, mirroring results from production.

In Experiment 3, participants read sentences like those in (3), where commas between the clauses are considered optional. Once again, reading times demonstrated interactions of length and comma presence. Specifically, go-past times on the post-comma region (*and I'll*) were shorter after a comma only when the RHS was long ($t_{\text{interaction}}=2.19$). This influence of RHS length on reading time suggests that readers made use of parafoveal and peripheral information about sentence length. In addition, go-past times on the final region (*when you're done*) were shorter after a comma only when the LHS was short ($t_{\text{interaction}}=2.11$).

Although the current results raise questions about the specific conditions under which LHS and RHS length affect implicit prosodic representations, they provide clear evidence that readers are sensitive to both prior and upcoming constituent length in their implicit phrasing of non-ambiguous sentences, consistent with results from overt production. Moreover, the late appearance of these effects in the eye-movement record suggests that readers engage in prosodic reanalysis upon encountering unexpected or missing commas.

- 1) After the| (annual holiday)| party(,)| we went| to the park| (to play with our children).|
- 2) After the| party/Yesterday|(,)| we went| to the park| (to play with our children).|
- 3) You will wash the| (pasta-encrusted)| dishes(,)| and I'll| dry them| (when you're done).|

Retrieval of irregular polysemes: Evidence from priming and eye-movements

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Polysemy; Homonymy; Lexical ambiguity; Priming

We investigated the representation and processing of **irregular** polysemes like *cold*(illness; temperature) which have multiple, semantically-related senses that cannot be derived via productive rules and homonyms (*bank*: financial institution; side of river) whose meanings are semantically unrelated. Eye-tracking investigations of homonyms (Duffy et al., 1988; Tabossi & Zardon, 1993) show that lexical access is affected by the relative frequency of meanings, indicating that meanings are stored separately. While only a homonym's dominant meaning is accessed in the absence of context, previous context supporting the subordinate meaning leads to meaning competition. In eye-tracking investigations, **regular** polysemes (mostly metonyms like *novel*: object; content) are either unaffected (Frisson & Pickering, 1999) or marginally affected (Frazier & Rayner, 1990) by sense frequency and biasing context. Thus, they may have a single entry from which either interpretation can be derived with equal ease. Evidence regarding **irregular** polysemes is mixed. Some studies support separate entries (Klein & Murphy, 2001). Others support a single-entry account (Beretta et al., 2005). Crucially, no study has carefully controlled the relative frequency or degree of semantic relatedness of irregular polysemes senses. These factors were controlled in priming and eye-tracking experiments.

In Experiment 1, prime words were visible. In Experiment 2, primes were masked and "invisible". Trials consisted of a homonymous (BANK) or polysemous (SOUR) prime and a target instantiating their dominant (ROB | LEMON) or subordinate (SWIM | DAIRY) meaning. Inconsistent context words preceded primes (LEMON – SOUR – DAIRY) on half the trials and were counterbalanced across lists. Targets following unrelated words served as baselines. Lexical decisions were made to each visible word.

Without context, dominant meanings were facilitated for homonyms after visible primes, and inhibited after "invisible" primes. For polysemes, both dominant **and** subordinate meanings were numerically facilitated and inhibited respectively, favoring a single-entry account. When contexts required switching from dominant to subordinate senses, only polyseme targets were facilitated following visible primes. Following invisible primes, only homonym targets were facilitated. Thus, again, homonyms and polysemes patterned differently. When contexts required switching from subordinate to dominant meanings, equivalent facilitation was observed for both homonyms and polysemes following visible primes. No effects were observed following "invisible" primes. Results from switching conditions are explained by semantic relatedness interacting with feedback from orthography and lateral inhibition (Hino & Lupker, 1996; Locker et al., 2003). Specifically, shared semantic features of polysemes counteract inhibition from dominant context words.

We also eye-tracked clauses containing homonyms or irregular polysemes that were preceded or followed by a subordinate-reading context clause. We substituted matched words to provide a baseline. Only homonyms and their spillover region took longer to read following context clauses. Subordinate contexts only following homonyms were read more slowly. However, longer reading times were observed in the polyseme spillover region. This suggests that interpreting irregular polysemes has a short-term cost arising from a delay in sense commitment which has not been shown for regular polysemes (Frisson & Pickering, 1999; Frazier & Rayner, 1990).

In sum, irregular polysemes are processed differently than homonyms suggesting that they are represented differently. Our results are most consistent with a single-entry account where shared features ease retrieval of less frequent senses following inconsistent contexts, and moderate full commitment to either sense.

Polyseme, Context-Before: Even though *the orchestra had not practiced much* everybody agreed that the **notes/tones** were clear enough.

Homonym, Context-Before: Because *the dinosaur was very exotic* everybody paid close attention to the **horns/bones** during the visit.

Polyseme, Context-After: Everybody agreed that the **notes/tones** were clear enough even though *the orchestra had not practiced much*.

Homonym, Context-After: Everybody paid close attention to the **horns/bones** during the visit because *the dinosaur was very exotic*.

Number agreement and attraction in late Italian-English bilinguals

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Broken agreement; Code-switching; Bilingual sentence production; English; Italian

Bilingual speakers tend to be good at controlling their languages, but this control is not perfect: Under at least some circumstances, their production is affected by syntactic properties of the language they are not currently speaking (*non-current language*), suggesting the *current language* is not always the most strongly activated language [1]. But under what circumstances does this occur, and what can this tell us about bilingual processing? We report an experiment that investigated whether co-activation of languages affects the computation of bilingual agreement in bilingual production.

Moderate/high proficiency late Italian-English bilinguals produced English and Italian completions for singular complex subject NPs involving English and/or Italian head and local nouns (1a-h). We manipulated *current language* (i.e., language of completion; English vs. Italian), *language task* (1- vs. 2-language), and *local noun number* (singular vs. plural). Previous research in monolingual production suggests the local noun is normally “insulated” from the agreement between the head noun and verb, but sometimes this insulation breaks down, yielding *attraction errors* (e.g., *The report of the forest fires were unbelievable*). We examined whether such errors also occur in bilingual production, and if so, the factors that affect them. Following earlier work, we expected more errors following plural local nouns, but that this effect would be stronger in two-language production (i.e., more errors in (1d) than (1b) and in (1h) than (1f)), because the current language would be more strongly activated than the non-current language, yielding a weaker influence of the head noun (and a correspondingly stronger influence of the local noun).

LME analyses on the likelihood of producing incongruent responses (i.e., when the head noun and verb disagreed in number) showed the best fit model included current language and number, with more incongruent responses when the local noun was English than Italian (33 vs. 14 errors), and when the local noun was plural than singular (35 vs. 12). The inclusion of language task did not improve the model (1-language vs. 2-language: 23 vs. 24), nor did the inclusion of any interactions.

These results suggest that as in monolingual production, bilinguals’ production of agreement was influenced by local noun number, with interference when the head noun and local noun were incongruent in number. However, unexpectedly, agreement was not disproportionately affected when the utterance involved activation of both languages than when it involved activation of one language only. The fact that bilinguals produced more errors when the local noun and verb were in their L2 (English) than their L1 (Italian) suggests differential activation of the two languages. L2 might be less strongly represented in memory than L1 in late bilinguals, yielding greater within-language interference in the computation of L2 than L1 agreement.

Taken together, our results suggest that bilingual speakers activate their languages in different ways, and that this impacts on syntactic processes in production, but there is not a straightforward relationship between the production of one- or two-language utterances and cross-linguistic interference.

- (1a) The hunt for the black whale
- (1b) The hunt for the black whales
- (1c) La caccia for the black whale
- (1d) La caccia for the black whales
- (1e) La caccia alla belena nera
- (1f) La caccia alle balene nere
- (1g) The hunt alla balena nera
- (1h) The hunt alle balene nere

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Anticipatory deaccenting in online language comprehension: A phonemic restoration study

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Deaccenting; Prosody; Information structure; Visual world paradigm; Phonemic restoration; English

Most studies characterizing the contributions of prosodic and lexical cues to online language comprehension have found relatively weak effects of prosody [e.g. 1]. However, typical language processing studies may exaggerate the reliability of lexical information relative to prosodic information. In real life, speech errors, noise, and increased uncertainty about how a sentence will unfold reduce the reliability of lexical information. Preceding prosodic patterns may play a larger role in such cases, allowing listeners to “fill in” lexical information they have missed.

The present study investigates these questions within the domain of *anticipatory deaccenting* [2]. Although nouns are normally deaccented only when contextually given, context-new nouns can optionally be deaccented in anticipation of their repetition within a parallel construction, as in [i]. Because both [i] and [ii] are felicitous, however, anticipatory deaccenting is a *valid* but *unreliable* cue to upcoming parallel information structure. We therefore predict that partially masking the second occurrence of a repeated noun in a parallel construction should increase the contribution of anticipatory deaccenting to information-structural expectations.

To test this hypothesis, we adapted the phonemic restoration paradigm [3,4] in a visual world experiment ($n=16$). Participants followed spoken instructions to move a target object (e.g., a square with a mouse) to one of two destination objects that either had the same post-nominal attribute as the target object (e.g., a triangle with a mouse) or a different post-nominal attribute rhyming with the target attribute (e.g., a triangle with a house). Half of the instructions were produced with deaccented object attributes [iii] and half were produced with accented attributes [iv]. Crucially, lexical ambiguity in the destination attribute was introduced by replacing the initial consonant with a cough (e.g., *#ouse*). Any residual bias toward one lexical interpretation over the other in individual items was quantified in a norming study.

Reaction times, responses, and fixation patterns provided novel converging evidence that anticipatory deaccenting guided participants' interpretation of the ambiguous attribute. Each dependent measure (log reaction times measured from utterance offset, response choices, and the logit-transformed ratio of the proportion of fixations to the same-attribute destination over the proportion of fixations to both destinations) was analyzed with a multi-level regression model containing accent pattern, trial number, baseline item bias, response, and their interactions as fixed effects, and by-participants and by-items intercepts and slopes as random effects. Even after accounting for other contributions to the variance, deaccented items elicited faster response times ($p<0.05$), more selections of same-attribute destinations ($p<0.05$), and more fixations to same-attribute destinations shortly following the onset of the second attribute ($p<0.005$) than accented items. Further, effects of deaccenting were strongest early in the experiment, crucially demonstrating that the significant effect of prosodic condition was not based on contingencies within the experiment.

These results suggest that expectations from preceding prosody play a crucial role in word identification during online language processing when segmental information is degraded or ambiguous. Furthermore, this study establishes deaccenting as a rich domain for future quantitative investigations of cue-integration theories explicitly manipulating the relative reliability of different cues.

Examples

- i. Move the SQUARE with a [mouse]_d to the CIRCLE with a [mouse]_d.
- ii. Move the SQUARE with a MOUSE to the CIRCLE with the [mouse]_d.
- iii. Move the SQUARE with a [mouse]_d to the CIRCLE with a [#ouse]_d.
- iv. Move the SQUARE with a MOUSE to the CIRCLE with a #OUSE.

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Uncertainty and prediction in relativized structures across East Asian languages

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Relative clauses; Computational modeling; Chinese; Japanese; Korean

Incremental reading difficulties can be quantified using information-theoretic notions such as Entropy Reduction (ER, Hale, 2006). ER quantifies the amount of information contributed by a word in reducing structural uncertainties. This work extends ER to East Asian languages: Chinese, Japanese and Korean. This extension yields a quantitative viewpoint on ambiguities readers face when understanding prenominal relativized structures. It uncovers a range of language-specific factors that all pertain to the distribution on “unchosen” alternatives.

A Minimalist Grammar (Stabler, 1997) was written for each language. Weighting relevant construction types by treebank attestation counts allows us to estimate probabilistic “intersection” grammars conditioned on prefixes (Nederhof & Satta, 2008). Besides computing entropies, our system can also sample syntactic alternatives from intersection grammars to get an intuitive picture of how uncertainties are reduced during parsing.

Our modeling confirms the subject relative clause (SR) preference in Korean reported by Kwon et al. (2006) and further shows that this effect could emerge as early as the accusative/nominative marker in (1-2). This reflects, among other factors, a greater entropy reduction brought by sentence-initial nominative noun phrases.

Controversy has attended reports of a Chinese SR/OR asymmetry (Hsiao & Gibson, 2003; Lin & Bever, 2006). Our modeling derives an SR advantage in line with structural frequencies (SR 55% vs OR 45%). It also implicates headless RCs as a grammatical alternative whose existence makes processing easier at the head noun in SRs. A corpus study reveals that 14% of SRs have a null head whereas 31% of ORs are headless. This asymmetry suggests that an overt head is more predictable in SRs and less work needs to be done. All these predictions are derived from a grammar that covers various alternatives including *pro*-drops and *de* as a possessive marker.

The subject preference also holds in Japanese (Ishizuka, 2005; Ueno & Garnsey 2008). Kahraman et al. (2011), however, reported a puzzling inverse effect in Japanese clefts (5-6) that have the same word order as their relative clause counterparts. At the “-no-wa” marked embedded verb, object clefts are read faster than subject clefts. Our modeling technique derives a pattern consistent with this finding by tracking the frequency asymmetry between complement clauses and clefts. Upon reaching the topic marker “-wa”, both constructions are still in play. But since complement clauses with object-*pro* are extremely rare, clefts become the more predictable structure.

In sum, examining contextualized syntactic alternatives shows how processing difficulty reflects the uncertainty associated with syntactic predictions. By using probabilistic grammars based on corpus counts, this methodology leverages a strong grammar-parser relationship.

- (1) [e_i uywon -ul kongkyekhan] kica_i -ka yumyenghaycyessta (Korean Subject Relatives)
 senator ACC attack-ADN reporter NOM became-famous
 ‘The reporter who attacked the senator became famous.’
- (2) [kica -kae_i kongkyekhan] uywon_i -i yumyenghaycyessta (Korean Object Relatives)
 reporter NOM attack-ADN senator NOM became-famous
 ‘The senator who the reporter attacked became famous.’
- (3) [e_i yaoqing fuhao de] (guanyuan_i) da-le jizhe (Chinese Subject Relatives)
 invite tycoon DE official hit reporter
 ‘The official/Someone who invited the tycoon hit the reporter.’
- (4) [fuhao yaoqing e_i de] (guanyuan_i) da-le jizhe (Chinese Object Relatives)
 tycoon invite DE official hit reporter
 ‘The official/Someone who the tycoon invited hit the reporter.’
- (5) [e_i sobo -o kaihooshita -no] -wa shinseki_i da (Japanese Subject Clefts)
 grandma ACC nursed NO WA relative COP
 ‘It was the relative who nursed the grandma.’
- (6) [sobo -ga e_i kaihooshita -no] -wa shinseki_i da (Japanese Object Clefts)
 grandma NOM nursed NO WA relative COP
 ‘It was the relative who the grandma nursed.’

Focusing on indefinite noun phrases in German and English: Consequences of reference form on the subsequent discourse

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Indefinite noun phrases; Referential persistence; Pronominalization; Sentence continuation task; German; English

Introduction: One of the fundamental questions underlying theories of language production concerns referent-tracking. A body of linguistic and psycholinguistic studies found out that several factors (e.g. syntactic and thematic prominence) influence the frequency of re-mention and the rate of pronominalization of referents. In this paper, I focus on referents mentioned in non-prominent positions (i.e. direct objects realized by indefinite noun phrases) in English and German and argue that different types of indefinite noun phrases give structure to the subsequent discourse in different ways.

Study1: The English data (Indefinite-*this* vs. indefinite-*a(n)*)

According to several studies (Prince 1981, Ionin 2006), English *this* can be used as an indefinite determiner alongside the simple indefinite article *a(n)*. The Experiment (**Exp1**) investigates whether referents introduced by *this* and *a(n)* differ in terms of frequency of subsequent mention and likelihood of pronominalization. **Design.** In a sentence-continuation task with no pronoun-prompt, participants ($n=20$) read story fragments and were asked to add five logical and natural-sounding sentence continuations to each of the stories. The critical referents were constructed in direct object position and were realized as indefinite noun phrases. Only the morphological realization of the direct objects was manipulated, which resulted in 2 conditions: *this*-condition vs. *a(n)*-condition. In light of previous studies on indefinite-*this* (Gernsbacher & Shroyer 1989), the prediction is that *this*-referents will be: (i) more frequently picked up, and (ii) more likely to be mentioned with a pronoun in the subsequent discourse, compared to the *a(n)*-referents. **Results.** *This*-referents were picked up more often in the subsequent discourse than *a(n)*-referents (in 85% vs. 15% of the cases), but, contrary to the initial predictions, the anaphoric expressions used for the referents of both types of indefinites were definite noun phrases.

Study2: The German data (Indefinite-*so'n* vs. indefinite-*ein(e)*)

The distribution of the German determiner *so'n* comes very close to that of English indefinite-*this* (Chiriacescu 2011). Experiment 2 (**Exp2**) had the same design as Exp1 and tested the impact on the discourse of indefinite-*so'n* compared to that of a simple indefinite headed by *ein(e)* ('*a(n)*'). Again, I manipulated only the type of indefinite noun phrase, which resulted in 2 conditions: *so'n*-condition and *ein(e)*-condition. The prediction is that if the discourse function of *so'n*-referents is comparable to that of referents preceded by indefinite-*this*, then the results of the two experiments should be similar. **Results:** Similar to the findings of Exp 1, *so'n*-referents were picked up more often in the following discourse than the *ein(e)*-referents (in 80% vs. 17% of the cases), but did not show a preference for pronominalization.

Conclusions: In this paper I argue that indefinites not only introduce new referents in the discourse, but that they are *forward-looking* as well, as they give information about the *future* discourse properties of the referents they are associated with. Specifically, I showed that noun phrases headed by indefinite-*this* in English and indefinite-*so'n* in German signal the referential persistence of their referents. The findings of the two experiments furthermore indicate that *the frequency of subsequent mention* of a referent and its probability to be mentioned with *a particular type of referring expression* in the subsequent discourse should be kept apart, as these two factors point to different characteristics of that referent (see Kehler et al. 2008 for a similar observation).

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Word skipping in eye movements during sentence reading: Effects of lexicality of the letter string in parafoveal preview

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Word skipping; Word recognition; Lexical status; Eye-tracking during reading; English

Patterns of eye movements provide basic information about the coordination of sentence comprehension, word recognition and attention during reading. Particularly, word skipping is a phenomenon strongly influenced by oculomotor factors (visual acuity and saccade accuracy) and by the linguistic properties of the word in parafoveal preview, such as its predictability or frequency¹. Lexical properties affect skipping only when the previewed letter string is an actual word, not when it is a nonword created by transposing the positions of two internal letters of a word (e.g., jugde derived from the base word judge). Skipping of these transposed-letter nonwords is not affected by repetition or frequency of their base words², even though they are visually very similar to the base words and provide high levels of lexical priming in a variety of tasks; an alternative possibility is that lexical effects in these cases were blocked by disruption of sublexical orthographic or phonological patterns. The two experiments reported here investigated whether lexical status of the letter string in parafoveal preview influences word skipping, using conditions involving pseudohomophone and homophone previews, neither of which causes any disruption in sub-lexical orthographic or phonological representation. They used the boundary technique³ to vary the letter string in parafoveal preview to determine how lexical status affects the targeting of saccades during reading. Experiment 1 used pseudohomophone previews and Experiment 2 used homophone previews.

Experiment 1 investigated the rate at which a critical target word embedded in a sentence was skipped under three parafoveal preview conditions: valid preview (e.g. brain-brain), pseudohomophone preview (e.g. brane-brain), and orthographic nonword control preview (e.g. brant-brain). If lexical status of the preview string is a necessary condition for language-based skipping, then higher skipping rates should be observed for the valid preview condition (where the preview string is a word) than for the pseudohomophone and orthographic-control preview conditions (where the preview strings are nonwords that preserve the phonological and orthographic patterns found in the target words). Experiment 2 also investigated three preview conditions: valid preview (e.g. beach-beach), homophone preview (e.g. beech-beach), and orthographic control preview (e.g. bench-beach). If word skipping were influenced by lexical status we would expect no skipping difference among these three conditions because the letter string in parafoveal preview is a word, and word frequency and word predictability are controlled across conditions.

Higher skipping rates were observed in Experiment 1 for the valid condition (27.4%) where a word was in preview than for the pseudohomophone (18.9%) and orthographic-control (18.8%) conditions where a non-word was in preview ($F_1=7.09$, $p<.05$; $F_2=3.70$, $p<.05$). In contrast, no difference in skipping rates was observed in Experiment 2, where the valid (25.2%), homophone (22.2%) and orthographic control (24.2%) conditions all involved preview of a word ($F_s < 1$, ns).

This pattern indicates that advancement of the eyes during reading is critically related to processes that are sensitive to the lexical status of letter strings in the periphery, and that the lexical status of briefly-seen words in the parafovea is assessed by mechanisms that target saccades during the reading of sentences.

Sentence Examples

1. Valid/Pseudohomophone/Orthographic Control Preview:

Wendy had always wanted to study the complex brain/brane/brant:**brain** activity involved in problem solving.

2. Valid/Homophone/Orthographic Control Preview:

Taylor expected the nearby beach/beechn/bench:**beach** to be crowded, but it was deserted when she got there.

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Different effects of focus in intra- and inter-sentential pronoun resolution in German and French

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Anaphor resolution; Information structure; French; German

It is widely assumed that focused entities are more salient than non-focused ones. In line with this, experimental data have shown that an antecedent is particularly available for a pronoun in a subsequent sentence when it is focused (e.g., Foraker and McElree, 2007). Contrary to this evidence, in recent on- and off-line studies on intra-sentential anaphor resolution in French and German, referents in focus were consistently less accessible than non-focused ones. There is good reason to believe that the difference between the two studies is due to differences between intra- and inter-sentential pronoun resolution: A sentence such as (1) is a felicitous answer to the question: "Who has slapped John when he was young?". The aboutness topic is thus "slapping John when he was young". Binding a pronoun in the subordinate clause to "Peter" would imply a change in topic within the sentence, thus reducing intra-sentential coherence (see also Grosz, Joshi & Weinstein, 1983 for the one topic constraint within sentences). In other words, within a sentence, binding a pronoun to the topic (the non-focused referent) makes the sentence more coherent by keeping the sentence topic constant between the matrix clause and the subordinate clause. By contrast, between sentences, focusing a referent in a given sentence may be taken as a cue for an upcoming topic shift, thus establishing this referent as a potential topic of the following sentence. A pronoun in the following sentence may thus access a focused antecedent more easily because this antecedent has been introduced as a potential new topic.

In the present study, we tested ambiguous pronouns in structures that were identical to those used in the earlier studies on French and German, but in which the ambiguous pronoun and the potential antecedents were in different sentences. The interpretation of the ambiguous pronoun was assessed in three conditions: a baseline condition as in (2), a focused subject condition as in (3) and a focused object condition as in (4). Participants completed written questionnaires by filling a gap in a sentence following the critical sentence (e.g., "_____ was an apprentice" for the examples 2-4). The percentages of choices for the first noun (N1) as the antecedent of the pronoun are in brackets. Our results replicated the cross-linguistic difference already observed before between French and German with more N1 interpretations in German than in French. More interestingly, we observed a preference for the focused antecedent in both languages, which was consistent with our predictions. N1 was chosen significantly more often when N1 was subject and focused as in (3) than in the baseline condition (2) ($t_1(48) = 3.02, p < .005$; $t_2(26) = 3.31, p < .005$; $t_1(36) = 2.97, p < .01$; $t_2(26) = 2.14, p < .05$ respectively for German and French). N1s which were focused and object were numerically but not reliably more accessible than N1 in the baseline condition across languages. The opposite effect, i.e. an "anti-focus" effect, has been reported for the German and French equivalent of the intra-sentential pronoun ambiguity (1). The different function of focus within and across sentences can explain the pattern of results across experiments.

(1) It was Peter who slapped John when he was young.

(2) Pierre a giflé Jean. Il était à l'époque apprenti. (54,4%)

Peter hat Hans geohrfeigt. Er war damals Lehrling. (62,4%)

Peter has slapped John. He was then an apprentice.

(3) C'est Pierre qui a giflé Jean. Il était à l'époque apprenti. (58%)

Es ist Peter, der Hans geohrfeigt hat. Er war damals Lehrling. (71,7%)

It was Peter who has slapped John. He was then an apprentice.

(4) C'est Pierre que Jean a giflé. Il était à l'époque apprenti. (63%)

Es ist Peter, den Hans geohrfeigt hat. Er war damals Lehrling. (65,7%)

It was Peter who John has slapped. He was then an apprentice.

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Text change blindness and alternative focus sets

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Focus; Alternative focus sets; Text; Change blindness

One influential theoretical approach to focus proposes that focus status indicates the presence of alternatives that are relevant for interpretation (Féry & Krifka, 2008; Rooth, 1992). The interpretation (and thus processing) of focus crucially involves not only the focus referent itself, but also the set of alternatives to that referent, no matter whether those alternatives are given explicitly or implicitly. We used a text-change methodology to investigate whether members of alternative focus sets were processed as part of focus interpretation.

Previous work using text-change has found that readers are poorer at detecting whether a single word has changed between two presentations of a text if the changed word in the second presentation (the replacement) is semantically related to the word in the first presentation (the original) (Sanford & Sturt, 2002). Detection accuracy is improved when the changed word is focused (Sturt et al., 2004), and some evidence suggests this focusing effect may be due to an increased strength of representation of the focused referent and a suppression of the non-focused referents in the text (Sanford et al., 2009).

However, no prior work has explicitly examined focus-alternative replacements, and it is not known whether detection accuracy will be influenced by replacements taken from implicit or explicit alternative sets. According to the alternative focus approach, in a constrained context there should be a finite set of alternatives that will be considered as part of interpreting the focus referent, even when an alternative set is not explicitly given. If this set of alternatives is considered as part of focus processing, then it could interfere with readers' ability to accurately determine whether the focus was the previously given referent or the activated alternative. This means that change detection should become more difficult when the changed word comes from the set of alternatives in the text, and further, that this should be the case even if the alternative set is not explicitly given as a set. However, it is also possible that focus is not interpreted against an alternative set if one is not provided. In this case, we would expect to see no increased difficulty for detection for members of an alternative set.

We tested these predictions with short passages that contained question-answer pairs and clefts to manipulate focus and alternative set membership. In the example, the words in square brackets show the original word followed by the replacement. The replacement was a previously unmentioned word (New), from an explicit alternative set (Explicit set), from an implicit set (Implicit set), or a previously mentioned word that was not part of the alternative set (Other). Target words were controlled for frequency

Our results show that detection accuracy for *new* replacements was 97%, which was significantly higher than all other replacement types (Explicit: 81%, Implicit: 83%, Other: 88%). The accuracy rate for *other* replacements was numerically larger than for *explicit* and *implicit* replacements, but only reached marginal significance in comparisons against the *explicit* replacement. These results are consistent with the idea that focus alternatives are considered as part of focus processing.

Stimulus Example

First two sentences (all conditions): A chef and a waiter were quickly plating some dishes in the kitchen. There were several things they needed to work with, including zucchini, spinach and some rice.

New ending: The waiter asked what the chef's favorite part of the dish was, the zucchini or the spinach. According to the chef, it was the [zucchini/broccoli] that was his favorite. He'd loved it since he was a kid.

Explicit ending: The waiter asked what the chef's favorite part of the dish was, the zucchini or the spinach. According to the chef, it was the [zucchini/spinach] that was his favorite. He'd loved it since he was a kid.

Implicit ending: The waiter asked what the chef's favorite part of the dish was. According to the chef, it was the [zucchini/spinach] that was his favorite. He'd loved it since he was a kid.

Other ending: The waiter asked what the chef's favorite part of the dish was, the zucchini or the spinach. According to the chef, it was the [zucchini/rice] that was his favorite. He'd loved it since he was a kid.

The time-course of reference resolution in picture noun phrases: Evidence from eye-movements during reading

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Sentence processing; Anaphora; Eye-tracking; English

Although binding theory (Chomsky 1981) originally predicted that reflexives and pronouns should be in complementary distribution ('John₁ injured himself₁/him₁'), complementarity breaks down in certain contexts (see e.g. Reuland 2011). One such context is the picture noun phrase (PNP; 'John₁ saw a picture of himself₁/him₁'), and the question of whether possessed PNPs (PPNPs; 'John's₁ picture of himself₁/him₁') should also be exempt from binding theory has been the subject of some debate (see Runner et al. 2006).

Psycholinguistic research has examined to what extent binding constraints are violable during sentence comprehension. While it has been argued that, for reflexives, binding theory applies early to guide the antecedent search for binding theory *accessible* antecedents ('John' in 'Steven knew John had injured himself') rather than *inaccessible* ones ('Steven') during comprehension (Sturt 2003), it has been claimed that inaccessible antecedents can have early effects on processing in (P)PNP contexts (Kaiser et al. 2009; Runner et al. 2006).

We examined reference resolution in (P)PNPs in four eye-tracking experiments. In each experiment, 28 native English speakers read 32 critical and 64 filler texts while their eye-movements were monitored. Experiments 1 and 2 examined reflexives in PNP and PPNP contexts (e.g. 1a/b). Critical texts contained one accessible and one inaccessible antecedent, and gender congruence (match vs. mismatch) between each antecedent and the reflexive was manipulated in a 2x2 design. Experiments 3 and 4 examined pronouns in PNP and PPNP contexts (e.g. 2a/b) using a similar manipulation, except that use of the temporarily ambiguous female pronoun was avoided (see Clifton et al. 1997).

Experiments 1 and 2 indicated the same relative time-course of antecedent effects for reflexives in both PNP and PPNP contexts. In both experiments, comparatively earlier reading time measures were longer when the accessible antecedent mismatched the stereotypical gender of the reflexive compared to when they matched, while effects of the inaccessible antecedent were in comparison delayed. For example, in (1b), stereotypical gender mismatches between the reflexive and accessible antecedent incurred longer reading times during the initial inspection of the reflexive and a spillover region, whereas effects of the inaccessible antecedent were only observed in second pass times of the spillover region. In Experiments 3 and 4 we observed reliable effects of the accessible antecedent only. For example, in both experiments, second pass times of the pronoun were reliably longer following a stereotypical gender mismatch between the pronoun and accessible antecedent in comparison to when they matched.

The results of Experiments 1 and 2 extend previous findings that binding theory applies early to guide reference resolution for reflexives (Sturt 2003). Although offline studies indicate comprehenders will accept 'inaccessible' antecedents as a potential antecedent for a reflexive inside (P)PNPs (Runner et al. 2003 Experiment 1) our results suggest that, contra Runner et al. (2006) who did not include gender mismatching conditions in their visual world experiments, accessible antecedents only are initially considered as potential antecedents for a reflexive during earlier stages of processing during reading. The antecedent search for pronouns in (P)PNP contexts appears to be similarly constrained.

- (1) Jonathan/Jennifer was walking through the military barracks. He/she heard...
 - (a) ... that the soldier had a picture of himself/herself in the middle of the mess hall.
 - (b) ... about the soldier's picture of himself/herself in the middle of the mess hall.
- (2) The medical staff had a meeting in the office. The surgeon/nurse recalled...
 - (a) ... that Jonathan/Jennifer noticed a portrait of him over at the back of the room.
 - (b) ... about Jonathan's/Jennifer's portrait of him over at the back of the room.

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Word-order uncertainty induces alternative, non-veridical structures in online comprehension

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Parsing; Uncertainty; Sentence comprehension; Hallucinated garden-paths; Self-paced reading; English

Human sentence processing takes place in noisy conditions. As a result, a rational approach to sentence processing should include and use uncertainty about word identities and word order during online comprehension [1]. However, the traditional approach to human sentence comprehension has an implicit modularity assumption that the words of the sentence are read without residual uncertainty, and without the possibility of later revision.

Previous work suggests that this modularity assumption is too strong. Humans do maintain uncertainty that is affected by later information [2,3], and revising this uncertainty may explain online comprehension effects, such as regressive eye-movements during reading [4,5] and garden-pathing onto syntactic analyses inconsistent with veridical input [6]. This previous work investigated structural uncertainty stemming from word identity uncertainty.

In this experiment, we look for evidence of word order uncertainty. We consider a set of sentences where a sentence-initial relative clause may be re-analyzed as a complement clause (CC) if the semantic roles of the embedded and extracted NPs were swapped. If readers maintain uncertainty about the order of the words they have previously read (motivated by the possibility of, e.g., speaker error or faulty memory), they may assign some probability to this non-veridical swap-CC structure.

To look for this structure, we designed a 2x2 moving-window self-paced reading study using sentences like (1). These start with an ORC-modified animate noun, with an inanimate NP as the RC subject. The relative pronoun varies between *that*, which allows swapping the NPs to get a CC partial-parse (2), or *who*, which blocks both the NP swap and CC partial-parse. We also vary whether the embedded NP is able and biased to take a CC or unable to take one. The relative clause verb is chosen to be plausible but unlikely with the inanimate embedded subject, encouraging the swap-CC partial-parse. This swap-CC alternative is removed when the main verb appears, terminating the CC without an object.

If readers maintain word order uncertainty and update their distribution over previous words based on later information, we predict an interaction effect at the relative clause verb (RCV) and main verb (MV), as the likelihood of the swap-CC parse increases at RCV and decreases at MV. The *that*-biasCC condition is predicted to exhibit a stronger slowdown at these verbs than conditions with only *that* or only a CC-biased NP. The prediction is borne out in self-paced reading, where the *that*-biasCC condition has superadditively high reading times at both RCV and MV ($p < .001$). It is not obvious how this superadditive effect would be explained under existing retrieval/interference frameworks.

This gives evidence that readers maintain uncertainty about word order as part of a rational response to input over a noisy channel. Furthermore, this uncertainty influences online parsing to the point that comprehenders can pursue an analysis of the sentence that is inconsistent with the surface input.

Stimuli

- | | | |
|-----|---|---------------|
| (1) | a. The journalist that the fact surprised came to the press conference late. | [that-biasCC] |
| | b. The journalist who the fact surprised came to the press conference late. | [who-biasCC] |
| | c. The journalist that the article surprised came to the press conference late. | [that-noCC] |
| | d. The journalist who the article surprised came to the press conference late. | [who-noCC] |
| (2) | The fact that the journalist surprised (someone) came... [swap-CC] | |

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High-cost referential support of relative clause ambiguities

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Syntax-discourse interactions; Eye-tracking; English

Although context effects on syntactic ambiguity resolution have been examined in a number of studies since Altmann & Steedman's original work (Cognition, 1988), we still know little about the inferential mechanisms that support contextual integration in sentence processing. Previous work suggests that more difficult ambiguities, such as relative clauses, may result in a reduced effect of context (see, e.g. Binder et al., JML, 2001; and Traxler and Tooley, 2007). It remains unclear to what degree these contextual results are due to superficial strategies, as context and target have tended to be repeated word-for-word in prior studies. Here, we present a series of experiments designed to explore this question.

We manipulated both the difficulty of contextual inference and the strength of the garden path across four experiments, adapting materials from McRae et al. (JML 1998). Each experiment crossed ambiguity [Reduced relative clause (RRC) vs. unreduced RC (URC)] with context [relative-supporting (Example (5)), vs. non-relative-supporting (e.g. with only one individual compatible with modification in NP1)]. Experiments 1(a) and 1(b) used a plausible agent of the target verb as NP1, as in Example (1) (harder garden path), whereas Experiments 1(c) and 1(d) used a plausible patient in NP1, as in Example (2) (easier garden path). In Experiments 1(a) and 1(c), NP1 was a synonym or hyponym of the contextually mentioned noun(s), (harder contextual inference) whereas Experiments 1(b) and 1(d) had a word-for-word repetition of NP1 with the context (easier inference). Example (3) shows a supportive context and Example (4) an unsupportive context from Experiment 1(a), which did not have repetition; Example (5) gives an example of a supportive context from Experiment 1(d), which did have repetition. The other five options follow a similar pattern.

Analyses of regressions out of NP2 show context effects even without lexical repetition: when analyzed individually or together (with experiment and NP2 length as fixed factors), a mixed effects model showed a consistent interaction between context and syntax, including in Experiments 1(a) and (c), which have a hard contextual inference. The ambiguity penalty (although present in both contextual conditions) was significantly reduced in a supportive context.

Thus, even in a difficult garden path, the inference supporting contextual integration went beyond a superficial strategy involving word repetition. This is notable because context effects are hard to elicit in ambiguous relative clause constructions (cf. Traxler and Tooley, 2007). Although there is a presumably a cost involved in making an inference, it appears as if the Principle of Referential Support (Altmann & Steedman, 1988) is robust against such penalties.

(1) Target 1(a,b) [NP1 The postman] (who was)/ [V carried] by/ [NP2 the paramedics]/ was having trouble breathing.

(2) Target 1(c,d) The newborn (who was)/ carried by/ the nurse/ was having trouble breathing.

(3) Supportive Context 1(a) Two workers were at the mail sorting office when an accident happened The paramedics put one of the workers on a stretcher and took him to the hospital, but the other walked away unharmed.

(4) Neutral Context 1(a) A worker and a customer were at the mail sorting office when an accident happened. The paramedics put the worker on a stretcher and took him to the hospital, but the customer walked away unharmed.

(5) Supportive Context 1(d) Yesterday at the nursery, two newborns suffered asthma attacks. The paramedics arrived and carried one newborn to the intensive care section, but the other had recovered by the time they arrived.

Quantifier scope ambiguity and the timing of algorithmic processing

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Quantifier scope ambiguity; Self-paced reading; Timing; Heuristics; Good-enough processing; English

Recent work by Ferreira and colleagues (Christianson et al., 2001; Ferreira, 2003; Swets et al., 2008) argues that language comprehension occurs using simple heuristics, in addition to using syntactic algorithms. However, at present, it is unclear how heuristic processes are coordinated with the output of syntactic algorithms. In the present work, I argue that results of 3 self-paced reading experiments examining the processing of quantifier scope ambiguous (QSA) sentences argue that heuristic processes apply FIRST, and algorithmic processes SECOND.

The processing of two-sentence discourses as in (1) was investigated, where context sentences exhibited QSA. Note that plural continuation sentences are consistent with surface scope interpretation as in (1), and singular continuations with inverse scope, as in (2). Below, stimuli were separated by previous norms that indicated biases for plural vs. singular continuations (Dwivedi et al., 2010). From a processing perspective, the logical interpretation of scope, which is an algorithmic process, should show a surface scope bias, since this interpretation is consistent with surface linear order. Experiment 1 ($N=80$) used stimuli that were heavily biased for a plural continuations, yet surprisingly, demonstrated no difference in reading times (RTs) to plural vs. singular continuations, compared to controls (3) (cf. Fodor, 1982). While this effect mirrored our previous ERP study of QSA (Dwivedi et al., 2010), it ran counter to other findings, (e.g., Kurtzman & MacDonald, 1993).

In order to address this, we added questions (4) to the design of the experiment, in order to ensure deeper processing of the discourses, in Experiment 2 ($N=48$). Results indicated that RTs for continuation sentences now did show a difference, indicating that participants were paying more attention. Plural continuation sentences overall were read faster than singular ones. In other words, RTs were consistent with the lexical-pragmatic interpretation of number associated with context sentences, and were not indicative of scope computation. However, question-response accuracy was consistent with the algorithmic computation of scope. That is, accuracy rates were only at chance when questions queried inverse scope conditions as in (2). In Experiment 3 ($N=40$), stimuli that were equi-biased between singular and plural continuations were used (5). Again, RTs for continuation sentences were consistent with the lexical-pragmatic bias of context sentences, now continuation sentences following unambiguous control contexts took less time to read than those following scope ambiguous sentences. However, interestingly, question-response accuracy rates were exactly the same as in Experiment 2. This indicates that while reading QSA sentences, people are only sensitive to their lexical-pragmatic bias; that is, they are engaged in fast and frugal heuristic processing. In other words, it's only when participants are actually queried about scope interpretation that they interpret the sentences deeply using algorithmic rules of logical form interpretation. As a result, there is a huge complexity effect for inverse scope conditions (even though these college-aged participants just read singular continuation sentences) such that accuracy rates for these sentences are below chance. These results suggest that for certain constructions, language processing is superficial and deeper processing sensitive to structure only occurs if required. Implications for recent studies of scope ambiguity are discussed.

- (1) Every kid climbed a tree. The trees were in the park. Ambiguous Context-Plural continuation
- (2) Every kid climbed a tree. The tree was in the park. Ambiguous context-Singular continuation
- (3) Every kid climbed that/those trees. The tree(s) was/were in the park. Unambiguous Control (singular/plural)
- (4) How many trees were climbed? ONE SEVERAL
- (5) Every jeweler appraised a diamond. The diamond(s) was/were clear and flawless.

Picture priming of logical form generalizes across nouns, but not across verbs

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Logical form; Structural priming; Comprehension priming; Picture choice; English

Sentences containing two quantifiers, like *Every boy climbed a tree*, have two interpretations – one where there is a single tree that every boy climbed, and another where every individual boy climbed some tree, but no two boys necessarily climbed the same one. The systematicity of this ambiguity is well-captured by theories that posit two possible representations at the level of logical form with different scope relations between the quantifiers. But does this characterization merely describe the two meanings from a theorist's-eye view, or are these distinct logical forms invoked in the process of interpreting these sentences?

This question has recently been investigated in 4-year-olds (Viau, Lidz and Musolino, 2010) and adults (Raffray and Pickering, 2011) using a priming paradigm. Raffray and Pickering used a picture choice priming method with adults where ambiguous target trials follow unambiguous prime trials. Participants are told to pick the picture which matches the sentence they see. On prime trials, an ambiguous sentence (e.g. *Every boy climbed a tree*) is presented with two pictures, one of which matches one of the possible readings of the sentence (e.g. for a universal-wide reading, three boys each climbing a different tree; for an existential-wide reading, three boys climbing the same tree). The other does not match the lexical content of the sentence (e.g. each boy climbing a different ladder). Thus the context forces one interpretation of the ambiguous sentence. In the following target trial, a new sentence (e.g., *Every hiker climbed a hill*) is accompanied by two ambiguous pictures – one of three hikers climbing a single hill (an existential-wide reading), and another where each hiker climbs their own hill (the universal-wide reading).

Raffray and Pickering (2011) found that participants were more likely to choose a universal-wide target after having seen a universal-wide than an existential-wide prime. This priming only occurs when the particular combination of quantifier and thematic role is preserved across the prime and target. Thus priming is found from *Every kid climbed a tree* to *Every hiker climbed a hill*, but not from *A kid climbed every tree*. Note, however, that the verb remains the same across target and prime. If logical form priming depends on thematic roles, as Raffray and Pickering conclude, rather than more concrete representations of specific events, then priming should persist across different verbs with the same argument structure.

To test this prediction, we explored quantifier scope priming both within and across verbs (e.g., from *Every boy climbed a tree* to *Every shark attacked a surfer*). We counterbalanced the order of sentences, as well as the prime type of every item such that each prime sentence was accompanied by a universal-wide forced picture choice for half of the participants and an existential-wide picture choice for the other half. We replicate a significant priming effect across sentences with the same verb (see Table 1; $N=132$; $p<0.01$), but find no effect of prime type across different verbs ($N=135$; $p=n.s.$) and a significant interaction between the two conditions ($p<.05$). We discuss three possible explanations and their relation to prior accounts of **syntactic** priming during comprehension: 1) priming occurs over abstract scope representations which are lexically mediated (Pickering & Ferreira, 2008); 2) priming occurs over concrete representations of events (which generalize to new event-participants but not new verbs); 3) verb overlap focuses participants on commonalities across adjacent trials and thus priming is attentionally mediated.

Feiman, Aiello & Snedeker	U-wide Prime	E-Wide Prime
<i>Within Verb</i>	71.2%	66.2%
<i>Between Verb</i>	47.3%	47.5%
Raffray & Pickering		
<i>Within Verb</i>	77%	69%

Table 1: The percentages of participants selecting a universal-wide picture after either a universal-wide or an existential-wide prime trial.

Integrating cross-domain information in predictions

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Prediction; Visual world paradigm; English

It is now widely accepted that language comprehension involves prediction. Upon hearing *eat* in the sentence “*the boy will eat the cake*”, listeners are more likely to look toward an edible object than upon hearing a verb that does not impose this restriction upon its theme, such as *move* (Altmann & Kamide, 1999). In addition to the prediction of semantic features of words (e.g. whether they need be edible), participants have been shown to predict syntactic (van Berkum et al., 2005) and phonological features (DeLong et al., 2005) given preceding contexts which produce completions with high cloze probabilities.

In cases when a verb may be compatible with more than one potential referent, for example if hearing “*the man will ride the motorcycle*” with both a motorcycle and carousel visible, listeners may also combine information from other sources to refine their predictions, using pre-existing knowledge that a man may be more likely to ride a motorcycle than a carousel (Kamide et al., 2003). This finding demonstrate that predictions can be driven by the combined semantic information provided by multiple sources (the agent and the verb). What has so far not been investigated, however, is whether listeners can make predictions by combining information about two different linguistic domains, for example semantics and phonology.

Using the visual world paradigm, we investigated the ability of listeners to predict phonological features of themes and to subsequently combine these with the predictions made from the semantic restrictions of verbs. We exploited a regularity in English where the indefinite article is realised differently depending on whether the word that follows begins with a consonant or vowel (*a* or *an*, respectively). If listeners are sensitive to this regularity when making predictions, we may expect that upon hearing *a* they will anticipate that the following word should begin with a consonant. Participants heard sentences where verbs and determiners were manipulated to place different restrictions (shown below), while viewing scenes containing the target (cake), a semantic competitor (apple; edible but vowel onset), a phonological competitor (pen; a consonant onset but inedible), and a distractor (accordion; inedible and vowel onset).

Semantic & Phonological:	The boy will eat a cake
Semantic only:	The boy will eat his cake
Phonological only:	The boy will move a cake
Unrestricted:	The boy will move his cake

Relative to the onset of the verb, participants were faster to initiate saccades toward the target following a restrictive verb. They were also, independently, faster when the determiner placed phonological restrictions on the theme. Taken as a whole, our findings demonstrate that listeners can use regularities of the English indefinite article to predict phonological features of upcoming words, and that they are able to combine this with information from other linguistic domains, provided by other words in the sentence, in order to refine their predictions.

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Phonological and orthographic overlap effects in fast priming

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Fast priming; Eye-tracking; English

We used the fast priming paradigm to examine the influence of phonological and orthographic overlap between prime and target (N = 56). We tested 4 types of overlap, with 40 item pairs per overlap type: (1) high-phonological high-orthographic end-overlap (P+O+: track-crack), (2) P+O+ begin-overlap (swoop-swoon), (3) low-phonological high-orthographic overlap (P-O+: bear-gear), and (4), high-phonological low-orthographic overlap (P+O-: fruit-chute). The primes and targets were controlled for length and frequency between the different types and the prime was always higher in frequency than the target. Before the eyes fixated on the target word, the target word preview consisted of a string of random consonants. When the eyes crossed an invisible boundary placed just before the target word location, the consonant string changed to the overlapping prime word (*bear*) or a prime control pronounceable non-word (*qulk*), which was presented for either 32 or 50 ms, before being replaced by the target word:

(1) Joshua picked up the| [dnlw (preview) → bear (prime) / qulk (control) → gear (target)] that he needed for his surfing trip.

Facilitatory priming, compared to the control word, was found on the single fixation and gaze duration measures for both P+O+ conditions at both prime durations, which did not differ from each other (though there was a slight numerical advantage for begin-overlap items). The single fixation duration analyses indicated that the priming effect was greater, and that the target word was read faster, when both phonology and orthography overlapped than when the overlap was only at the phonological or the orthographic level. Finally, when the overlap was only phonological, no priming was observed at the shortest prime duration.

The evidence suggests that, unlike what has been found in masked priming lexical decision tasks (e.g., Davis & Lupker, 2006), the presence of an orthographic neighbor does not inhibit reading. Further analyses indicated that this reversal of the orthographic neighbor effect was not due to syntactic or larger sentential priming during reading. Together, these results point to a substantially greater reliance on orthographic information during reading and indicates that conflicting phonological information can be easily ignored. At the same time, consistent phonological information can slightly boost recognition.

We will discuss these results in light of previous fast priming results and recent models of word recognition (e.g., the bi-modal interactive activation model, Grainger & Holcomb, 2009).

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Processing of subject relatives in SLI children during structural priming and sentence repetition

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Relative clauses; Specific Language Impairment (SLI); Syntactic priming; Italian

Subject relative clauses (SRC) are generally early acquired, at around 3 years in typically developing children (TDC; e.g., Crain et al., 1990). However, children with Specific Language Impairment (SLIC) display persistent difficulties in producing sentences containing subject (as well as object) relative clauses (Novogrodsky and Friedmann 2006). This difficulty extends to repetition of sentences (Conti-Ramsden et al., 2001).

Recent research has suggested that in TDC, prior exposure to even difficult structures can facilitate their subsequent production (e.g., Bencini & Valian, 2008). Such effects have been identified as manifestations of syntactic priming, whereby an abstract syntactic representation is facilitated (Bock, 1986). In adults, syntactic priming appears to be implicated in sentence repetition (Potter & Lombardi, 1998), and is generally enhanced by lexical repetition. It is therefore striking that SLI children do not show facilitated production of SRC in sentence repetition: We might have expected them to benefit from a syntactic priming effect, which should be enhanced by the exact lexical repetition. Such evidence appears to support the claim that SLIC do not have a representation of SRC. However, SLIC's poor performance in sentence repetition may reflect working memory or other non-syntactic impairments.

We compared SLIC's (and control TDC's) production in a syntactic priming paradigm using picture description with their performance in sentence repetition task where they have to repeat a sentence with a picture as a context. 38 (19 SLI, 19 TD) pre-school Italian children participated (mean 5;4 years, Non-verbal IQ > 92). Children repeated verbatim SRC sentences (repetition), and described pictures after hearing the experimenter describe a picture with an SRC ("the boy that's chasing the girl") or a simple Noun ("chair") as a baseline in a within-participants manipulation (priming; Branigan et al., 2005).

In the priming task, LME analyses showed significant main effects of Group and Prime: TDC produced more SRC than SLI, and both groups were more likely to produce SRC after hearing an SRC. We also found cumulative priming: The more SRC the child had previously produced, the more likely he/she was to produce an SRC. Crucially, there was no significant interaction between Prime and Type. Hence both groups showed equivalent structural priming. However, we find a significant effect of cumulative priming on TDC but not SLI, whereby a TDC is more likely to produce an SR after being exposed to it. Between-tasks comparisons showed SLIC to be significantly more impaired for SRCs in repetition than in priming, relative to TDC. Moreover, SLIC were more likely to produce SRCs that exactly repeated the experimenter's utterance in the priming task, where they spontaneously generated the utterance, than in the sentence repetition task.

These results show that SLIC are able to spontaneously produce SRCs after being exposed to them, and that their spontaneous production of SRCs in this context is less impaired than their elicited repetition of SRCs, relative to TDC. This study therefore suggests that SLIC have an abstract representation of the SRC that they can recruit during production, when it has been facilitated through previous use; moreover, this facilitation is not cumulative for SLI children.

The absence of cumulative priming in SLIC is an index that SR can be accessible in a priming task but implicit learning is not present in SLIC. We argue that SLIC's poor performance in sentence repetition does not reflect a lack of syntactic knowledge, but rather a task-specific difficulty, likely related to decoding and mapping the semantic representation in the repetition task.

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**Unifying the perspective-taking debate within a cue-integration framework:
Addressees are sensitive to both perspective and referential fit**

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Perspective taking; Common ground; Comprehension; Probabilistic cue integration; Referential fit; Visual world paradigm; English

In studies examining how addressees use common ground due to visual co-presence in real-time reference resolution, a confederate director instructs a naïve matcher to move objects in a real or virtual grid of cubbyholes. Some cubbyholes are occluded so the director cannot see the object, making it privileged to the matcher. When an object in privileged ground is a better referential fit for a referring expression than the intended referent in common ground (e.g., “tape” when adhesive tape is in privileged ground and cassette tape in common ground; “small candle” when the smallest of three candles is in privileged ground) matchers frequently look at and sometimes reach for the privileged object, suggesting they are behaving egocentrically (e.g. Keysar et al., 2000). In normal language use, however, visual co-presence and referential fit are each probabilistic cues. Therefore when both cues are available, an optimal Bayesian cue integration framework predicts that addressees’ use of ground will be modulated by other cues and the strongest and earliest effects of ground would emerge when the referential expression matches both objects equally well.

We conducted a visual world experiment with 8 items in a 4x4 visual display that mimicked cubbyholes. Naïve participants (n=16) played a referential communication game with a confederate director. Six items were in common ground and two were privileged to the addressee. On each trial, the confederate instructed the addressee to move 5 objects in the display. 16 critical trials included two instructions like (1) and (2). Displays contained two non-identical tokens of an object which contrasted in size (e.g. big and small cat) in common ground. The critical set had an additional token the same size as the target of the second critical instruction (e.g. another small cat). The typicality of the two small cats was manipulated such that they were both typical tokens, both atypical tokens (e.g. hairless cat) or one of each. The condition where the small atypical cat was in common ground and the small typical cat was in privileged ground mimics the “Keysar” experimental conditions. Norming determined typicality and established that names were acceptable for typical and atypical tokens.

During (1), fixations to the big cat quickly deviated from competitors (450 ms after adjective onset, replicating Sedivy et al., 1999) except in the “Keysar” condition (850 ms), which was also the only condition where participants frequently fixated the privileged item. Thus, participants are sensitive to both the referential fit of the items and the common ground status of the items. During (2), participants rarely fixated or clicked on the privileged small cat, except in the “Keysar” condition, where participants clicked on the privileged cat on 20% of the trials and looked at it almost twice as often as in other conditions.

Thus within the same experiment, we find immediate use of ground information, while also replicating results interpreted as evidence for initial egocentrism suggesting that a cue-integration approach may unify the debate. We are currently testing quantitative predictions of a cue-integration model by manipulating degree of occlusion and VOT using objects that differ in word initial voicing (e.g., bug, pug).

Examples

- (1) Put the big cat above the tower.
- (2) Put the small cat below the spoon.

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Priming effects of spatial distance on semantic similarity: Abstract sentence comprehension is modulated by unrelated visual context

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Semantic interpretation; Eye-tracking reading; German

During comprehension, a sentence-embedded word (e.g., *piano*) can guide visual attention towards its referent but also to semantically related objects (e.g., *trumpet*)^{1,3}. In addition, visual context can rapidly facilitate language comprehension^{1,2}. It is not clear, however, to which extent visual context information (e.g., distance between objects) can modulate incremental language comprehension even when it is neither referenced by, nor overtly lexically associated with, words in the target sentence. To the extent that this happens, situated language comprehension accounts will want to accommodate these effects.

We conducted three eye-tracking reading studies in which participants inspected a visual context with two playing cards in different positions before reading a sentence that described the relationship between abstract nouns (e.g., *stupidity* and *wisdom*). We predicted that spatial information could modulate semantic similarity processing⁴. To test this prediction we manipulated the distance between the cards (close vs. far) and the semantic similarity expressed in sentences like (1) and (2) (similar vs. dissimilar, respectively). If spatial distance can modulate semantic interpretation of similarity in real time, we should see its effects when semantic similarity is mentioned (at the ADJ, e.g., 'similar'). In principle, effects could appear even earlier (at NP2) since semantic similarity could be established as soon as the two abstract nouns have been read.

Begabung_{NP1} und_{coord.} Weisheit_{NP2} sind_{VP1} freilich_{ADV} entsprechend_{ADJ}, das erklärte_{VP2} der Professor_{NP3}.
'Talent_{NP1} and_{coord.} wisdom_{NP2} are_{VP1} indeed_{ADV} similar_{ADJ}, explained_{VP2} the professor_{NP3}'

Dummheit_{NP1} und_{coord.} Weisheit_{NP2} sind_{VP1} bestimmt_{ADV} verschieden_{ADJ}, das erklärte_{VP2} der Professor_{NP3}.
'Stupidity_{NP1} and_{coord.} wisdom_{NP2} are_{VP1} certainly_{ADV} different_{ADJ}, explained_{VP2} the professor_{NP3}'

Experiment trials consisted of three consecutive steps. First, participants inspected the cards, which moved from the center of the screen to different locations (far apart vs. close together for critical trials). Subsequently, participants read a sentence and judged (*yes* vs. *no*) whether it described possible facts based on their world knowledge. Next, a picture with two cards was presented and participants verified (*yes* vs. *no*) whether they were identical to the cards seen before the sentence.

The independent variables (card distance; semantic similarity) were identical across all three experiments. Between experiments, we varied how the cards related to the sentence. If their relationship influences visual context effects, then we should see a modulation of any spatial distance effects: In Experiment 1, critical trials (N=48) displayed the first two sentential nouns of the subsequent sentence, while most filler trials (N=72) had blank cards. In Experiment 2, by contrast, only fillers presented nouns of the subsequent sentence and participants learnt the first two sentential nouns of the experimental (and some filler) trials before each of six experiment blocks. This can reveal whether spatial distance effects emerge even when semantic information is separated from the visual context. In Experiment 3, all trials had blank cards.

Analyses of the eye-tracking data (each N=32) revealed rapid and extended interaction effects between spatial distance and semantic similarity in all three experiments with some time-course variation. In Experiment 1, we found first-pass (ADJ; NP3) and total-time (NP3) interaction effects, whereby reading times were shorter for sentences implying similarity (1) after seeing cards close together (vs. far apart), and vice versa for sentences implying difference (2). In Experiment 2 we observed these effects in regression path duration (ADJ) and total times (ADJ), and in Experiment 3, we only observed first-pass interaction effects (NP2; VP2). Our results suggest that sentence comprehension can be incrementally modulated by non-linguistic information even in the absence of direct referential or lexical-semantic associative links and that such modulation is relatively (but not entirely) invariant across different picture-sentence relationships.

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Perspective-taking behavior as the probabilistic weighing of multiple domains

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Common ground; Perspective taking; Bayesian modeling; Visual world paradigm.

Perspective information distinguishes knowledge shared by both interlocutors (common ground) from knowledge privileged to one interlocutor. Studies ask whether listeners are sensitive to this distinction by examining the referential domain used in interpreting definites, arriving at apparently-contradictory conclusions: listeners use all objects available (including privileged) as the (egocentric) domain [1,2], or listeners use common ground as the domain [3,4]. We propose a novel approach where listeners simultaneously consider **both** domains, weighing them probabilistically. This captures the idea that a listener's perspective-taking behavior arises from considering their knowledge together with the speaker's, which must be inferred from indirect cues.

We model reference resolution as the probability of choosing an object *obj* given a referring expression *RE* and a referential domain *k*: $P(obj|RE,k)$. Using Bayes' rule, this is proportional to: $P(RE|obj,k)P(obj|k)$. $P(RE|obj,k)$ captures the referential fit: how much is *RE* expected for each object in *k*; this depends on properties of all objects in *k*. $P(obj|k)$ captures the prior likelihood that an object will be referred to, with objects privileged to the listener less likely referents. The model weighs the influence of two possible domains, egocentric ($k=e$) and common ground ($k=c$): $\alpha P(RE|obj,k=e)P(obj|k=e) + (1-\alpha)P(RE|obj,k=c)P(obj|k=c)$ where α near 1 reflects a listener who weighs *e* more and is thus predicted to exhibit egocentric behavior; α near 0 is a listener who weighs *c* more, showing more adaptation to the speaker's knowledge. α is expected to vary across situations and listeners, depending on how the listener integrates various ground cues.

Our hypothesis is that the difference between [1] (egocentric behavior) and [4] (common ground behavior) is due to referential fit, and not different perspective-taking strategies (cf. [3,4]). Specifically, in our model the referential fit of the *RE* **in each of the two domains** influences reference resolution. Using elicited production data (A), we model comprehension conditions (B1-2), simulating experiments [1] and [4] respectively.

Production Experiment. Twenty participants instructed a confederate to click on images (interlocutors used different screens). *RE* data in four conditions (A) that correspond to domains *e* and *c* for (B1-2) were used to estimate the model's referential fit component. The model's response was qualitatively different for (B1) and (B2). In (B2) the target was a better fit to the *RE* than the competitor in domain *c*, and just as good a fit in domain *e*, so it should be preferred for any $\alpha \neq 1$. In (B1), the target was again a better fit to the *RE* in domain *c*, but not in domain *e* where the competitor was a better fit, so the target should be preferred for a smaller range of α , and more competition is expected from the (privileged) competitor.

Comprehension Experiment tested these predictions. Participants followed instructions from a confederate to click on images as their eye-movements were recorded. Preliminary results suggest (i) more looks to the competitor in (B1) than (B2) and (ii) response errors only in (B1). This supports our proposal that egocentric and common ground domains are considered simultaneously, allowing us to reconcile the apparently-contradictory results [1] and [4].

Production Experiment: displays from the participant's side (the speaker)

HIDDEN was a grey square with no object; the participant knew the listener saw an object.

(A1e) Triplet-Domain *e* big candle, medium candle, small candle, bowl.

(A1c) Triplet-Domain *c* HIDDEN, medium candle, small candle, bowl.

(A2e) Pairs-Domain *e* big candle, small candle, big bowl, small bowl.

(A2c) Pairs-Domain *c* big candle, small candle, big bowl, HIDDEN.

Comprehension Experiment: displays from the participant's side (the listener)

Objects privileged to the listener (**bolded**) had a grey background (not visible to the speaker).

(B1) Privileged-Triplet **big candle** [competitor], medium candle [target], small candle, bowl.

(B2) Privileged-Pairs big candle [target], small candle, big bowl [competitor], **small bowl**.

(B3) Control-Triplet big candle, medium candle, small candle, bowl.

(B4) Control-Pairs big candle, small candle, big bowl, small bowl.

Spoken instruction: "Click on the big candle"

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Brain responses to negation: An fMRI study with Japanese negative polarity items

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Negation; Negative polarity; Syntax; Semantics; fMRI; Japanese

Despite its common occurrence in daily communication, negation takes numerous forms. The combinations of semantic and syntactic structures that are used to form negated sentences reveal a complex and multi-faceted phenomenon. This study aimed to investigate how the brain contends with such complexity, and specifically, the areas of the brain responsible for processing Japanese sentences with SIKA, a negative polarity item that requires negation as its syntactic licenser (see (a) below), and the focus particle DAKE, whose inclusion in an affirmative sentence results in a semantic interpretation similar to that of the SIKA-negation sentence (see (b') below). In contrast to SIKA, DAKE does not require negation as a syntactic licenser. It was essential to contrast those sentences with SIKA and DAKE, as well as their controls, to disentangle the different processing factors involved in sentence comprehension, and to locate the brain regions responsible for them. The results showed that the left Inferior Frontal Gyrus (BA 44) is responsible for processing the syntactic licensing required by Japanese negative polarity SIKA. This process differs from that of computing a semantic interpretation associated with focus particles.

An event-related fMRI method was applied to investigate brain responses while readers read sentences displayed on a screen a single word at a time. As shown in the example materials below, SIKA or the focus particle DAKE was attached to the subject noun phrase in the main clause. Both negative and affirmative counterparts of the negative sentences were included in DAKE (b and b') and control (c and c') sentences. There was no significant difference in the accuracy of the comprehension questions provided after each sentence, which suggests that the different sentence types tested were understood equally well. SIKA sentences, which demanded negation as a syntactic licenser, showed increased activation in the left Inferior Frontal Gyrus (BA 44) and the left Insula, when compared against DAKE sentences as well as negative sentences without a focus particle. Enhanced activation of the left Inferior Parietal Lobule was also observed for SIKA sentences; this is likely due to the increased load on working memory required to compute the syntactic dependency involved, within the sentences. In processing sentences with a focus particle DAKE, a semantic network that comprises the left BA 47 and Angular Gyrus was activated. This was supported by comparisons between sentences with DAKE and those without a focus particle.

Overall, the results of this study suggest that different processes involved in interpreting Japanese negative polarity SIKA was supported by different, specific regions of the brain. That is, the left Inferior Frontal Gyrus is responsible for computing syntactic SIKA-negation dependencies, while the left Inferior Parietal Lobule is recruited when working memory load increases. The interpretation of focus particles is supported by an independent semantic network. Such results imply that the parser is equipped with mechanisms binding different levels of representation during on-line comprehension. The study's further implications for parsing theory will be discussed.

Materials Examples

a. SIKA-negation

[Tenmongakusya-sika [sinbunkisya-ga kaigan-de sinwakusei-o mokugekisita] toiukoto-o sinzinakatta.]
astronomer-SIKA reporter-NOM shore-on new planet-ACC witnessed (fact) that believed-NOT
Only the astronomer believed that a reporter spotted a new planet on shore.

b. DAKE-negation / b'. DAKE-affirmative

[Tenmongakusya-dake [sinbunkisya-ga kaigan-de sinwakusei-o mokugekisita] toiukoto-o sinzinakatta.]
astronomer-DAKE reporter-NOM shore-on new planet-ACC witnessed (fact) that believed-NOT
sinzimasita.]
believed

Only the astronomer (b. did not believe / b'. believed) that a reporter spotted a new planet on shore.

c. Control-negation / c'. Control-affirmative

[Tenmongakusya-wa [sinbunkisya-ga kaigan-de sinwakusei-o mokugekisita] toiukoto-o sinzinakatta.]
astronomer-WA reporter-NOM shore-on new planet-ACC witnessed (fact) that believed-NOT
sinzimasita.]
believed

Only the astronomer (c. did not believe / c'. believed) that a reporter spotted a new planet on shore.

The effect of sociolinguistic cues on dialectal speaker adaptation: A study on *pin-pen* merger

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Speaker adaptation; Visual world paradigm; American English dialect with pin/pen merger

Speaker adaptation takes place when a listener stores speaker-specific phonetic details in memory and uses such information for subsequent lexical processing. Past studies demonstrated that a brief exposure to speaker-specific pronunciations facilitates recognition of words previously unheard in the tested voices [1, 2]. Speaker-adaptation also leads to an immediate lexical re-organization, such that cohorts become non-cohorts when listening to a speaker with dialect-based allophonic variation [3]. Previous work, however, has examined adaptation to speakers in isolation, without taking into account preexisting sociolinguistic knowledge of listeners. The current study investigates the role of sociolinguistic stereotypes on perceptual expectations prior to adaptation and on the process of adaptation itself.

The experimental design used the *pin-pen* merger in which the front vowels /ɪ/ and /e/ are merged before nasal stops. In two eye-tracking experiments, merged and non-merged voices gave instructions for an object search task (e.g., "Click on the pencil") in three blocks. Each voice was paired throughout the task with a photo of a White or Black face in professional or non-professional dress, counter-balanced across participants. In Block1, three target /ɛn/-words were pronounced unambiguously by all four speakers, minimizing lexical competition if only vocal cues are used. Block2 presented /ɪn/-words, which for our merged speakers were moved to overlap with their /ɛn/-words, leading to higher competition between the target (e.g., fins) and its competitor (e.g., fence). The non-merged voices were predicted to remain unambiguous. Block3 presented the same words as Block1 plus three previously unheard /ɛn/-words. If listeners use their knowledge about speaker-specific pronunciations, their target detections should be delayed for merged-voices for both repeated and novel target words. In contrast, the detection of repeated words should become faster for non-merged voices, based on the speaker adaptation literature. Social cues, if used, should lead to greater competition in Block1 for voices paired with Black pictures and for non-professional pictures. If they also contribute to the adaptation process, we expect the adaptation to the merged voices to be facilitated for those pictures.

The results show clear effects of both speaker adaptation and pre-existing sociolinguistic stereotypes. Regardless of which voice was heard, Block1 showed higher lexical competition (e.g., between *pencil* and *pins*) when the race was Black and the dress was unprofessional, indicating a strong effect of visual cues on dialectal perception *before* listeners learned the voices. Block2 showed the expected higher lexical competition with merged than with non-merged voices, as the ambiguous tokens were encountered. In Block3, both previously heard and novel tokens /ɛn/-words from merged voices led to increased looks to the /ɪn/-word competitor compared to Block1. In contrast, non-merged voices showed reduced competition compared to Block1. Despite this clear evidence for adaptation based on speaker pronunciation, however, the influence of picture-triggered sociolinguistic expectations remained active in Block3, with non-professionally dressed, Black, merged speakers showed the highest competition effects. Thus, the results confirm rapid adaptation to speaker cues, including the adjustment of cohort effects, but also a perceptual effect of sociolinguistic stereotypes which survives exposure to speech tokens.

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The processing of case markers in near-native Mexican Spanish

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Non-native sentence processing; Case markers; Self-paced reading; Mexican Spanish

The Shallow Structure Hypothesis¹ claims that abstract and hierarchical elements of syntax are unavailable during non-native sentence processing and that verb argument roles are instead assigned on the basis of semantics, pragmatics, and general world knowledge. The present study tested this prediction by examining the non-native processing of case markers in Spanish, where case markers are critical to comprehension because of flexible word order.

A group of near-native speakers of Spanish ($n = 23$), all native English speakers residing in Mexico City, was screened for native-like general proficiency² and long-term residence ($m = 14.08$ years) in Spanish-speaking countries. The processing behavior of this near-native experimental group was then compared to that of native speakers of Mexican Spanish ($n = 35$) in a self-paced reading experiment with a phrase-by-phrase non-cumulative display. Two sets of experimental stimuli tested the processing of differential object marking of direct objects (20 items) and of double-object constructions with dative-marked indirect objects (20 items). As can be seen in the examples in (1) and (2) below, the two conditions for each type of stimulus varied with regard to the presence or absence of the appropriate case marker.

Reading time data for the two different stimulus types were analyzed separately. Mixed design ANOVAs and follow-up t -tests by subject and by item revealed an immediate effect at the site of the case violation in the differential object marking stimuli (Region 3), but only among the native speakers. The near-native participants showed no such effect at any point in this first set of stimuli. With the double-object constructions, on the other hand, both participant groups exhibited both an immediate effect at the point of the case violation (Region 4) and a spillover/wrap-up effect on the subsequent/sentence-final region of the stimuli (Region 5). Thus, the non-native participants in this study were sensitive to some violations of case marking, an outcome which contradicts the Shallow Structure Hypothesis. Furthermore, the hypothesis cannot account for the interesting observation that the non-native participants exhibited native-like sensitivity to violations of one type of case marking, yet were unaffected by violations of another type of case marking. Alternative explanations include the pre-verbal clitic *le* as a cue to look for a case marker and native language transfer from English.

- (1) a. Verónica \\\ visita \\\ al presidente \\\ todos los meses. *Grammatical*
 b. Verónica \\\ visita \\\ el presidente \\\ todos los meses. *Case Violation*
 “Veronica visits the president every month.”
- (2) a. La empresa \\\ le dio \\\ un aumento \\\ al director \\\ este año. *Grammatical*
 b. La empresa \\\ le dio \\\ un aumento \\\ el director \\\ este año. *Case Violation*
 “The corporation gave the director a raise this year.”

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Processing English object relatives: Where L2 sentence processing differs from L1

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L1-L2 processing; Relative clauses; Cognitive control; Self-paced reading; Stroop; English

Recent accounts of syntactic difficulties that advanced second-language (L2) learners experience in their L2 (e.g., Sorace, 2011) hypothesize that the underlying cause is the allocation of processing resources. L2 learners employ less-automatic procedures than native speakers, and need to suppress their other language, leading to fewer processing resources to process complex constructions in their L2. We sought to further test this hypothesis by investigating the processing of cross-language structural ambiguities. If L2 speakers need to suppress their L1, the differences between native speakers and L2 learners will become most apparent in such constructions. Furthermore, we predicted that L2 learners with better ability to suppress prepotent information (better cognitive control) will more closely resemble L1 speakers.

We tested 39 native speakers of English, and 71 advanced Dutch late learners of English on English proficiency measures (Peabody Vocabulary, word naming task, C-test) and cognitive control tests (Stroop, Trails, Attentional Network Task). In addition, participants completed a moving-window self-paced reading task in English, which included object relatives as in (1). The relative clause subject was either plural (1a, b) or singular (1c, d); the auxiliary in the relative clause either agreed with the relative clause subject (1a, c) or did not (1b, d). For Dutch learners of English, (1b) creates a potential language conflict since this structure corresponds to a grammatical subject-relative in Dutch (2); (1c) is ambiguous between a subject and an object relative in Dutch. We predicted that Dutch learners of English would be more likely than the native English participants to assign a subject-relative interpretation to English object relatives, and to show a smaller grammaticality effect in the conflict condition (1b) vs. (1a) than in the non-conflict condition (1d) vs. (1c), compared with native English speakers. In addition, we expected these effects to be modulated by cognitive control and English proficiency.

Performance on end-of-sentence questions probing thematic relations suggested that the L2 group selected a subject-relative interpretation more often than the native English for (b), (c) and (d), even though the L2 learners knew the grammar of English object relatives. In the self-paced reading data, the L2 learners showed a smaller and later grammaticality effect ((1b, d) vs. (1a, c)) than native English speakers. This grammaticality effect was stronger and started earlier in L2 learners who had a smaller Stroop effect (better cognitive control), but did not correlate with proficiency. The grammaticality effect in the native English speakers was not affected by cognitive control. In contrast to expectation, the on-line data showed no difference in the grammaticality effect between the conflict (plural subject) and non-conflict (singular subject) conditions in either group.

Our findings suggest that L2 speakers experience L1 interference off-line, but not while processing local agreement relations on-line. In addition, L2 learners with better cognitive control more closely resemble native speakers regarding the timing and size of the on-line effects in complex constructions. This supports the view that native and L2 speakers differ in resource allocation during sentence processing, but that this is not related to suppressing conflicting L2 information.

1a. **[plural subject, grammatical]** Over there is the stewardess who the passengers **have** insulted during the flight.

1b. **[plural subject, ungrammatical]** Over there is the stewardess who the passengers ***has** insulted during the flight.

1c. **[singular subject, grammatical]** Over there is the stewardess who the passenger **has** insulted during the flight.

1d. **[singular subject, ungrammatical]** Over there is the stewardess who the passenger ***have** insulted during the flight.

2. Daar is de stewardess die de passagiers heeft beledigd tijdens de vlucht.

there is the stewardess who the passengers has insulted during the flight

“Over there is the stewardess who the passengers has insulted during the flight.”

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A discourse explanation for ellipsis parallelism effects

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Ellipsis; Parallelism; Discourse processing

Verb phrase ellipsis is formed by omission of a verbal constituent, for which an interpretation must be supplied by context. Ellipsis acceptability appears to be conditioned on the syntactic structure of the antecedent clause, and various proposals implicate syntax in the processing of ellipsis. These hold alternately that ellipsis interpretation requires retrieval of syntactic structure [1,2], that non-parallel antecedents require post-retrieval 'repair' [2], and that the parser favors antecedents of a particular syntactic type [2,3].

An alternative view models ellipsis resolution as a form of discourse-based inference. While syntactic parallelism effects have traditionally posed a challenge for this approach, we propose a solution. We take as a starting point the resolution algorithm proposed in [4], which holds that the first step to interpretation is the identification of thematically parallel referents. We hypothesized that parallelism effects might be explained as a disruption of this crucial first step. We report findings from two self-paced moving-window reading time studies as evidence.

Experiment 1 compared parallel and non-parallel ellipses following either a lexical NP or pronominal subject (1)-(2). Where syntax-based accounts predict a penalty for both non-parallel conditions, we predicted an interaction where only the lexical NP condition is affected. This follows because the pronouns were unambiguous, facilitating identification of parallel referents via co-reference. For lexical NPs, however, we predicted a lack of parallelism would make it harder to identify thematically parallel referents. Analysis of residual reading times in the target clause showed an interaction between parallelism and NP type at the target subject (consistent with the identification of linguistic focus in the lexical NP condition) and a main effect of NP type at the ellipsis site, where reading times were faster following pronominal subjects. No effects were observed in the spill-over region following the ellipsis, and notably, no main effects of parallelism were observed in any region.

For **Experiment 2** we predicted that the advantage seen previously at the ellipsis site for pronominal subjects might be eliminated using ambiguous pronouns. To that end we compared parallel and non-parallel ellipses following ambiguous and unambiguous pronominal subjects (3)-(4). Analysis of raw reading times in the target clause showed no effects at the target subject. At the ellipsis site, non-parallelism led to a reliable increase in reading times only in the ambiguous pronoun condition. This pattern suggests readers preferentially interpreted the ambiguous pronoun as co-referent with the subject of the antecedent clause, a reference pattern that was ultimately confirmed at the ellipsis region in the parallel condition, but not in the non-parallel condition. Unlike Experiment 1, a main effect of parallelism was observed in the spill-over region following the ellipsis.

These results demonstrate an *indirect* effect of syntactic parallelism on ellipsis processing, which is modulated by the referential properties of the subject NP preceding the ellipsis.

Exp 1 (n=48)	(1) The rangers didn't inspect the campsite as thoroughly as a. ... the firefighters did after the big blaze. b. ... it could have been after the big blaze.	[lexical NP, parallel] [pronoun, non-parallel]
	(2) The campsite wasn't inspected by the rangers as thoroughly as a. ... the firefighters did after the big blaze. b. ... it could have been after the big blaze.	[lexical NP, non-parallel] [pronoun, parallel]
Exp 2 (n=40)	(3) a. The interview wasn't conducted by the officers as quickly as b. The officers didn't conduct the interview as quickly as ... it could have been at the crime scene.	[unambiguous, parallel] [unambiguous, non-parallel]
	(4) a. The interviews weren't conducted by the officers as quickly as b. The officers didn't conduct the interviews as quickly as ... they could have been at the crime scene.	[ambiguous, parallel] [ambiguous, non-parallel]

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Interference-insensitive local anaphora resolution: Evidence from Hindi reciprocals

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Reciprocals; Retrieval; Parsing; Hindi

It has been observed that antecedent-retrieval for English reflexives is robust to interference from similar, but structurally illicit constituents. These findings of apparent immunity-to-interference in local anaphoric binding suggest that c-command-sensitive dependencies can be implemented on-line [1,2,3,4,5]. These findings have been used, most recently, to argue for a structure-sensitive, rather than a content-addressable retrieval mechanism for reflexive antecedents (though see [6] for discussion of interference with reflexives in Chinese).

Yet, findings on English local binding cannot conclusively determine whether a structure-sensitive search procedure is employed, or whether some other method is employed. English reflexives require a clause-mate antecedent, and they follow the verb, which raises the possibility that grammatically accurate retrieval might be achieved simply through a verb-mediated heuristic, e.g., by retrieving the agent of the immediately preceding verb. We avoid this confound of previous studies by testing local binding relations in Hindi, a verb-final

language, that must be established before verb information is encountered. The results of a self-paced reading experiment show that the structure-sensitivity of antecedent-retrieval is not due to a verb-mediated strategy.

The design of the experiment used the interference logic of previous reflexive studies, using reciprocals in Hindi. Hindi reciprocals must be locally licensed [7], like their English counterparts, but since Hindi is an SOV language they appear pre-verbally, thus making antecedent-retrieval through mediation by the verb's argument structure impossible. Reciprocals must be bound by a plural-marked, c-commanding NP, thus the diagnostic content cue for retrieval (apart from structural cues) is [+plural]. The experiment manipulated plural-marking on the main clause subject and on a potential interfering NP in a pre-nominal relative clause (RC) that linearly

preceded the reciprocal. The structure of a test-sentence is given in (1) below. When NP1 (the main clause subject) is plural it can bind the reciprocal. NP2, embedded inside an RC (boundaries marked with brackets), cannot grammatically bind the reciprocal, regardless of its number. In (2) the main clause subject *doctor(s)* (underlined) can bind the reciprocal *ek-dusre* when plural. The potential interferer NP *patient(s)* (italicized) is embedded inside a pre-verbal RC *the nurse who took care of the patients*, where it cannot bind the reciprocal.

If relational information restricts the search for potential binders, no effect of plural-marking on *patient(s)* is expected. If verb-mediated retrieval is required to block interference, we expect interference from *patients*.

24 sets of items were distributed across 4 lists in a Latin Square design and combined with 50 filler items. The experiment ($n=30$, native-speakers of Hindi from Northwestern India, ages 18-26, tested in Delhi) revealed immediate sensitivity to the constraint on reciprocal licensing. Data were fit to a mixed effects linear model with Subject and Item as random effects [8]. A main effect of main-clause subject match (in number) was observed in the region immediately following the reciprocal phrase ($p < .05$), and no interaction with the number of the interfering subject noun.

The results support the hypothesis that relational information, not a verb-mediated heuristic, constrains retrieval.

(1) NP1{sg/pl} [... NP2{sg/pl} ...] ... Reciprocal... {AdvP} V.

(2) उस डॉक्टर(ों) ने मरीज़(ों)-को देखभाल करने वाली नर्स के स्टेशन में

Us/un doctor(on)-ne [mariz(on)-ko dekhbhal karne wali] nurse ke station me

That/those doctor(s)-ERG patients(s)-ACC care doing RP nurse GEN station in

एक-दूसरे के बारे में गुप्त रूप से बात की।

ek-dusre ke-bare me gupt-ruup-se baat kii.

one-another about secretly chat did.

'That/those doctor(s) talked secretly with one another at the station of the nurse who was looking after the patient(s).'

Early bilinguals' on-line use of lexical and grammatical information in sentence processing

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L1-L2 processing; Nominal control construction; Eye-tracking; Self-paced reading; English

According to the Shallow Structure Hypothesis (Clahsen and Felser, 2006), L2 speakers fail to build detailed structural representations of the L2 during on-line sentence processing, and tend to rely on lexical semantics rather than grammatical structure. In the current study, we investigate early bilinguals' on-line use of lexical and grammatical information in sentence processing. Our participants are early bilinguals from the multi-linguistic community of Singapore, who use both English and Chinese in daily life. They differ from the late bilingual populations typically studied in L2 experiments. Thus the study allows us to test the generality of the application of the shallow structure hypothesis.

Here, we report a self-paced reading experiment that probed for the on-line use of nominal control information. Control constructions varied with respect to the thematic roles of the controller: giver (GvC: refusal (1)) and recipient (RpC: request (2)) control). Match and mismatch conditions were created using a reflexive gender matching paradigm. We assumed that, if the control information was used online, and the reflexive interpreted in accordance with Principle A, then processing difficulty will be found when the reflexive refers to a PRO with mismatching gender (1b,2b) relative to matching gender (1a,2a).

Reading times at the reflexive showed an interaction of control*matching, with a mismatch cost for the Recipient control conditions, but a match cost for the Giver conditions. This early effect can be interpreted in terms of a recency strategy, where PRO initially targets the most recent potential antecedent (e.g. "Janet" in 1,2) as a referent, ignoring the lexical control information, leading to difficulty when the reflexive gender mismatches this. However, two words downstream from the reflexive, there was an overall effect of matching, with longer reading times for the mismatching conditions in general, suggesting that the final interpretation of PRO was in line with the control information.

These results suggest that our population of early bilinguals showed a delay in the use of detailed grammatical and lexical information in sentence processing. A companion experiment run on monolingual English speakers using the same stimuli (but using eye-tracking) showed a mismatch cost for both types of control condition, with no evidence of an early phase ignoring control information. However, the monolingual speakers did show a small increase in regressions out of the infinitival region ("to dress") for Giver control relative to Recipient control, suggesting that the assignment of PRO to the non-recent antecedent caused measurable processing difficulty, although unlike for the bilingual speakers, this did not influence the choice of antecedent for PRO.

Overall, our results suggest that while early bilinguals are able to apply grammatical and lexical knowledge (Principle A and control information) to on-line sentence processing, lexical information can be ignored in early stages of processing. Thus the early bilinguals appear to occupy an intermediate position between L1 speakers and late bilinguals, though their difficulty appears to lie in the use of lexical (semantic) information, rather than in grammatical structure building.

(1a) Giver control (GvC) Match

Apparently David's promise to Janet to dress himself in comfortable clothing went unheeded.

(1b) Giver control (GvC) Mismatch

Apparently David's promise to Janet to dress herself in comfortable clothing went unheeded.

(2a) Recipient control (GvC) Match

Apparently David's reminder to Janet to dress herself in comfortable clothing went unheeded.

(2b) Recipient control (GvC) Mismatch

Apparently David's reminder to Janet to dress himself in comfortable clothing went unheeded.

Speech rate mediated compensation for assimilation in spoken word recognition

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Spoken word recognition; Speech rate; Visual world paradigm

The role of speech rate has received relatively little attention in spoken word recognition, although speech production studies have shown that it can alter patterns of coarticulation and assimilation (e.g. [1]). Previous studies have shown that listeners can compensate for coarticulation, perceiving identical sounds differently in different contexts (e.g. [4]). In addition, listeners may also compensate for assimilation ([3]), a phenomenon observable in sentences like “A quick *run* picks you up.” Here, *run* may sound like *rum* when /n/ becomes assimilated to /m/ due to the influence of /p/. We wanted to test whether listeners’ processing of (potentially) assimilated sounds is sensitive to speech rate. Given that faster speech rates are associated with more coarticulation, *run* may be more acoustically similar to *rum* at faster speech rates than slower speech rates. Therefore, when identical lexically-ambiguous forms resulting from coronal assimilation are presented to listeners, we predict that these forms should be (i) more likely to be interpreted as the unassimilated form (e.g. *run*) when embedded in fast speech rates but (ii) more likely to be interpreted as the assimilated form (e.g. *rum*) when embedded in slower rates.

To test whether speech rate influences the interpretation of lexically-ambiguous forms, we conducted a **visual-world eye-tracking study**. Target sequences (noun+verb) were spliced into carrier phrases with different speech rates (fast/medium/slow, ex.1). The critical noun+verb sequences had two different coarticulation overlap patterns between the noun and verb (less overlap=more /n/-like vs. more overlap=more /m/-like), elicited with different prosodic contexts. Thus, we had a 3x2 design (36 targets, 50 fillers). To avoid neighborhood-density or plausibility confounds, critical nouns were nonwords: Participants were taught the nonwords were the names of aliens. Participants (n=24) listened to sentences and saw displays showing different aliens, two of which were the critical images (e.g. pictures of aliens called *Vone* and *Vome*). They were instructed to click on the alien mentioned.

Results: Eye-movement patterns show speech rate x overlap interaction 100-300ms and 400-600ms after alien-name onset ($p < .05$). More specifically, in the ‘more overlap’ conditions (more /m/-like), participants are more likely to look to the unassimilated form (e.g. *Vone*) in the fast and medium speech-rate conditions, but in the slow speech-rate condition, there are more looks to the assimilated form (e.g. *Vome*). In the ‘less overlap’ conditions (more /n/-like), participants tend to look at the unassimilated form in the slow speech-rate condition instead.

Conclusions: Even with identical acoustic materials, listeners’ online interpretations of ambiguous words are influenced by the speech rate of the surrounding carrier sentence. These findings are consistent with work on speech rate and perception of function words ([2]), as well as research showing that listeners are sensitive to sub-phonemic variation (e.g. [5]). While existing theories may accommodate our findings in different ways, the general point that emerges from our study is the importance of including speech rate in models of spoken recognition.

(1)	Carrier phrase part 1	Target N+V sequence	Carrier phrase part 2
	Every time the waiter brings out a strawberry cheesecake from the kitchen,	Vone peeks or Vome, peeks	to see if he can steal a piece.
	Fast, medium, or slow	Less or more overlap	Fast, medium, or slow

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The subtleties of frequency in morphological processing

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Morphological processing; Lexical decision; English

Overview: The role of frequency is a long-standing issue in probing the mechanisms of lexical processing. We explore the effects of frequency in lexical decision by using mega-study-scale data and mixed effects modeling to evaluate the claims of Alegre and Gordon (1999) and Baayen et al. (2007) (henceforth AG1999, B2007) regarding word frequency and present a more nuanced view of frequency effects.

Procedure: We modeled the English Lexicon Project (Balota et al., 2007) database of visual lexical decision trials, analyzing 192,117 correct-response trials of regularly inflected (-s, -ed, -ing) English words for which reliable word and base frequency estimates could be obtained. Mixed effects linear regression models of log reaction time (RT) were fitted with a random effect for subjects and fixed effects of trial number, education level, gender, and item-based predictors: squared orthographic length (New et al., 2006), orthographic neighborhood size (Yarkoni et al., 2008), word frequency (SUBTLEX norms), base (also called root/cluster) frequency, conditional probability of suffix given base, and suffix frequency. Residualization was performed among correlated predictors to eliminate multicollinearity (see Gorman, 2010, for the residualization strategy employed).

Frequency effects: We found significant effects ($pMCMC = .0001$) for all other fixed effects, but no significant effect ($pMCMC = 0.5344$) of word frequency on reaction times after base frequency and other multicollinear predictors (length, neighborhood density, stem/suffix conditional probability) were accounted for.

We additionally modeled the residuals of a mixed effects model that did not include word frequency as a predictor, allowing us to determine the contribution of frequency while other predictors were controlled for. We compared trials of words whose base frequency was near the .10, .25, .50, .75, and .90 quantiles, grouping trials by whether they were base- or word-frequency dominant and using a Bonferroni corrected two-tailed Wilcoxon rank sum test to compare groups within each quantile. At the lowest base frequency quantile (.10), higher word frequency inhibited RT ($p = 0.0046$); at one higher quantile (.75) it facilitated it ($p = .0034$). It was not significant elsewhere. We conclude that, consistent with fully decompositional approaches (Taft, 2004) and contrary to the claims of B2007, when base frequency is correctly accounted for, word frequency plays only a marginal role and its contribution varies drastically across base frequency ranges. AG1999 claimed that there is a threshold above which word frequency should have a linear effect beyond base frequency; after exploring a range of possible thresholds we were unable to replicate this on our larger dataset.

Effect of norms: We found that if we instead used norms based on a smaller sample, such as the Francis and Kučera norms used by AG1999 or the CELEX norms used by B2007, frequency was a significant predictor ($pMCMC = .0001$) even when properly residualized, demonstrating the impact of norm selection. We conclude that the disparity between the AG1999 and B2007 findings and the current study is best explained by methodological issues stemming from their use of poor frequency estimates (Burgess and Livesay, 1998).

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Quantity judgments in Yudja (Tupi)

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Count/mass distinction; Quantity judgments; Sentence-picture matching; Yudja

Three studies explored the semantics of the count-mass distinction in Yudja (Tupi; Brazil). It has been claimed that there is no count-mass distinction in Yudja; all nouns can be counted after combining with a contextual atomic function f_c that maps their basic denotation to a set of atoms (Lima 2010). We tested whether speakers make a distinction between notional mass nouns such as *y'a* 'water' and notional count nouns such as *karaxu* 'spoon' in tasks involving the evaluation of a quantity of objects/stuff. A total of 18 adults and 22 children (7, 2-5 years old and 15, 6-11 years old) participated in the studies. The studies were based on Barner and Snedeker (2005) and were fully prepared and elicited in Yudja. A control group with 10 Brazilian Portuguese adults responded the same as English adults have in prior studies (Barner and Snedeker 2005).

Study 1 While presenting two different drawings one with a big portion of *X* (Quantity) and another with many different portions of *X* (Number), we asked:

	<i>Ma de bitu</i>	<i>X</i>	<i>dju au?</i>	
	Who more	<i>X</i>	have	'Who has more <i>X</i> ?'

Results Subjects answered 3 questions with a notional mass noun (e.g., *asa* 'flour'), 3 questions with a notional count noun (e.g., *xaa* 'bowl') and 2 questions with a notional fake mass noun (e.g., *abeata* 'clothes'). Participants had to point to one of the drawings to answer the question. Independent evidence in Yudja shows that *bitu* 'more' does not bias Number or Quantity. **Results** Yudja adults and 2-5 years old children favored the Number criterion for all nouns. 6-11 years old children old disfavor the Number criterion for all nouns (Table 1).

Study 2 We tested whether the results from Study 1 for adults are an effect of a strong dispreference for a single big portion of *X* in comparison to many portions of *X*. We asked the questions presented in Study 1 accompanied by two drawings: one with two big portions of *X* and another with six small portions of *X*. **Results** All three groups tested kept the pattern observed in Study 1 (see Table 1).

Study 3 In principle, Studies 1 and 2 may suggest an absence of a conceptual distinction between Quantity and Number. In Study 3, children saw the drawings presented in Study 1 and answered two different questions:

<i>Ma de</i> (1) <i>itxibi/</i> (2) <i>urahu X dju a'u?</i>				
Who (1) many/(2) a lot <i>X</i> with have?				'Who has (1) many portions/ (2) a big portion of <i>X</i> ?'

The issue was whether children would establish a conceptual difference between Quantity and Number. These quantifiers enforce this distinction and are unambiguous. **Results** Children associated *urahu* to Quantity and *itxibi* to Number (Table 2). In other words, they conceptually distinguish Quantity from Number.

Conclusion the studies show that Yudja adults and young children tend to conceptualize as count both nouns that are count and nouns that are mass cross-linguistically. Older children show a different pattern, which may suggest a 'u' curve in the acquisition path and/or influence of external factors (e.g., exposure to Portuguese in school).

Table 1. 'Number' responses in Study 1 and 2 (in percentage)

	Notional count nouns		Notional mass nouns		Notional fake mass nouns	
	Study 1	Study 2	Study 1	Study 2	Study 1	Study 2
Adults	85%	83%	87%	72%	81%	78%
Children (2-5)	62%	57%	52%	57%	71%	71%
Children (6-11)	33%	20%	27%	27%	43%	27%

Table 2. Quantifiers *urahu* (Quantity) and *itxibi* (Number) – Study 3 (in percentage)

	Notional count nouns	Notional mass nouns	Notional fake mass nouns
	Adults	100%	100%
Children (2-5)	67%	67%	72 %
Children (6-11)	98%	85%	94%

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Shared processes in passives and unaccusatives: Evidence from ERPs

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Derived subjects; Unaccusativity; Passives; Unergatives; Event Related Potentials (ERPs); N400; P600; English

The subjects of passives and unaccusatives are similar in that they are both interpreted as themes, unlike subjects of typical transitives and unergatives. This similarity is thought to result from a shared syntactic structure: both passives and unaccusatives involve movement of an underlying object to surface subject position (Burzio, 1986). Previous research using behavioral techniques appears to confirm this hypothesis by showing evidence of reactivation of the surface subject in the trace position (Friedmann et al., 2008). However, these results could also be attributed to the fact that the surface subjects in both constructions share the same thematic role (i.e., theme); thus, reactivation effects could be indexing thematic mapping operations (Melinger, 2006), and not movement. One way to differentiate between these structural and interpretive processes is to use techniques and measures that are differentially sensitive to the two types of processing.

Here, we used event-related potentials (ERPs) to distinguish between structural and thematic processes by assuming a time-course model of language processing proposed by Friederici (2005). We predicted that passives and unaccusatives would result in additional processes (representing either movement or thematic mapping operations) that would be evidenced by differences in ERP activity compared to unergatives (which require no additional processing). We further predicted that if reactivation effects are related to movement, we would see modulation of ERP components associated with structural processing (i.e., early left anterior negativity (eLAN) and/or P600) for both passives and unaccusatives compared to unergatives. Alternatively, if reactivation involves thematic mapping, we would see modulation of ERP components associated with argument and lexical processing (e.g., LAN and N400).

Fourteen adults read 192 randomly ordered sentences comprising a 3x2 design (verb type x plausibility) (Table 1). The subject noun phrase was always animate so as to bias the parser to adopt an initial agent interpretation for all three verb types. Since N400s are elicited by factors other than thematic interpretation, plausibility was also manipulated to provide additional evidence that LAN/N400 responses were sensitive to thematic interpretation. Sentences were presented visually, word-by-word (650ms, 50ms ISI), and ERPs were time-locked to the onset of the main verb. Results of a grand average and a temporal-spatial principal components analysis revealed that the earliest point of difference between conditions was at approximately 400ms. Passives and unaccusatives elicited a centrally-distributed N400 effect compared to unergatives. In addition, there was also a significant verb x plausibility interaction, with implausible unergatives more negative compared to plausible unergatives only.

We take these findings as evidence for a thematic account of the similarities between passives and unaccusatives. Under this view, the larger amplitude N400 for the passives and unaccusatives compared to the unergatives reflects more effortful mapping of the initial agent interpretation to the required theme interpretation for that subject. The absence of plausibility effects on passives and unaccusatives suggests that this thematic reanalysis stage may have blocked or delayed plausibility evaluation for subjects in these constructions. However, plausibility evaluation was preserved in unergatives in which there was no conflict between thematic interpretations of the subject.

Table 1

Verb type/Plausibility	Plausible	Implausible
Passive	The general was saluted	The dancer was saluted
Unaccusative	The lover had swooned	The cop had swooned
Unergative	The newborn had cried	The builder had cried

Binding accessibility and online anaphora processing

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Anaphora processing; Eye-tracking; English

How do binding constraints influence the online processing of reflexive anaphors? According to the *binding-as-initial-filter hypothesis* (Nicol & Swinney, 1989), Principle A applies early in sentence processing such that only grammatically accessible noun phrases (NPs) are entertained as antecedents for reflexives. The *defeasible filter hypothesis* (Sturt, 2003), on the other hand, posits a more flexible system. Under this model, although Principle A constrains the earliest stage of processing, binding-inaccessible antecedents can be considered at later stages, particularly if they are in structurally-prominent (c-commanding) positions and are focused in discourse. An alternative is that the processing of reflexives is *not* initially constrained by Principle A (for such a proposal, see Badecker & Straub, 2002). The model proposed here is that reflexives trigger an antecedent search that considers both binding-accessible and -inaccessible antecedents, particularly if the latter are in local subject positions. This proposal will be referred to as the *constrained local search (CLS) hypothesis*.

These competing models were tested ($N=40$) by examining eye movements/reading time (RT) patterns on sentences (i) in which the main-clause subject was modified by either a subject- or object-extracted relative clause (SRC or ORC) and (ii) in which this subject matched or mismatched the gender of the NP in the RC (see the example sentences).

Predictions: Both the binding-as-initial-filter hypothesis and the defeasible filter hypothesis predict that only the binding-accessible, main-clause subject (*lady*) will be considered as the antecedent of the reflexive (*herself*). The CLS hypothesis, however, predicts that both the main-clause subject (*lady*) and RC NP (*princess/prince*) will initially be entertained as antecedents, particularly when the latter is the subject of an intervening ORC. Unlike the other two models, this hypothesis therefore predicts processing difficulty at the reflexive in ORC sentences.

Results: In line with other studies (e.g., Gordon et al., 2006), longer RTs were obtained across measures at the RC in ORC sentences. Consistent with the CLS hypothesis, the results also indicated that both the main-clause subject and the binding-inaccessible ORC subject were initially entertained as antecedents. Longer first-pass, regression-path, and total RTs were found at the reflexive in ORC sentences. Separable processing costs in these sentences suggest that these effects are unlikely due to spill-over from the RC. In the region after the reflexive, ORC/mismatched sentences induced more first-pass regressions than their matched counterparts, indicating a persistent mismatch effect. Furthermore, ORC/matched sentences incurred longer total RTs than all other sentence types at the main clause subject, suggesting heightened confusion about the correct antecedent for the reflexive in these sentences. This interference was also evident in participants' performance on comprehension questions, which targeted the antecedent of the reflexive (*Who got pricked by the rose?*). The incorrect antecedent was selected most often for ORC/matched sentences, indicating difficulty recovering the correct antecedent-anaphor link after an initial misparse.

Conclusion: The results suggest that binding theory constraints do not apply at the earliest stage of processing. Rather, both binding-accessible and binding-inaccessible NPs, and in particular those in local subject positions, appear to be considered potential antecedents for reflexive anaphors.

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Example Sentences (with demarcated regions of interest)

- SRC/matched: The **lady** that | greeted the **princess** | pricked | herself | on a rose | in the garden. |
 SRC/mismatched: The **lady** that | greeted the **prince** | pricked | herself | on a rose | in the garden. |
 ORC/matched: The **lady** that | the **princess** greeted | pricked | herself | on a rose | in the garden. |
 ORC/mismatched: The **lady** that | the **prince** greeted | pricked | herself | on a rose | in the garden. |

Broca's area shows a distance effect for both syntactic movement and backwards anaphora in fMRI

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Syntactic movement; Backwards anaphora; Broca's area; fMRI

The processing of sentences sometimes requires the computation of long-distance dependencies, or relationships between non-adjacent elements of a sentence. One example is syntactic movement, whereby a moved element, the filler, must be linked with its original position in the sentence, the gap (*Which song* did the band that won the contest play ___?) Another example is referential binding, whereby a pronoun is linked with its antecedent (*The man* went to the store because *he* wanted a carton of milk). Previous research has documented increased activation in the anterior portion of Broca's area in fMRI for sentences with syntactic movement with a longer distance between filler and gap, but not for sentences with referential binding with longer distance between antecedent and pronoun (Santi & Grodzinsky, 2007). Santi and Grodzinsky interpret these results to suggest that this region in Broca's area responds *selectively* to syntactic movement, and not to other processes involved in dependency resolution. However, the dependency resolution processes involved for syntactic movement are online and active (Stowe, 1986; Frazier & Flores D'Arcais, 1989) given that the presence of a filler predicts a gap, whereas the dependency resolution processes for standard binding generate no such prediction (Kazanina, 2007). Therefore, the lack of a distance effect obtained by Santi & Grodzinsky (2007) for the binding condition in Broca's area does not rule out the possibility that the activation for movement reflects other dependency resolution processes, such as working memory or the active search for a gap. The current study corrects for this by using backwards anaphora, wherein the pronoun *precedes* the antecedent, creating an online prediction for the antecedent (Because *he* wanted a carton of milk, *the man* went to the store). We manipulated distance by inserting a relative clause either between the filler and gap in WH-movement sentences or between pronoun and antecedent in backwards anaphora sentences. This created a 2x2 design with factors construction (WH-movement, backwards anaphora) and distance (short, long). In addition, two other conditions were added: semantically anomalous sentences and a speech articulation task (repeat the sequence /pa/.../ta/.../ka/ subvocally for 5s). All conditions were presented randomly within each experimental run; sentences were presented auditorily. The semantically anomalous sentences were constructed by creating WH-movement and backwards anaphora sentences of both short and long distances and creating a selection restriction or thematic role violation (*Which car* did the squirrel that had a fuzzy tail drive ___?) The subjects were instructed to press a button if they heard a sentence that was unusual in meaning; this was to ensure that subjects paid attention throughout the experiment. The subvocal articulation condition was included to test the hypothesis that at least some activation in Broca's area might be due to verbal working memory, according to Rogalsky et al. (2008). Each experimental trial had duration of 10s: onset of the stimulus jittered by 0-1.5s, followed by stimulus of length 3.5-5.5s, followed by a variable length of silence until the next run. Subjects were cued to articulate by a flickering fixation point that lasted for 5s. Subjects were scanned in 10 functional runs of 5min 15s duration and 1 anatomical scan at the Philips Achieva 3T scanner on the UCI campus. Whole brain data were collected using a gradient-echo EPI sequence with the following parameters: TR=2s, TE=30ms, matrix=110x90, FOV=220x180mm, 43 sequential ascending slices with 3mm slice thickness (0.5mm gap) resulting in 2x2x3.5mm voxel dimensions, flip angle=90°. The data were analyzed in AFNI with standard preprocessing steps, and a regression analysis performed on each subject's individual data. Regression coefficients from each subject were entered into a second level random-effects analysis using AFNI's 3dANOVA2 function. Our results revealed a main effect of distance as well as simple effects of distance for both constructions in the anterior portion of Broca's area. The fact that backwards anaphora produced distance effects as well as movement constructions suggest that this region's involvement in sentence processing is not restricted to movement *per se*, but another dependency resolution process such as working memory or the active search for a gap/antecedent. Further research is required to determine whether these activations reflect a more general linguistic process such as thematic role checking (Caplan et al., 2008) or semantic unification (Hagoort et al., 2005), or if they reflect a non-linguistic process such as cognitive control (Novick et al., 2005).

Reconstruction of censored taboo words in sentence processing

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Reconstruction; Taboo; Censorship; Eye-tracking; Recognition; English

Natural language has characteristics that are not typically considered in traditional language processing research such as disfluencies, slips of the tongue, and taboo words. However, when a taboo word (damn) is censored (d@*m), this offers an opportunity to study lexical access where the underlying form of a word must be reconstructed before lexical access can occur. We hypothesize that this reconstruction process is costly for word processing, but ultimately provides the comprehender with a representation that is similar to the taboo version.

While censored taboo words have not received much attention in the literature, studies of uncensored taboo word processing provide evidence for an internal monitor in language production (Severens, Janssens, Kühn, Brass, & Hartsuiker, 2011), and reveal that taboo words produce Stroop-like effects, suggesting that they are processed automatically (Mackay & Ahmetzhanov, 2005). Although taboo words are automatically accessed, censored taboo words may not be, leading to slower lexical processing. If comprehenders reconstruct underlying forms, censored and uncensored sentences may be similar in memory, similar to the phoneme restoration effect (Warren, 1970).

We examined these predictions using an eye-tracking reading task followed by a memory recognition task. In the eye-tracking task, participants read a sentence containing a taboo ("damn"), censored ("d@*n"), or neutral word ("hard") which were contextually appropriate and matched in length. Subsequently, participants completed a recognition task in which half of the sentences were altered and half were unaltered. The critical word in the conditions was manipulated so all possible alterations were included and counterbalanced across subjects.

Results from the eye-tracking study showed that subjects process taboo words similar to censored and neutral words in early (first-pass) reading measures but faster in late (total) reading measures (Table 1). This suggests that subjects required additional time to process and reconstruct the censored word. Additionally, this reconstruction effect was mediated by a learning effect: processing time for censored words decreased over the course of the experiment relative to taboo words in both early and late reading measures.

The memory task revealed that while subjects were highly accurate on taboo-to-neutral and censored-to-neutral alterations, they were less accurate on taboo-to-censored and censored-to-taboo alterations (Table 2). Reading measures, however, did not predict performance in memory task. These results suggest that subjects could distinguish censored and taboo words from neutral words but confused censored and taboo words. Thus, while taboo and censored words were processed differently, they became similarly represented in memory.

This study provides the first evidence, to our knowledge, for mechanisms involved in the processing of censored taboo words. The faster processing of taboo words relative to neutral words suggests that taboo words are easier to process whereas censored taboo words are treated differently during processing. The comprehender spends time reconstructing censored items, resulting in their final representation being similar, if not identical, to those of non-censored taboo words. A second experiment is being run that matches taboo and neutral words on frequency and adds censored neutral words (mess → m**s) to examine reconstruction of censored neutral words as well.

Table 1

Reading Measures in Sentence Processing Task

Condition	First-Pass (ms)	Total-Time (ms)
Censor	300	387**
Neutral	286	385**
Taboo	276	306

** p < 0.01 in comparison to taboo

Table 2

Accuracy in memory task

Read Condition	Altered Condition		
	Censor	Taboo	Neutral
Censor	0.79	0.41	0.94
Taboo	0.26	0.74	0.88
Neutral	0.69	0.64	0.65

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Backward NPI dependencies in Dutch: An ERP investigation

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Negative polarity items; Active search; Backward dependencies; Negation; Event Related Potentials (ERPs); Dutch

The backward licensing of dependencies constituted by a Negative Polarity Item (NPI) and negation has received little attention in the processing literature [1]. NPI-negation dependencies can be used to elucidate if the same active search mechanism present both in wh-gap [2, 3, 4] and backward anaphora dependencies [5, 6] is triggered in NPI dependencies. This study examined whether the parser triggers a search for a licenser (e.g. negation) immediately upon encountering a NPI in backward NPI dependencies in Dutch where the NPI appeared linearly before its licenser [7,8].

The experimental sentences contained the NPI *ook maar iets* within an embedded sentence; the NP linearly preceded negation even though negation was in a structurally higher position in the matrix clause. We tested whether the processing of NPI-dependencies is affected by the distance from the NPI to negation. We increased the distance at different positions in the sentence (main clause and embedded clause) to evaluate if it affected the parsing of the sentence differently. We predicted that increasing the distance at the embedded clause where the NPI is contained -as in (1b) and (1c) - would be less costly for the parser than increasing the distance at the main clause right after the copula *is* where negation is highly required- as in (1d) and (1e).

We conducted an ERP experiment where EEG was continuously recorded while 24 native speakers of Dutch read silently 35 sentences such as (1a-e) interspersed with 35 fillers and answered a comprehension question for every sentence. ERP results show that negation *niet* evoked a central anterior negativity in the time window 200-600 ms at all conditions with respect to (1a) (significant interaction of factors Condition and Position (Anterior, Central, Posterior); $F(8,184)=2.554$; $p=0.038$). This negativity was bigger in amplitude at (1d) ($A>D$; $p<0.001$) and (1e) ($A>E$; $p<0.001$) where the extra material was included after the main verb *is* when compared with (1b) ($A>B$; $p=0.0023$) and (1c) ($A>C$; $p=0.0046$) where the extra material was included after the NPI in the embedded clause.

Results show that there is a search started for a licenser when there is an NPI in the input that needs to be licensed. Increasing the linear distance between the NPI and its licenser creates disruption in processing, particularly if material is inserted at the main clause. This is shown by the amplitude of the central anterior negativity elicited in (1b),(1c),(1d) and (1e) conditions at negation. The anterior negativity increased in amplitude as material was inserted in the main clause with respect to sentences where material was inserted in the embedded clause, indicating an increase on the parsing difficulty. Taken as a whole, results support an active search approach to NPI—neg dependencies where the position for negation is actively searched for.

1a. [Dat de man **ook maar iets** gezegd heeft] is **niet** waarschijnlijk.
That the man anything said has is not probable.

1b/c. Dat de man **ook maar iets**(b/c) {over zijn problemen}(c) {tegen zijn moeder} gezegd heeft is **niet** waarschijnlijk.
That the man anything over his problems to his mother said has is not probable.

1d/e. Dat de man **ook maar iets** gezegd heeft is (d/e){in dit geval} (e){om verschillende redenen} **niet** waarschijnlijk.
That the man anything said has is in this case for different reasons not probable.

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Priming datives by datives and locatives: No evidence for differential effects of animacy

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Structural priming; Sentence production; Animacy; Phrase structure; German

Structural priming refers to the tendency of speakers to reproduce previously used constructions. However, the locus of the effect is a matter of debate (cf. Pickering & Ferreira, 2008, for a recent overview). In their seminal paper, Bock and Loebell (1990) showed that the production of dative PO (vs. dative DO) sentences in English can be primed by locative constructions. Considering the difference in event structure they argued for a phrase structural interpretation of the effect and against an account in terms of thematic roles. This argumentation is questioned by contemporary semantic and syntactic analyses that treat recipients in dative sentences and goals in locatives alike (e.g., Pylkkänen, 2008). Despite these parallels, Potter and Lombardi (1998) found weaker priming of dative PO responses by locative as compared to dative sentences. As their dative and locative primes had not been matched for lexical content, they suggested that animacy might be a confound.

We conducted a sentence generation experiment in German in order to disentangle effects of phrase structure from those of animacy. To this end, we presented dative and locative primes in four conditions ((1) dative DO, (2) dative PO, (3) locative PO with animate goal, and (4) locative PO with inanimate goal) and paired them with dative alternation targets (5). All recipient referents in dative primes and targets were animate. Targets were presented vertically aligned on the screen for 1300 ms, participants were instructed to generate simple sentences using those words.

- (1) Der Mechaniker vermietet der Kundin den ramponierten Wagen.
- (2) Der Mechaniker vermietet den ramponierten Wagen an die Kundin.
'The mechanic rents the client the banged-up car / the banged-up car to the client.'
- (3) Der Mechaniker steuert den ramponierten Wagen zu der Kundin.
- (4) Der Mechaniker steuert den ramponierten Wagen in die Waschanlage.
'The mechanic steers the banged-up car to the client / into the car-wash.'
- (5) Inhaber Firmenleitung Prokurist übergeben
'owner management confidential clerk render'

Overall, participants produced 56% PO (vs. DO) responses. A Generalized Linear Mixed Model was computed with the dative DO prime condition as reference (42% PO). All other primes were found to increase the proportion of PO responses (dative PO: 67% PO, $coefficient = 1.64$, $p < .001$; animate goal: 56% PO, $coefficient = 1.14$, $p < .05$; inanimate goal: 60% PO, $coefficient = 1.31$, $p < .01$). Despite the relative decrease of coefficient size, Tukey's HSD test revealed no differences in priming between the dative PO and both locative conditions.

We conclude that syntactic and semantic parallels between dative PO and locative constructions (cf. Pylkkänen, 2008) are sufficient for structural priming to arise whereas an additional overlap in animacy features has only minor if any effects.

Differences in effect size between the locative conditions seem to run contrary to an effect of animacy. However, they are most probably due to differences in prepositional case assignment. Whereas *an* ('to') in datives and *in* ('into') in inanimate locatives assign accusative case, *zu* ('to') in animate locatives assigns dative case. It is a question of future research whether case in PPs modulates effects of structural priming.

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Memory for words in sentences: The influence of word frequency and fixation time

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Frequency effects; Memory; Eye-tracking; English

Little is known about the factors that influence episodic memory for words encountered in the course of normal language comprehension. However, the recognition memory literature has shown a reliable benefit for low-frequency (LF) items: The *mirror effect* is a classic finding in which LF words are both better recognized as old when previously studied (higher hit rate) and better rejected as new when not previously studied (lower false alarm rate) compared to HF words (Glanzer & Adams, 1985; 1990). The present study tested whether 1) LF words are also better remembered after they are encountered in normal reading, in the absence of any explicit instructions to remember target words, and 2) the time the eyes spend on a word predicts later memory for that word, independent of any frequency effect.

Subjects ($N = 28$) each read 100 sentences for comprehension while their eye movements were monitored. Each sentence contained a critical HF or LF word, which was not marked in any way; the words were closely matched on a range of lexical characteristics. Linear mixed effects models revealed standard frequency effects on eye movements (Inhoff & Rayner, 1986; Rayner & Duffy, 1986), with longer first fixation durations ($b = .10$, $SE = .02$, $t = 5.30$), gaze durations ($b = .24$, $SE = .03$, $t = 7.51$), and total times ($b = .32$, $SE = .04$, $t = 8.44$) on LF words. At test, studied words and an equal number of new words were presented in a standard recognition design. The mirror effect was evident, as LF words had both higher hit rates [.72 vs. .66; $t = -2.12$, $p = .043$] and lower false alarm rates [.25 vs. .38; $t = 5.27$, $p < .001$]. Surprisingly, the time spent fixating a word, whether measured by first fixation duration, gaze duration, or total reading time, did not predict later memory accuracy for that word after including frequency in mixed-effects logistic regression models (first fixation: $b = -.009$, $SE = .17$, $z = -.05$, $p = .958$; gaze: $b = .04$, $SE = .13$, $z = .35$, $p = .730$; total time: $b = .04$, $SE = .13$, $z = .35$, $p = .730$). This was a convincing null effect, as examination of fixation times as a function of later 'hit' or 'miss' revealed no consistent trends.

The critical results of this study are that word frequency does affect memory for words encountered in normal reading, but the time spent fixating a word does not independently predict memory performance. We emphasize that this latter finding has implications for encoding-based accounts of the mirror effect. With respect to language processing, the present results imply that even words that receive only very brief eye fixations in reading are encoded well enough to be remembered on a subsequent recognition test. We regard this conclusion as consistent with the assumption that the eyes do not move on from a word until the process of lexical access is essentially complete (e.g., Reichle, Rayner, & Pollatsek, 2003).

Cognate processing in L1 and L2 sentence context: A first ERP study

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Bilingual cognate processing; Event Related Potentials (ERPs); French; English

When reading a book, newspaper or website in a foreign language, words that are similar in form and meaning to words in one's native language (so-called "cognates") are easier to comprehend than words that do not share form and meaning across languages. For instance, a French learner of English will easily understand the English sentence "*I took a taxi from the restaurant to the hotel*" because *taxi*, *restaurant*, and *hotel* share orthographic form and meaning between French and English. Indeed, both behavioral and ERP studies have shown that cognates are processed more quickly than matched control words (e.g., [1][2][3]). It is still under debate, however, whether such facilitation for cognate words occurs in both native language (L1) and second language (L2) sentence reading. In addition, it is unknown whether the same orthographically and semantically identical cognates are processed in a similar or in a different way in an L1 and an L2 context. Our study was the first to record ERPs to cognates and control words in a sentence context, both when bilinguals read sentences in their L1 and L2.

Twenty French-English late bilinguals were presented with one block of English and one block of French sentences. The order of presentation of the blocks was counterbalanced across participants. Sentences were seven words long, low-constraint, and presented in word-by-word serial visual presentation. The French sentences were exact translations of the English sentences. Every sentence contained a cognate or a matched control word as the target word. The target words were matched on log word frequency, word length, neighborhood density, and concreteness across conditions. They were always the middle word in the sentence. The same participant saw only one version of the sentence (cognate or control) within and across the language blocks. ERPs time-locked to the visual onset of cognates and control words were compared both in the L1 and the L2 sentence context.

Our results showed a significant difference in the amplitude of the P200 component for cognates compared to controls in L2, but not in L1. In addition, when cognates in L1 sentence context were compared to the same cognates in L2 sentence context, a similar P200 effect was found. This is a striking finding, because the compared cognates had exactly the same orthographic form and the same meaning across language blocks, and they were presented in sentences that were exact translation equivalents.

We conclude that the cognate status of a word influences its recognition in an L2 sentence context. Furthermore, our study shows that cognate effects in L2 sentences show up earlier than expected on the basis of ERP studies presenting cognates in isolation [2][3]. Our most important finding is that words that have exactly the same orthographic form and meaning across languages, are nevertheless processed differently depending on the language of the sentence they are encountered in. We argue that the different phonology of cognate words across languages plays an important role in explaining this difference.

Example stimuli

- | | |
|----------------------|--|
| 1. English - cognate | Flora saw the statue in the harbor. |
| 2. English - control | Flora saw the flag in the harbor. |
| 3. French – cognate | Fleur vit la statue dans le port. |
| 4. French – control | Fleur vit le drapeau dans le port. |

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Predicting the predictable:**The effect of proficiency on lexical-semantic processing strategies in adult L2 learners**

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L1-L2 processing; Semantic processing; Proficiency; Event Related Potentials (ERPs); German

Since second language (L2) processing has been investigated with Event-Related Potentials (ERPs), there is an ongoing debate whether native speakers and L2 learners have access to the same neural processing capacities and therefore should show comparable ERP responses to linguistic stimuli. With respect to syntactic processing, small changes in the onset of the age of acquisition (AoA) have shown to have a massive impact upon the observed ERP patterns of L2 learners; however, when it comes to semantic processing, even late learners show a qualitatively similar pattern (N400) as native speakers, though onset/peak latencies, amplitude, effect sizes, and distributional parameters of the N400 may slightly differ (e.g. Weber-Fox & Neville 1996; Moreno et al. 2008). Whereas most discussions about lexical-semantic N400 effects are based on the "N400 congruity effect" (difference wave between congruous and incongruous words) or proceed from the assumption that "larger N400s" for incongruent relative to congruent words always reflects increased processing costs for the former, only few studies considered the possibility that the N400 might not be a monolithic effect, but – at least under certain conditions – could involve *qualitatively* different processes (e.g. Vespignani et al., 2010; for an extensive discussion of this issue see Molinaro & Carreiras, 2010).

For example, Roehm et al. (2007) found evidence for distinct parsing strategies due to task demands and/or semantically restrictive contexts. In a sentential context involving antinomies (e.g. The opposite of *black* is ...) participants showed a P300 for the sentence-final word in the antonym condition (*white*), in contrast to graded N400s for the related (*yellow*) and non-related (*nice*) conditions. The authors suggested that the P300 reflects the match between the parsers' prediction of an incoming element (pre-activated representation) and the target stimulus. In this experiment we wanted to investigate whether a prediction-based processing strategy is observable in high cloze-probability sentences for native speakers of English and whether such a strategy is restricted to L1 speakers or is also accessible to speakers with English as L2.

13 native English speakers and 13 advanced German learners of L2-English (\emptyset AoA = 9.9 yrs, \emptyset years of learning = 12.7) read sentences where the sentence-final word either was semantically congruent (A) or incongruent (B) with the previous context. In all sentences (20 sentences per critical condition), the prior context enabled a strong prediction about the upcoming last word. The stimulus material was part of a larger study with various other conditions (reported elsewhere). Crucially, the two groups showed no differences with respect to behavioral measures (accuracy, RTs).

As in previous studies (see Moreno et al., 2008), semantically deviant structures elicited a similar N400 for both groups (L1 & L2) suggesting similar processes for native and L2 speakers. More interestingly, only the native speakers showed an early positivity in the N400 time window for semantically congruent sentences (similar to the P300 for predictable antonyms in the Roehm et al. study) thereby indicating a prediction-based parsing strategy. As the early positivity was absent in the L2 group, we conclude that L2 learners - even with an advanced proficiency level - do not use to the same processing strategies as native speakers (at least in sentences / contexts which are not subject to certain highly specific restrictions).

- A. semantically congruent: The tree was too high to climb.
B. semantically incongruent: The tree was too high to laugh.

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The effects of task on frequency and predictability effects

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Eye-movements; Reading; Proofreading; Task effects; Frequency; Predictability

Studying eye movement behavior in different language processing tasks can provide insight into how people adapt their eye movement strategies and yield evidence about the common or differing processes underlying a range of language tasks. For example, Rayner and Raney (1996) demonstrated that the effect of word frequency—longer reading times on lower frequency words—which was robust when reading for comprehension, was absent when searching for a particular word in text. This presumably reflects the fact that a word search task can be accurately performed by visually matching the probe to each word. Therefore, most words do not need to be fully identified (i.e., to the point of lexical identification) to be ruled out, and thus word frequency information is less relevant. Under this interpretation, the result suggests that readers have the flexibility to ignore a source of information that they would otherwise usually utilize. A contrasting result is provided by Kaakinen and Hyönä (2010), who demonstrated a different interaction of word frequency and task: relative to reading for comprehension, the size of the frequency effect increased in a proofreading task in which readers searched for spelling errors (non-words).

There are at least two possible explanations of Kaakinen and Hyönä's result. One possibility is that, because searching for non-words does not require constructing sentence-level representations, readers are not doing so. Instead, subjects are effectively performing a sequence of isolated-word lexical decisions and the interaction arises because frequency effects are larger in lexical decision than in reading (Schilling, Rayner, & Chumbley, 1998). Under this account, Kaakinen and Hyönä's result suggests that, like in the Rayner and Raney study, proofreaders ignore information they would otherwise use: predictability. That is, the standard predictability effect—longer reading times on less predictable words—would be reduced in proofreading. An alternative possibility is that readers do identify each word, but must do so more carefully to rule out possible misspellings. Under this account, Kaakinen and Hyönä's result indicates that readers rely to a greater extent on non-visual information about a word (i.e., frequency) to enable more careful word identification. Therefore, one would expect that readers would also rely more on other non-visual information, like predictability.

Thus, these accounts make conflicting predictions for how predictability effects would change between the two tasks. We tested these with an experiment analogous to that of Kaakinen and Hyönä, in which subjects both read for comprehension and proofread for spelling errors (non-words produced by transposing letters, e.g., *fltue* for *flute*). We factorially manipulated not only word frequency but also predictability and analyzed how the magnitude of these effects changed between tasks. Overall, reading times (e.g., gaze durations) were longer in the proofreading task than the reading task. Crucially, both frequency and predictability effects were magnified in the proofreading task compared to reading. These results replicate Kaakinen and Hyönä's findings for overall task effects and for frequency, and provide evidence against an account in which readers ignore predictability information during this proofreading task. Together with the aforementioned studies, these data form a coherent picture of the relationship between word frequency and/or predictability and task demands, in which these effects increase as the task emphasizes more careful word identification: from negligible in visual search, to robust in reading for comprehension, to even larger in proofreading for spelling errors.

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**Grammatical agreement can direct eye movements:
Evidence from monolingual and bilingual processing in Russian**

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Grammatical agreement; Visual world paradigm; Gender; Number; Bilingual heritage processing; Russian

Listeners use linguistic (verb affordances, thematic roles, etc.) and non-linguistic information (task effects and personality characteristics) to predict the potential referents in a visual scene. A few studies have been conducted to measure predictive processing of such morphosyntactic features as gender and case, but effects of grammatical agreement in gender and especially in number have yet to be investigated. Here we ask whether agreement in number and gender (subject-predicate and modifier-noun) can cause anticipatory eye movements to the referent that is yet to come in monolingual and bilingual heritage spoken language comprehension.

The participants were 25 monolingual and 25 bilingual heritage Russian speakers who learned Russian as their first language but switched to English when their families immigrated to the U.S. Participants' eye movements were recorded as they viewed 30 visual displays with 4 animated pictures. Each picture depicted the same event (e.g., flying) using different agents. In the Fem-UNAMB condition, the Target *ptica* 'bird_{FEM}' contrasted in gender with two objects (a balloon and a plane, both masc) and the third picture in plural (clouds, PL). In the Fem-AMB condition, there was a Competitor of the same gender (a rocket). The gender of the Target was crossed with referential ambiguity, i.e., Gender of the Target (masc vs. fem) x Referent (UNAMB vs. AMB). The 5th Plural condition used 2 objects (clouds) as Target without gender. The participants listened to the sentences in (1)-(2) and clicked on the Target (the bird or the clouds). The inverse word order Locative-V-Adj-N ensured that the pre-nominal number and gender agreement markers were available twice (on the V and Adj) in all five conditions and prior to the N referent, but their first occurrence was ~600 ms earlier in the PL and UNAMB conditions.

- (1) **FEM:** *Po nebu letela serebristaja ptica.* **MASC:** *Po nebu letel serebristyj samolet.*
 In sky was flying_{Fem-Sg} silver_{Fem-Sg} bird_{Fem-Sg} In sky was flying_{Masc-Sg} silver_{Masc-Sg} plane_{Masc-Sg}
- (2) **PL:** *Po nebu leteli serebristye oblaka.*
 In sky were flying_{Pl} silver_{Pl} clouds_{Pl}

The monolinguals were at ceiling for accuracy (0.04% errors) and significantly faster (by ~470 ms) (Table 1) than the heritage speakers (5.7% errors in the gender but not in the number condition). For the number agreement, total proportions of looks during the Adj region indicate that both monolingual (48.07%) and bilingual (44.67%) participants were able to rapidly compute the Target from the V agreement alone. For gender agreement, similar but overall weaker predictive effects were found in the Fem-UNAMB condition (38.17% vs. 37.63%). However, bilinguals didn't use gender agreement in Masc-UNAMB; they also exhibited a significantly longer competition than monolinguals in both AMB conditions. Thus, number cues (available in Russian and English) were informative of the identity of the upcoming N referent whereas gender cues were used differentially. These findings provide a novel evidence for predictive effects of morphosyntactic cues on eye movements, but show that number and gender can be processed differently based on the degree of their perceptual salience.

Table 1. Accuracy, RTs, and Looks to Target during the Adjective Region

	MONOLINGUAL			BILINGUAL		
	Accuracy (%)	RTs (ms)	Looks to T (%)	Accuracy (%)	RTs (ms)	Looks to T (%)
PLURAL	99.4	4040	48.07	100	4594	44.67
UNAMBIGUOUS:						
Fem	100	4249	38.17	98.67	4695	37.63
Masc	99.3	4140	37.65	90.71	4600	24.66
AMBIGUOUS:						
Fem	99.4	4293	34.73	92.62	4716	26.45
Masc	100	3987	33.11	92.50	4457	29.02

English lexical stress and spoken word recognition: An eye tracking and visual world study

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English lexical stress; Spoken word recognition, Eye-tracking

English lexical stress is of interest as it involves both suprasegmental and segmental cues (reduced vowels). Studies that have explored the role of lexical stress in English have shown that it contributes to spoken word recognition. More specifically, a trochaic stress pattern facilitates target word recognition more than an iambic stress pattern does (e.g., Cutler & Norris, 1988; Cooper, Cutler & Wales, 2002). Though some studies have shown reduced and unreduced unstressed vowels have different effects on the perception of stress (e.g., Fear, Cutler & Butterfield, 1995), most studies have explored the issue by quantifying suprasegmental cues to distinguish stressed syllables from unstressed syllables. The present study investigates how English speakers process lexical stress information with and without vowel quality cues during spoken word recognition, employing an eye tracking methodology.

Twenty three English speakers and twenty English speakers participated in two separate eye tracking experiments that had the same experimental design with different sets of stimuli. In both experiments, participants were trained over three sessions to associate drawings of novel 'aliens' with trisyllabic nonword names that had primary stress either in the first or second syllable. The first experiment had full vowels in both stressed and unstressed syllables, whereas the second experiment included the reduced vowel, *schwa*, in unstressed syllables. After the training session, eye movements were monitored as listeners followed the auditory instruction, "Click on the (alien name) now" and selected a correct alien from a set of three: the target (e.g., *JAKuner*), a stress competitor with the alternate stress pattern to the target (e.g., *jaKUna*), and an irrelevant distractor (e.g., *FUgiser*).

To examine the strength of bias toward the target over the competitor word, the log gaze probability ratios for the target over the competitor was compared to 0 by conducting *t*-tests in successive 200 ms windows after the offset of the first syllable. In the first experiment, both item and subject analyses revealed that there were significantly more looks to the target over the competitor after the first syllable during trochaic word recognition and after the second syllable during iambic word recognition ($ts(15) > 2$, $ps < .05$), suggesting that the word recognition process was initiated when listeners encountered the stressed syllable in a word. In contrast, the second experiment showed significantly more looks to the target over the competitor after the first syllable for both trochaic and iambic words with a comparable strength in the subject analysis ($ts(15) > 2$, $ps < .05$) and after the second syllable in the item analysis ($ts(15) > 2$, $ps < .05$). This indicates that, though there was some variation in the first syllable effect (needs to be further explored), listeners exploited the segmental distinction between stressed and reduced-vowel unstressed initial syllables to constrain the activation of stress competitors during word recognition.

The finding that stressed syllables initiate English word recognition when spoken words do not provide any segmental correlate to lexical stress is consistent with previous studies in the literature. The current work further provides empirical evidence that an unstressed syllable with reduced vowel may serve as an equally important cue to the activation of a target word at the early stages of word recognition.

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The bilingual advantage: Conflict monitoring, cognitive control, and garden-path recovery

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Cognitive control; Conflict monitoring; Syntactic ambiguity; Self-paced reading; Bilingualism

Mounting research findings demonstrate that balanced bilinguals enjoy certain cognitive advantages relative to monolinguals. On tasks requiring cognitive control (CC)—the ability to regulate mental activity and resolve among competing representations—bilinguals frequently outperform monolinguals selectively on trials inducing conflict [1]. Other evidence reflects broader patterns: bilinguals are better at conflict *monitoring* during goal-directed tasks, performing faster generally under high, but not low, conflict-monitoring conditions [2]. Considering psycholinguistic research emphasizing that domain-general CC enables recovery from temporary misanalysis [3], we investigate whether bilinguals' putative CC advantage improves their garden-path recovery abilities. We also test if brief practice on an N-back memory task with high (but not low) conflict-monitoring demands affects subjects' syntactic ambiguity resolution abilities.

Balanced Spanish-Catalan bilinguals (N=59) and Spanish monolinguals (N=51) performed three tasks in this order: a (Spanish) self-paced, moving-window reading task involving sentences that were temporarily ambiguous between a preferred subject-first or dispreferred object-first cleft interpretation; a 20-minute high- or low-interference version (randomly assigned) of an N-back task; and a posttest form of the reading task. In the reading task, comprehension probes tested lingering effects of misinterpretation in object-first sentences [4; see example]. During N-back, subjects viewed single words sequentially and indicated whether an item appeared 3 trials previously. Only the high-interference version contained "lures"—words that appeared 2, 4, or 5 items before, forcing subjects to override a familiarity bias to correctly indicate that the item was not a 3-back target.

On N-back, bilinguals were significantly more accurate than monolinguals in the high-interference ($p < .01$), but not the low-interference version ($p > .37$). However, language-group did not interact with trial type in either version, suggesting the benefit is not limited to stimuli requiring conflict resolution (lures), but instead reflects a general conflict-monitoring advantage in high conflict-monitoring conditions, consistent with [2]. In the reading task, subjects spent longer in disambiguating regions of, and were less accurate on, object-first versus subject-first items (p 's $< .01$)—the expected garden-path effect; but there was no interaction with group. Bilinguals had higher accuracy than monolinguals generally across all item types (object-first, subject-first, and filler probes; $p < .05$); thus, bilinguals' comprehension advantage was not specific to garden-path recovery.

Interestingly, regardless of language group, subjects' accuracy improvement throughout the N-back task on lure trials, but not other trial types, predicted their improvement from pre- to posttest selectively on object-first comprehension probes ($r = .28$, $p < .05$), which necessitated syntactic reanalysis. Some individuals therefore adaptively increased CC recruitment during brief interference-resolution practice, and transferred this benefit to sentence re-interpretation, further supporting the theory that domain-general CC underlies syntactic-ambiguity resolution.

Together these results suggest that balanced bilingualism bestows a general cognitive benefit in high, but not low, conflict-monitoring situations—namely, when there is repeated switching between conflict (lures) and non-conflict (target, non-target) trials—non-specific to conflict trials independently. Similarly, bilinguals enjoy a general comprehension advantage during a sentence-parsing task involving conflict-monitoring. We discuss findings in terms of bilinguals' advantage in conflict-monitoring, which enables them to detect situations requiring frequent conflict-resolution and flexibly increase domain-general CC, which also supports syntactic ambiguity resolution processes.

Example

Object-first/ Subject-first Cleft Sentence (probe in parentheses): Este es el cajero que cuestionaba [el/ al] gerente sobre el inventario. (El cajero cuestionaba al gerente/ El gerente cuestionaba al cajero.)

English: This is the cashier who [the manager questioned/ questioned the manager] about the inventory. (The cashier questioned the manager/ The manager questioned the cashier.)

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Accommodating syntactic violations during online speech perception

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Syntactic processing; Speaker accommodation; Word recognition; Visual world paradigm; French

Comprehending spoken language entails more than accessing successive words in the mental lexicon. Words within sentences relate to one another and the recognition of one word can help process adjacent words. One such co-occurrence pattern concerns gender marking. In gender-marking languages, the gender of a noun determines the form of the preceding article. In French, for example, masculine nouns are preceded by the definite article *le* (e.g., *le bateau* 'the boat') whereas feminine nouns are preceded by the article *la* (e.g., *la banane* 'the banana'). Although grammatical gender increases article complexity compared to languages with a single definite article, both adults (Dahan et al., 2000) and young children (Lew-Williams & Fernald, 2007; Van Heugten & Shi, 2009) have been shown to readily integrate this type of information during word comprehension. The early and rapid integration of grammatical gender may lead us to believe that initial syntactic gender processes, much like early local phrase structure processes (Hahne & Friederici, 1999), are automatic. This raises the question of how syntactic cues are integrated under conditions of reduced reliability. That is, does poor speaker proficiency diminish listeners' reliance on gender cues during language comprehension? While (late) syntactic repair processes are reportedly influenced by speaker idiosyncrasies (Hanulíková et al., in press), much less is known about such influences on first-pass parses.

In the current study, we employed an online measure of lexical activation, as provided by the Visual World Paradigm, to examine the earliest effects of speaker reliability on the processing of grammatical gender. Native French-speaking participants' eye movements were recorded as they listened to French sentences instructing them to click on a target picture (e.g., *Cliquez sur le bateau* 'Click on the boat'). Pictures of four objects were displayed on the screen: one depicting the target word (e.g., *bateau* 'boat'), one depicting a cohort competitor starting with the same syllable (e.g., *banane* 'banana'), and two depicting unrelated distracters (e.g., *grenouille* 'frog'; *cactus* 'cactus'). In same-gender trials, the target and cohort competitor were of the same gender, while in different-gender trials, target and competitor mismatched in gender. Participants in Experiment 1 listened to a reliable speaker who always correctly applied gender marking. By including definite articles with incorrect gender markings in the filler trials such that half of the speaker's articles were ungrammatical, in contrast, the same speaker became unreliable to participants in Experiment 2. This allowed us to test for the automaticity of gender cue uptake.

In line with Dahan et al. (2000), Experiment 1 shows that the initial consideration of the cohort competitor in the same-gender trials is eliminated by the informative gender cues in the different-gender trials. In Experiment 2, however, the speaker's gender violations on filler trials rendered gender information uninformative, thereby failing to eliminate the initial activation of the cohort competitor in different-gender trials. The finding that gender information constrains lexical access for reliable, but not unreliable speakers suggests that listeners immediately adapt to a speaker's use of grammatical gender. Syntactic parsing may thus be less automatic than previously thought.

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Masked priming ERP supports the role of literal meaning in figurative language comprehension

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Figurative language; Metonymy; Metaphor; Combined masked priming ERP; German

Metonymies and metaphors require the construction of meaning that goes beyond pure literal composition. However, there is a controversy over the role of literal meaning components. The indirect access account claims that literal aspects are processed first, and when no satisfactory interpretation is reached, additional meaning components are computed [1,2]. The direct access account claims that figurative aspects are accessed immediately [3]. Since the behavioral findings have been mixed, we used a combined masked priming and event-related potential (ERP) paradigm to get a finer resolution of the time-course of the comprehension of metonymies and metaphors. In particular, we wanted to tap early processing stages during which semantic activation occurs unconsciously, thereby eliminating potential influences from post-perceptual processes [cf. 4].

We compared metonymies (1a) and metaphors (2a) with their non-figurative counterparts (1b/2b). (1a) requires a transfer from the author (*Schiller*) to his work; (2a) involves a mapping, during which one or more properties of one conceptual domain (*hyaenas*) is conveyed to another (*lobbyists*). In the combined masked priming ERP paradigm, critical sentences were presented auditorily and a pattern masked prime was displayed visually 100ms before critical word onset for 67ms (see [4]). The prime (1c/2c) was semantically relevant for the literal meaning (selected in pretests). Participants performed two tasks, i) a color-change detection task occurring on the mask, to assure that they were focusing the visual display, and ii) a word recognition task at the end of each trial, probing participants' attention. Only trials with correct responses entered the analyses. As a between-subject factor, half of the participants heard the critical stimuli and were presented with a masked prime, the other half heard the critical stimuli without being presented with a prime. ERPs were time-locked to the recognition point of the critical word.

In the **unprimed conditions**, statistical analyses revealed a biphasic N400-LatePositivity pattern for metaphors and metonymies relative to their literal controls. This replicates previous findings from metaphor processing in English and Italian [5-7] and data from non-conventional metonymies in German [8]. It indicates that figurative meaning composition – across phenomena – proceeds in two phases, which we interpret to reflect demands from accessing an expression (N400) and carrying out pragmatic operations (Late Positivity).

Based on the N400-differences between figurative and literal conditions, we predicted the following masked priming effects. Direct access should be reflected by facilitation of literal conditions only, i.e. larger N400-differences in masked priming (relative to unprimed contrasts). The indirect access approach predicts facilitation of figurative and literal conditions (if literal aspects are always computed first), i.e. smaller N400-differences than in unprimed conditions. The **masked priming conditions** support the indirect access account or at least a 'lingering' account of literal meaning (smaller N400-differences). The Late Positivity emerged with a latency shift in the primed comparisons, probably due to interference from priming in earlier phases that hampers pragmatic operations. This serves as additional support for the influence of literal aspects. The combined methodology thus yields novel insights into the time-course and contribution of literal and figurative meaning aspects during online composition.

(1a/b) Metonymy: *Der Student las / begegnete damals **Schiller** bei einer Versammlung.*
("The student, at that time, read / met **Schiller** during an assembly.")

(1c) (Literal) prime: *talentiert* ("talented")

(2a/b) Metaphor: *Diese Lobbyisten / Raubtiere sind **Hyänen**, wenn man der Erzieherin glaubt.*
("These lobbyists / carnivores are **hyenas**, if you believe the kindergarten teacher.")

(2c) (Literal) prime: *fellig* ("furry")

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The acquisition of English dative alternation: Proficiency effects in French L2 learners

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Sentence processing; Second language acquisition; Dative alternation; Visual world paradigm; Expectation-based language processing; French L2 learners of English

This presentation concerns a Visual World eye-tracking experiment, which investigated the processing of English dative constructions (see 1a,b) by French learners of English. In English, there are two major ways of ordering the constituents in semantically dative sentences (shown below): Either with two bare noun phrases (1a) or with the use of a prepositional phrase for the recipient (1b). As reported by Bresnan et al. (2007) the choice between these two possible patterns is influenced by a wide variety of factors, crucially by idiosyncratic properties of the verb (verb bias). These properties of lexical items were found to have an effect on the native speakers' comprehension and production of syntactic alternations (Tily et al., 2008).

In (psycho-)linguistics, dative alternation has received particular attention. When comparing the verbs *serve* and *offer*, which have similar meanings in contexts like ones below, it has shown that the former has a stronger bias towards usage in a prepositional dative construction (1b), whereas the latter exhibits a bias for double-object dative constructions (1a) (Bresnan et al., 2007).

(1a) The maid will offer/serve the prince the wine. (double-object construction, DO)

(1b) The maid will offer/serve the wine to the prince. (prepositional object construction, PO)

In second-language research, the acquisition of these constraints has received little attention. The influence of probabilistic characteristics of the target language – English – on German L2 learners was investigated by Wolk et al. in 2011. They reported that less proficient learners had only little verb bias effects in the construction that was dominant in their L1 (DO). In most contexts, German does not have a prepositional dative object, and the ordering of objects in the double-object construction is preferred to be recipient before theme, thus matching the order of the English double-object dative. However, in French the prepositional object construction is the only possible pattern, i.e. double-object constructions do not exist in sentences in which only bare nouns are used.

This experiment investigated data from 28 French learners of English in varied degrees of proficiency. The Visual World study is a replication of the experiments conducted by Tily et al. (2008) and Wolk et al. (2011). Participants were presented with illustrations of subject, recipient and theme while listening to a recording of dative sentences. We compared anticipatory eye-movements across dative realizations (PO/DO construction), verb biases (towards PO/DO) and proficiency groups (low/high proficiency; level assessed with a subtest of the Cambridge Test) and found that speakers indeed acquire the norms of the target language. Additionally, it was discovered that sensitivity for verb bias is stronger for advanced speakers in both constructions.

Potential discrepancies between German and French L2 learners of English could be discussed further, especially the fact that German L2 learners showed different and more complex effects than French L2 learners: German learners of English featured a consistent effect of verb bias in PO constructions, whereas French speakers did not. All participants appeared to be strongly influenced by the animacy of the visual stimuli and seemed to avail themselves of bias when their expectation was violated.

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Friday, March 16

Paper Abstracts

Computing Minimalism: Simple doesn't mean easy

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Simplicity and efficiency are hallmarks of the computational system in the Minimalist Program. In particular, core operations, such as recursive Merge, should be the simplest possible mechanisms at the relevant level of abstraction. This principle ensures that core computation always enjoys priority in terms of design complexity over other operations. According to Chomsky (2011), language is first and foremost a thought system, and any conflict with parsing in terms of complexity is always resolved in favor of core computation. Put another way, in this framework, core computation is optimal, and parsing efficiency will fall wherever it must. This talk discusses what this might mean for faithful computer implementations of linguistic theories in the Minimalist Program. In particular, we will describe a system, currently under development, that implements the recursive Merge and probe-goal agreement system of Chomsky (2001), extended for syntactic Binding theory along the lines of Kayne (2002) and *tough*-constructions (Hicks 2009). This system will be compared and contrasted with a corresponding computational implementation of Government-Binding (GB) theory (Fong 1991).

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On directionality of phrase structure building

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The goal of this talk is to provide empirical arguments in favor of a derivational view of the grammar in which structure building occurs incrementally, top-down (Chesi 2004, 2007) and from left to right (Phillips 1996, 2003).

Following the spirit of Minimalist research (Chomsky 1995, 2008), I will show that the bottom-to-top orientation of phrase structure building is not a “virtual conceptual necessity” and that we can gain in descriptive adequacy if we move away from the idea that phrases are created by the recursive application of transformations like Merge. In a nutshell, I propose reversing the tree-structure building procedure. If phrases are expanded rather than being created by Merge, we can interpret Chomsky’s notion of Phase as the minimal domain in which a given set of syntactic features must be linearized and processed (either lexicalized or further expanded). This way, we better characterize the distinction between nested expansion domains (syntactic strong islands), which are highly computationally demanding, and cost-free recursive expansions such as the last selected complement of a verb.

I argue that Movement (creating a long-distance filler-gap dependency) is triggered by the fact that unexpected features are inserted in the computation. This is the case for wh-elements like “who” that are inserted in the left-periphery of the matrix phase to express an interrogative feature; but “who” also has argument features, which are not licensed in that peripheral wh-position. In order to reconstruct any non-local dependency in Top-Down, Left-Right terms, I propose using a Memory Buffer where unexpected feature bundles are stored until the relevant (thematic) licensing position is found. Regulating the access and inheritance mechanisms of the memory buffer in terms of phases, we succeed in capturing island-hood (Chesi 2004) and parasitic gap constructions (Bianchi & Chesi 2006). We also account for the intermediate status, in terms of transparency, of certain adjuncts (Pollard & Sag 1994), and for the reconstruction effects of some subjects of unaccusatives and passives (Bianchi & Chesi 2012).

I want to stress that this grammatical perspective does not provide a processing account of these phenomena — the grammar is not the parser from this perspective — but shows how a formal grammatical model that includes these directionality constraints is empirically more adequate in unifying a set of facts otherwise mysteriously related. However, I would also try to show that this grammatical model is explanatorily more adequate than the standard Minimalist one, and that memory load and feature confusion can account for locality constraints such as Relativized Minimality (Rizzi 1990) and for many asymmetries in the processing of minimal pairs of sentences, e.g., subject vs. object relative clauses (Traxler et al. 2002; Belletti & Chesi 2011).

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**Incremental development of incremental processing:
Anticipatory interpretation of novel sentential combinations in adults and children.**

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Sentence comprehension; Language development; Eye-tracking; Visual world paradigm

There is a host of evidence that adults and children rapidly integrate information from sentential agents and actions to incrementally generate expectancies for upcoming language (Borovsky, et. al., in press; Kamide, et. al., 2003; Nation, et. al., 2003). These relationships require going beyond simple lexical associations, and involve sensitivity to higher-order contingencies between agents, actions, objects, locations, etc. (Matsuki et al., 2011). However, relatively little is understood as to how this combinatorial knowledge is initially acquired and used.

We explore this question in 65 children (aged 3-10) and 64 adults by measuring the degree to which sentences depicting recently learned connections between agent, actions and objects lead to anticipatory eye-movements to the objects. Participants first heard stories accompanied by pictures portraying two agents (e.g. dog, monkey), who each complete the same two actions (e.g. eating, riding) and with different objects (e.g., the monkey rides in the car, and eats the candy, while the dog rides in the bus and eats the apple). All plausible combinations of agent, actions and objects were rotated across versions. In order to determine if this initial story presentation was sufficient to support subsequent incremental sentence interpretation, we then measured eye-movements to the objects of these novel relationships while participants heard sentences like "The monkey eats the candy." In addition to the Target picture (CANDY), the participants also saw the other four objects that served as Agent-Related (CAR), Action-Related (APPLE), or Unrelated (BUS) distractors.

Combinatory information about the agent and action yielded anticipatory eye-movements to the Target object in both adults and most children. Broadly, our findings suggest that adults and school-aged children can "fast-map" agent-action-object relationships and rapidly activate this knowledge in subsequent language processing. However, there were important developmental differences in the acquisition and activation of this knowledge. As expected, adults were faster than children (by 140ms) to generate anticipatory fixations to the target, but for children, the pattern of anticipatory fixations changed across development. 3-4 year old children's fixations reflected a simple association to the currently spoken item (e.g. fixations reflected look to the agent-related and action-related items as the agent or action was mentioned, respectively), but they failed to integrate the combinatorial information within the sentence. School-aged children's (aged 5-10 years) fixations mirrored the adult pattern; anticipatory fixations to the target were launched upon hearing the agent and action. Within this school-aged group, the timing of anticipatory fixations improved with age. The 5-6 year olds were relatively slower (by >100ms) to generate anticipatory fixations to the target than the older children (aged 7-10 years). In all groups, the looks to the action-related item was larger than seen in prior work that has measured anticipatory looks to well-known sentential relations. This indicates that the representation of these fast-mapped relationships might still be fragile, and the online activation of these connections may change with additional exposure.

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Overgeneralization of distributional cues across syntactic contexts in non-native speech segmentation

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L1-L2 speech segmentation; Eye-tracking; French

Listeners employ various cues to segment speech, but it is unclear how these cues interact. Speech segmentation has been proposed to operate as a function of a hierarchy of cues, with syntactic cues overriding lexical cues, and with lexical cues overriding phonotactic and acoustic-phonetic cues (e.g., Mattys, White, & Melhorn, 2005; Mattys, Melhorn, & White, 2005). This hierarchy stems from the greater reliability and saliency of higher-level cues over lower-level cues. This research aims to:

- (i) determine whether syntactic cues override distributional cues (assumed to approximate phonotactic cues) in native speakers' (NSs') speech segmentation; and
- (ii) establish whether non-native speakers (NNSs) rely on the same hierarchy of cues as NSs, and whether their relative reliance on these cues is contingent on their proficiency in the target language.

This study focuses on the misalignment of the syllable and word boundaries that resyllabification poses in French. French has a phonological process called liaison, whereby a word-final otherwise silent consonant is realized as the onset of the following vowel-initial word. Liaison is signaled by several cues, including:

- (a) syntactic cues: liaison is possible between a singular or plural adjective and noun (AdjN: *le(s) fameux [z]élu(s)* 'the famous elected-one(s)') and between a plural noun and adjective (NAdj: *les français [z]élus* 'the elected Frenchmen'), but not between a singular noun and adjective (*le français [z]élu* 'the elected Frenchman'); liaison is also more frequent in AdjN than in NAdj sequences (e.g., Durand & Lyche, 2008);
- (b) distributional cues: /z/ is a frequent liaison consonant but an infrequent word onset, whereas /t/ has the opposite distribution (e.g., Durand & Lyche, 2008; New, Pallier, Ferrand, & Matos, 2001).

Thirty-six native English speakers at various proficiencies in French and 33 native French speakers completed a visual-world-eye-tracking experiment. They heard stimuli containing singular AdjN and NAdj sequences, where the target word was /z/- or /t/-initial (*le fameux zélé* 'the famous zealous-one'; *le français zélé* 'the zealous Frenchman'; *le parfait taré* 'the perfect stupid-guy'; *le client taré* 'the stupid client'). The display contained pictures of the target, a vowel-initial "competitor" (*élu* 'elected-one/elected,' *Arabe/arabe* 'Arab/Arabic'), and two consonant-initial distracters. Acoustic analyses confirmed that the AdjN and NAdj sequences had similar prosodies. If syntactic cues override distributional cues, vowel-initial words should compete only in AdjN sequences, and more so for /z/- than for /t/-initial words.

Linear mixed-effects models on the (log-odd-transformed; Barr, 2008) proportions of competitor fixations (200-800 ms. from target onset), with syntax (AdjN-NAdj), consonant (/z/-/t/), time (six 100-ms. windows), and group (NSs-NNSs) as fixed effects, and with participant and item as random effects, revealed the following significant effects ($\alpha=.05$): consonant, group, time, syntax \times consonant, and syntax \times group. Subsequent models on NSs' fixations revealed an effect of syntax only for /z/, with competition only in Adj-N sequences. Subsequent models on NNSs' fixations, with the addition of proficiency (cloze-test scores; Tremblay, 2011), revealed a syntax \times consonant \times proficiency interaction: with only /z/-initial words, lower-level NNSs show more competition in Adj-N than in N-Adj sequences, whereas higher-level NNSs show the opposite pattern.

This suggests that syntactic cues override distributional cues for NSs, but not for NNSs. The NNSs' increasing competition across proficiencies in the NAdj sequences with /z/ is attributed to their overgeneralization from plural NAdj contexts, where liaison /z/ is possible. A different hierarchy of segmentation cues is proposed for NNSs, where distributional cues override syntactic cues and where the learning of distributional and syntactic cues is potentially served by distinct memory systems (e.g., Paradis, 2004, 2009; Ullman, 2001).

An ERP investigation of filler-gap processing in native and second language speakers

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Filler-gap dependencies; L1-L2 processing; Event Related Potentials (ERPs)

The past decade has seen a surge of studies on the extent to which even very proficient second language (L2) learners can become native-like in their real-time comprehension of sentences. Two areas of focus have been (1) whether proficient L2 speakers compute syntactic structures that have the same complexity as native language (L1) users', and (2) whether they do so within the same time frame (e.g. [2, 4]). Filler-gap constructions have revealed much about the sentence-processing system (example 2a). There is ample evidence that L1 speakers quickly identify the filler and attempt to connect it to a predicate, but the picture for L2 learners is mixed, (e.g., [2, 4]). It is likely that more proficient L2 learners show more native-like processing of filler-gap sentences, but to our knowledge this hypothesis has not been directly tested. We used ERP to test the comprehension of filler-gap sentences in L1 and L2 speakers, and used an individual differences approach to examine the relationship between L2 proficiency and N400 effects.

Participants: (1) 19 L1 English speakers; (2) 19 native Chinese speakers, advanced learners of English

Materials were fashioned after those in Garnsey et al. [3]. 30 sets of sentences with embedded questions were created: half plausible, half implausible; half were headed by 'whether', half began with 'which'.

Procedure: Participants completed 2 sessions, separated by 1 week, so that they read all 30 items from each condition. Each EEG recording session consisted of 4 blocks of 30 sentences, for a total of 240 sentences. Participants read sentences word-by-word. Each word appeared for 350 ms., followed by a 350 ms. blank interval. Each sentence was followed by an acceptability judgment. EEG was recorded using a Hydrocel Geodesic Sensor Net and an Electrical Geodesics Net Amps 300 amplifier. Participants were also administered a language background questionnaire and vocabulary tests (by which English proficiency was determined), along with tests of working memory.

Results & Conclusion: We focus on N400 effects at 9 electrode sites (CZ, C3, C4, PZ, P3, P4, F3, FZ, & F4) in the time window 300-450 ms at the critical words (underlined in (1) and (2)). For **No-Gap sentences**, both L1 and L2 groups showed an N400 effect at the critical word (*article* vs. *customer*), $F(1,36) = 6.18, p = .02$, with the L2 group showing a later N400 peak (L1= 363 ms.; L2=377 ms., $F(1,36) = 4.81, p=.03$), replicating a number of L2 studies (e.g. [1]). For **Filler-Gap** sentences, there was an interaction between group and plausibility, $F(1,36) = 4.21, p = .047$. The N400 effect was significant in native speakers but not L2 learners *as a group*. However, regression analyses showed that greater proficiency in L2 was correlated with larger N400 effects in the filler-gap sentences ($r=.28, p=.02$). These results suggest that although the L2 learners as a group are sensitive to plausibility variations, only the relatively more proficient L2 learners show such sensitivity in filler-gap constructions. Possible explanations for the lack of effect for relatively less proficient learners will be discussed.

Examples: (Underlined words are the critical words. Italicized words differ in contextual plausibility.)

No-Gap Plausible: 1a. The boss knew whether the secretary called the customer about the order.

No-Gap Implausible: 1b. The boss knew whether the secretary called the article about the order.

Filler-Gap Plausible: 2a. The manager knew which *customer* the receptionist called about the problem.

Filler-Gap Implausible: 2b. The manager knew which *article* the receptionist called about the problem.

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Some core contested concepts

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The most fundamental question we can ask about language is: What is it? (Q). Curiously, a question rarely raised, usefully at least, in classic texts, or even recent work where it should be relevant.

On the basis of a tentative “best theory” T about Q we can proceed to ask further questions, among them how the concepts of T enter into acquisition, use, evolution, neural representation, historical change (not to be confused with evolution). Reciprocally, what is learned about these topics can lead to recasting of T; the logical hierarchy of questions does not of course determine order of research into them.

By *language* here I mean *I-language*. Another concept that appears in the technical literature is *E-language*, now conventionally used in ways that do not seem to me coherent.

I-languages are systems of discrete infinity, so their study falls within the theory of computation (Turing machine theory, the theory of recursive functions). An I-language can be taken to be a computational (generative) procedure GP, internal to the mind/brain, which yields structured expressions, each assigned an interpretation at two interfaces, sensorymotor (SM) and conceptual-intentional (CI). So regarded, I-language satisfies a classical concept of language as sound with meaning – more accurately, it seems, meaning with ancillary sound (or other externalization), a very different matter.

Recursion is often confused with center-embedding; these are very different notions. Sometimes recursion is incorrectly assumed to be necessarily infinite. A recursive function may yield a single output (or nothing). It is easy to construct a GP lacking resources to generate more than a fixed number of expressions – more precisely, of non-deviant expressions. Were such an impoverished language to exist, it would be a mere curiosity, with no implications for the general study of language, contrary to substantial recent literature.

Among other such devices, English and other I-languages freely generate center-embedding, though without external aids (time, memory), subjects of course cannot interpret such structures beyond some bound – about 7, as predicted by Miller’s famous magic number. Self-embedding, a narrower notion, is much more sharply restricted, a fact of interest for the study of perception/parsing. Discussion of these topics is sometimes obscured by failure to distinguish competence and performance; loosely, what we know and what we do. The distinction is contested, but needlessly. It is familiar in investigation of any organic system, cognitive or not. Where competence is unbounded, use is restricted by available memory (e.g., arithmetical knowledge). To put it differently, there is a crucial difference between a Turing Machine with all memory in the control unit, and one that relies on external memory, though with bounded resources the two cannot be distinguished by superficial experiment. Note that the distinction is not to be confused with Marr’s analysis of levels of abstraction for processing systems, similar in spirit but different conceptually.

Acquisition of language, like development of any organic system, involves several factors: (i) external data, (ii) genetic endowment, (iii) more general principles. Factor (ii) includes (a) language-specific UG, (b) other cognitive systems, (c) constraints imposed by structure of the brain, a potential source of such information. Existence of (iia) is contested, but apparently on the basis of misunderstanding. For a computational system like language, (iii) can be expected to include at least principles of computational complexity. Though this too is contested (mistakenly, I believe), virtually all of what has been learned about I-language derives from (iia) and (iii) (and of course (i)).

Uncontroversially, we seek the simplest theory of UG, eliminating stipulations and avoidable complexity. From the earliest origins of the modern study of these topics 60 years ago, research has been directed towards this goal. In recent years this research has sometimes been called *the minimalist program*, a notion that has been widely misunderstood. It is a seamless continuation of early inquiry, differing only in the suggestion of some new research programs, which have led to interesting and sometimes far-reaching empirical conclusions, and have some independent motivation in terms of the very little that can be said with any confidence about how language evolved.

Fast Stuff and Slow Stuff: Is a unified theory desirable?

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There is an odd disciplinary divide in our field between those who focus on 'Slow Stuff' and those who focus on 'Fast Stuff'. Linguists have traditionally tried to characterize linguistic abilities in process-neutral terms that emphasize what speakers can do when freed of constraints of time and memory. Psycholinguists, on the other hand, are more typically fixated on process models that describe what speakers can do very quickly, with little interest in abilities that appear more slowly. (This is not as simple as a linguistics vs. psychology divide -- no corresponding separation is found in the study of language development.) The title of this year's special session suggests that a close relation between linguistic theories and models of language processing is obviously desirable. But this is not obvious. Rather, it is an empirical question. In this talk we will give a tour of the relevant empirical questions, and what we currently do and do not know.

For some it is self-evident that language is 'designed' for information transmission between speakers, i.e., comprehension and production, and that we are very good at it. For others it is self-evident that language is 'designed' for information encoding, storage, reasoning, etc., and that its properties are poorly suited to communication. There is serious empirical evidence for both of these positions. One key question is how close is the alignment between the knowledge that speakers reveal in the absence of time constraints and the knowledge that speakers reveal in rapid comprehension/production tasks. There are certainly many instances of close alignment, as seen in years of research on the on-line effects of various grammatical constraints. However, there are also notable instances of mismatches between on-line and off-line sensitivity to grammatical constraints (errors and 'grammatical illusions'). It is important to determine whether these mismatches reflect (i) embedding of grammatical rules and constraints in a noisy architecture, or (ii) evidence for distinct constraints that are used in on-line processes.

We will argue that the existing experimental evidence lends itself to the following view: human grammars are 'implementation dependent', i.e., speakers show scant evidence of being able to construct the same representation in different manners/orders. This motivates a tight relation between theories of Slow Stuff and Fast Stuff, and we offer suggestions on what such theories could look like. However, the goal of this exercise is not to take a menu of existing trade-marked grammatical theories and argue that one or another should be preferred because of its performance-friendly properties. Attempts to use on-line evidence as judges in a bake-off among competing formal theories have typically proven to be disappointing, and most of the conclusions about grammar-parser-producer relations have ecumenical implications.

Spatial information and representations of word meaning: Accessing semantic size information during reading

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Symbolic distance effect; Perceptual priming; Eye-tracking during word reading; English

Our ability to build spatial mental models from linguistic input suggests that spatial properties associated with lexical items are accessed during language comprehension, either as part of word meaning during the encoding stage, or as part of discourse integration and task-goal related processes. Studies investigating the symbolic distance effect (an inverse relation between the time required to compare two symbols and the distance between their referents on the judged dimension) have found similar patterns of reaction time for comparisons of symbolic and perceptual size, suggesting task-driven activation of analog representations of referent size¹. Studies on the representation of numbers suggest that magnitude information associated with digits and verbal numerals is stored at the lexical level and encoding stage of language comprehension, creating a numerical distance priming effect such that number processing is facilitated when targets are preceded by a numerically close prime². However, findings from studies of priming for perceptual or visuo-spatial features associated with lexical items do not provide a clear picture of the importance of task goals^{3,4,5}. An eye-tracking experiment, which investigated perceptual priming with lexical items, was conducted to determine the level(s) at which representations of semantic size become available during reading comprehension, and to assess the effect of task-specific goals on the mechanism of activation.

The experiment adapted a paradigm that has been used to show that numerical magnitude is automatically activated upon encoding of digits. Using a gaze-contingent display, participants read triplets of words referring to objects and animals (1), while performing either a size-order judgment or a memory task. Our results show a symbolic distance effect on the target word during the size-order task, such that gaze duration gets progressively longer for large ($M=534\text{ms}$, $SD=196\text{ms}$), medium ($M=544\text{ms}$, $SD=206\text{ms}$) and small ($M=577\text{ms}$, $SD=243\text{ms}$) size differences between the target and preceding word, $F(1,23)=7.66$, $p<.05$, $F(1,41)=20.43$, $p<.01$, indicating a decision-based activation of semantic size. First fixation duration showed no effect of size difference on encoding times, $F(1,23)=1.86$, $p=.185$, $F(1,41)=1.23$, $p=.28$, excluding the possibility of an initial encoding effect. Importantly, the symbolic distance effect did not occur during the memory task, $F(1,23)=.33$, $p=.57$, $F(1,41)=.21$, $p=.65$, indicating that visuo-spatial representations are activated *only* if this information is task relevant.

These results show that semantic size representations are accessed during task-specific decision processes, but are not activated automatically as part of word meaning. This conclusion challenges some theories of embodied cognition which claim that the word-meaning level encompasses visuo-spatial knowledge associated with concepts, represented in an analog fashion⁶. In addition, we identify the symbolic distance effect as a decision rather than encoding process. These results are in contrast with the numerical distance priming effect. First, this suggests a difference in the level of activation of semantic size associated with word meaning and numerical magnitude. Second, this indicates that the numerical distance priming effect and the symbolic distance decision effect cannot rely on the same processing mechanism or underlying mode of representation, and that the numerical distance priming effect cannot be fully explained by overlapping representations of number magnitude.

Stimuli

1a. Sheep – **Cow** – Monkey 1b. Eagle – **Cow** – Monkey 1c. Lobster – **Cow** - Monkey

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Locality and anti-locality effects in German: Insights from relative clauses

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Locality; Antilocality; Digging-in effect; Garden path; Relative clauses; Self-paced reading; German

Locality effects provide the prime evidence for working-memory constraints on sentence processing: Material intervening between two related elements (e.g., argument and verb) often increases processing difficulty. Yet, sometimes intervening material facilitates processing of the verb (anti-locality effect) (Konieczny, 2000). The present study contributes to the debate on the source and interpretation of locality and anti-locality effects by presenting further evidence from German showing that both effects can co-occur within the same language. Results from three self-paced reading experiments show that unambiguous sentences benefit from additional material and from familiarity of intervening NPs while garden-path strength increases with additional material.

Experiments 1 and 2 investigate the processing of German sentences like (1) which contain an unambiguous relative clause (RC). The two experiments show no penalty for object-extracted RCs (ORCs) as (1b) compared to subject-extracted relative-clauses (SRCs) as (1a). They do, however, show effects of NP-accessibility and length, both independent of RC type (SRC/ORC). Reading times in the second half of the RC are shorter when it contains a first-person pronoun rather than a non-pronominal and therefore less accessible NP (Experiment 1). Length had a positive effect as well: Reading times for the relative clause verb and the subsequent part of the matrix clause are shorter when the adverbial is present (Experiment 2). Experiment 3 concentrates on ORCs and compares unambiguous ORCs (2a) and locally ambiguous ORCs disambiguated by verb agreement (2b). As a second factor, an adverbial phrase is present or not. Reading times in unambiguous sentences replicate the anti-locality effect observed in Experiment 2. Ambiguous sentences, in contrast, show the opposite effect: Reading times in the matrix clause increase when the RC contains an adverbial phrase.

- (1) a. Ich weiß, dass der Patient, der {den Arzt | mich} (letzten Montag) fragte, den Pfleger kritisierte.
I know that the patient who.NOM the doctor me last Monday asked the nurse criticized
'I know that the patient who asked {the doctor|me} last Monday criticized the nurse.'
- b. Ich weiß, dass der Patient, den {den Arzt | ich} (letzten Montag) fragte, den Pfleger kritisierte.
I know that the patient who.ACC the doctor I last Monday asked the nurse criticized
'I know that the patient who {the doctor|I} asked last Monday criticized the nurse.'
- (2) a. Ich weiß, dass der Patient, den die Ärzte (letzten Montag) fragten, den Pfleger kritisierte
I know that the patient.M who.ACC the doctors last Monday asked.PL the nurse criticized
- b. Ich weiß, dass die Patientin, die die Ärzte (letzten Montag) fragten, den Pfleger kritisierte
I know that the patient.F who the doctors last Monday asked.PL the nurse criticized
'I know that the patient who the doctors asked (last Monday) criticized the nurse'

The absence of an SRC-ORC difference contrasts with studies showing a penalty for object-extraction in English (cf. Gibson, 2000) but is in line with previous results for unambiguous sentences in German (e.g., Friederici et al., 1998). This finding is compatible with memory-based accounts emphasizing the role of intervening material: in contrast to English counterparts, German SRCs and ORCs do not differ with respect to dependency lengths. The verb's clause-final position entails that the second argument always intervenes -- between subject and verb in SRCs and between relative pronoun and corresponding gap in ORCs. The anti-locality effect observed in Experiments 2 and unambiguous sentences in Experiment 3 -- additional adverbial phrases decrease reading times -- challenges working-memory accounts based on distance. Yet, the two instances of locality effects -- the pronoun-advantage in Experiment 1 and the stronger garden-path in long sentences in Experiment 3 -- argue in favor of such accounts. The facilitating effect of a pronoun replicates (Warren & Gibson, 2002) and also supports distance-based locality under the DLT's discourse-based definition of distance. The complicating effect of an adverbial in garden-path sentences corresponds to what Frazier & Clifton (1998) called 'visibility' and Tabor & Hutchins (2004) 'digging-in effects' (cf. Levy et al., 2009). Overall, our results argue for combining backward-looking, distance-based integration cost (cf. Gibson, 2000) and forward-looking, prediction-based facilitation (cf., Levy, 2008). Locality effects arise when the processing of the current item requires retrieval of an item processed earlier in the sentence. Retrieval is particularly hard when hampered by ambiguity, and therefore locality affects garden-path sentences in particular. Anti-locality effects, on the other hand, arise when intervening material narrows down the range of possible continuations.

A novel argument for the universality of parsing principles

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Universality of parsing; Attachment preferences; Questionnaire; Pseudo Relatives; Italian; Spanish; Portuguese

Attachment Preferences: [1], and much subsequent work, show that speakers of different languages differ in Relative Clause attachment preferences in complex NPs of the form NP1 P NP2: Low Attachment (LA) is found in English (1a), and High Attachment (HA) in Spanish (1b). Various factors (prosody, length of RC/breaks, position of complex NP a.o.) modulate preferences within a language, but crosslinguistic distinctions still prevail [2]. These findings questioned the universality of parsing principles as Right Association (Kimball 1973; Phillips 1996)/Late Closure (Frazier 1979)/Recency (Gibson 1991), and raised important problems for language acquisition [3-4].

We provide a new argument for the universality of parsing preferences by showing that variation across, and within, languages stems from structural differences: the availability of Pseudo Relatives (PR).

PR: (1a) and (1b) have been assumed to be substantially identical in this literature, with *that/que* introducing a RC that can either attach to NP1 or NP2. However, Spanish (and Italian, a.o.), but not English, allows for an additional parse (2) in which the clauses introduced by *que* are interpreted as PRs. PRs, like Small Clauses (SC) in English, are not modifiers of NPs but complements or adjuncts of V, to which they attach (see [5] and references cited therein for evidence that PRs correspond to SCs and not to RCs). Crucially, just like SCs (3), PRs necessarily take the higher NP as their subject, giving the illusion of high attachment.

Hypothesis: PRs availability is a primary factor modulating attachment: i. When PRs are available, they attach as complements of the main verb (Minimal Attachment), where only NP1 can be the subject of a PR giving the appearance of HA. ii. When PRs are unavailable, only RCs are available and LA arises (Late Closure).

Previous Findings: Several results from the literature support this hypothesis: i. Cross-linguistically HA Languages allow PRs (Spanish, Italian, French, Dutch, Croatian, Bulgarian, Japanese, Korean, Greek) and LA Languages do not (English, Romanian, German, see [6]); and ii. Within one language, when PRs are not available LA preference is also found (4-6 illustrate a few cases to be discussed).

Novel Results: In a questionnaire in Italian (n=30) we manipulated availability of PRs in a 2RCposition[Center Embedding, Right Branching]x2RCtype[subject, object] design (7). Due to syntactic constraints, PRs were only permitted in condition A. Meaning was kept constant across conditions. As predicted a HA preference was only found in (A), as shown through a significant interaction RCposition*RCtype ($t = 2.44$) in a mixed model regression. Further, the analysis showed the standard effect of RCposition ($t = 4.03$). Similar preliminary data obtained from the manipulation of verb type [perceptual/PRs vs. stative/*PR] in Spanish and Portuguese support these results.

Conclusions: PR availability is a major factor in determining attachment preferences. All attachment is local (PRs attach locally to closest VP), and parsing variation originates from grammatical variation.

- (1) a. I saw the son₁ of the man₂ that EC₂ was running b. Vi al hijo₁ del hombre₂ que EC₁ corría
 (2) Ho [visto [SC Mario che correva]] / *I saw Mario that ran / I [saw [SC Mario running]]
 (3) pro [Vi [SC al hijo del hombre que EC₁/*₂ corría]] / I [saw [SC the son₁ of the man₂ EC₁/*₂ running]]
 (4) Subjects: El hijo del hombre que corría es joven / The son of the man that ran is young [7]
 (5) Nominals: La foto de la casa que ardió / The picture of the house that burned [8]
 (6) RCs with rel. pron.: El hijo del hombre quien corría / The son of the man who ran [2]
 (7) A. Qualcuno ha visto il cugino del ragazzo che veniva picchiato dalla polizia (PR OK)
 Someone saw the cousin of the boy that was being hit by the police
 B. Qualcuno ha visto il cugino del ragazzo che la polizia aveva picchiato (*PR)
 Someone saw the cousin of the boy that the police had hit
 C. Il cugino del ragazzo che veniva picchiato dalla polizia è grasso (*PR)
 The cousin of the boy that was being hit by the police is fat
 D. Il cugino del ragazzo che la polizia aveva picchiato è grasso (*PR)
 The cousin of the boy that the police had hit is fat

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The persistence of the initial misanalysis without pragmatic inference: Evidence from Japanese relative clause structure

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Relative clauses; Incomplete reanalysis; Good-enough processing; Plausibility; Japanese

Past research showed that readers often preserve an initially adopted analysis after reanalyzing the sentence structure [1,2]. It is suggested that this is due to incomplete structural reanalysis, viz., failure to fully abandon the initial misanalysis. Previous studies, however, used structures with which the initial and correct analyses are not completely mutually exclusive. For example, even with a reflexive verb sentence *While Anna dressed the baby spit up on the bed*, people can make a pragmatic inference that the baby spit up while being dressed by Anna although such inference is not syntactically licensed. We tested Japanese relative clause sentences such as (1), with which readers typically adopt a main clause analysis initially and later reanalyze as a relative clause at the head noun (*joyuu*, 'actress'). Crucially, the correct interpretation following reanalysis with these sentences makes an interpretation for the initial analysis pragmatically incompatible, i.e., (1a) cannot indicate that the baby spilled the milk after reanalysis occurs. Two self-paced and one eye-tracking reading experiments examined the preservation of the initial analysis with this structure and the factors that contribute to the phenomenon.

In the first two experiments, we manipulated semantic bias of the second noun (underlined in (1,2)) as main clause bias (a), neutral (b), and relative clause bias (c) and relative clause length (short (1) or long (2)). We found that semantic bias affected both the accuracy of comprehension questions on the initial analysis and the reading time at the head noun (i.e., disambiguating region) only when the relative clause was long; Participants answered incorrectly more and spent longer at this region with (2a) than (2c) (the difference between (2b) and (2c) was marginal). The results suggest that with main clause bias nouns, participants committed more to the initial analysis and experienced greater cost for reanalysis, which resulted in persistence of initial analysis interpretation.

In the third experiment, we crossed semantic bias ((a) or (c)) with relative clause length ((1) or (2)) and investigated how the above results are underlain by online processing in natural reading. The analysis on first-pass reading times at the spill-over region (*jitto*, 'fixedly') showed an interaction of the two factors, showing that participants spent less in (2a) than in (2c) but longer in (1c) than (1a). Importantly, (2a) was accompanied by the highest regression-out rate at this region (0.42), suggesting that participants made regressive eye-movements immediately due to excessive processing difficulty. Consistently, the analysis on second-pass reading times showed the main effect of semantic bias (longer in (a) than in (c)) and that of relative clause length (longer in (2) than in (1)) across the regions from the second noun to the spill-over region. There was also an interaction at the first verb region, demonstrating that the effect of semantic bias was larger when the relative clause was long than when it was short. Our results taken together demonstrated that the initial analysis could persist even without pragmatic inferences and also revealed the link between the degree to which readers commit to the initial analysis and the likelihood for failing to abandon the analysis.

Example Sentences

(1a, b, c) Main clause bias / neutral / relative clause bias with short relative clause
Akachan-ga (miruku / nomimono / champagne)-o koboshita joyuu-o jitto mitusmeta.
 Baby-NOM [milk / drink / champagne-ACC spilled] actress-ACC fixedly stared at
 'The baby stared fixedly at the actress who spilled the milk / drink / champagne.'

(2a, b, c) Main clause bias / neutral / relative clause bias with long relative clause
Akachan-ga (miruku / nomimono / champagne)-o table-de hadeni koboshita joyuu-o jitto itusmeta.
 'The baby stared fixedly at the actress who spilled the (milk / drink / champagne) wildly on the table.'

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Friday, March 16

Poster Abstracts

The activated set of focus alternatives facilitates the processing of ellipses

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Eye-tracking; Sentence processing; Focus alternatives; Information structure; Ellipsis; Parallelism; German

It is well-known (see e.g., [1]) that parallelism between two conjuncts of elliptical coordinative structures leads to easier processing of the second conjunct. In addition, information structure, especially focus marking, crucially affects the interpretation and processing of ellipses [1,2,3]. In Rooth's alternative semantic theory (see [4]), focus activates a set of alternatives that is salient to the comprehenders at the current discourse state (e.g., [5]). We ran an eye-tracking study (n=57) to investigate how and when the activated set of focus alternatives affects the on-line processing of German elliptical structures. Moreover, we checked whether alternative activation requires (i) a particular structural marking, or (ii) is achieved by focus alone, by comparing the comprehension of elliptical utterances following focus cleft sentences and canonical sentences with default focus, respectively. Our experiment had a 2x2 design with the factors *focus* (cleft/default) and *unelided constituent* (subject/object) as exemplified in (1). In the first conjunct of (1a,b), the subject stands in narrow focus induced by clefting; in (1c,d), no element was focused syntactically i.e., readers had to assign default focus. In the second conjunct, everything except the object (1a,c), or subject (1b,d) was elided. The target items were preceded by a context to ensure that readers got the focus-background reading of the clefts in (1a,b); in (1c,d), the subject of the first conjunct representing new information is likely to receive focus. The statistical analysis was carried out using linear mixed models with several standard eye-tracking measures as dependent variables. We predicted an interaction of focus and unelided constituent such that the unelided subject in (1b) gets integrated more easily into the discourse due to its membership in the activated set of alternatives triggered by the clefted subject of the form *x called the father* (in line with the ellipsis licensing condition of [6]) in comparison to conditions where the unelided constituent is either a member of another alternative set of the form *Lisa and Jonas called x* as in (1a), or where no or a probably insufficiently activated alternative set is evoked as in (1c,d). The data showed facilitation effects at the region containing *außerdem*, where readers may already have processed parafoveally the next word (the high-frequency case-marked determiner which reveals whether the following constituent will be a subject/object). Significant interactions of *focus* and *unelided constituent* arose in the first-pass and right-bound reading time, and in total fixation time such that *außerdem* was processed faster when the unelided subject occurred in the cleft focus condition compared to the default focus condition.

In sum, we present evidence that comprehenders used the set of alternatives activated by a cleft during online ellipsis processing which led to an early processing facilitation when the unelided constituent of the second conjunct belonged to the set of alternatives evoked by the focused element of the first conjunct. Comprehenders did not use the set of alternatives in the default focus conditions because there was no reliable focus cue that justified either a strong activation of the alternatives or an activation at all. This finding suggests that readers computed an alternative focus set before entering the second conjunct and, therefore, they were not surprised when an alternative of the form *x called the father*, which addresses the same wh-question 'who called the father?' like the first conjunct, occurred in the second conjunct of the sentence.

(1) Context: Die Frau auf der Straße hört, dass nach dem Vater gerufen wurde
'The woman in the street hears that the father had been called.'

- a. Es sind Lisa und Jonas, die den Vater gerufen haben und **außerdem den Jungen**, bemerkt die Frau.
it are Lisa and Jonas that the.acc father called have and moreover the.acc boy notices the woman
- b. Es sind Lisa und Jonas, die den Vater gerufen haben und **außerdem der Junge**, bemerkt die Frau.
it are Lisa and Jonas that the.acc father called have and moreover the.nom boy notices the woman
- c. Lisa und Jonas haben den Vater gerufen und **außerdem den Jungen**, bemerkt die Frau.
Lisa and Jonas have the.acc father called and moreover the.acc boy notices the woman
- d. Lisa und Jonas haben den Vater gerufen und **außerdem der Junge**, bemerkt die Frau.
Lisa and Jonas have the.acc father called and moreover the.nom boy notices the woman

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The role of speaker conventionality in preschoolers' use of referential context: Evidence from eye movements

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Referential context; Scalar adjectives; Conventionality; Eye-tracking; English

In resolving ambiguous reference online, adults rely on expectations about conversational norms, such as the tendency for speakers to avoid informational redundancy. For example, in a situation where a modified noun phrase (e.g., "Look at the *tall* glass") distinguishes between two objects of the same kind (e.g., two glasses), adults begin to locate the target even before hearing the noun, even though the adjective also describes another object in the display (e.g. a tall pitcher). This phenomenon, referred to as the *contrast effect*, suggests that adults can make rapid use of pragmatic knowledge that adjectival modifiers tend to be omitted by speakers unless required for the purpose of establishing unique reference. This effect relies on the expectation that the speaker is behaving normally; Grodner and Sedivy (2003) found that by simply telling adults that the speaker had "an impairment that caused language and social problems" the contrast effect disappeared.

In light of findings that 5-year-olds, like adults, display a contrast effect (Huang & Snedeker, *in prep*), we examined whether this sensitivity hinges on expectations about speakers adhering to conversational norms or whether it is more lexical in nature, deriving from the inherent contrastiveness of scalar adjectives. Three- and four-year-olds ($n = 40$) were assigned to one of two groups. In the *conventional group*, a speaker was introduced by a confederate (i.e., "This is Monica"). During the labeling trials, this speaker labeled objects in a conventional manner (e.g., "Look at the banana"). In the *unconventional group*, the speaker was introduced as someone who used language unconventionally (i.e., "...and she says things in a very funny way"). During the labeling trials, she used unusual descriptions (e.g., "Look at the long, yellow piece of fruit that monkeys like to eat"). During critical trials, children in both groups heard an ambiguous phrase (e.g., "Look at the big one") accompanied either by a Contrast Set array including two objects of the same kind (e.g., a big and small doll) along with two unrelated objects (e.g., a big hat and a small sock), or a No Contrast array (e.g. a big ball and small pillow). If children use information about the speaker to disambiguate the utterances, they should show a stronger tendency to interpret the adjective contrastively in the *conventional group* than in the *unconventional group*.

To assess the degree of contrastive interpretation, we calculated a difference score for Target (e.g. big doll) – Distractor (e.g. big hat) in the pronominal "one" region. Here, preschoolers in the *conventional group* were faster to locate the target relative to the distractor in the Contrast Set trials, but not in the No Contrast trials, replicating a contrast effect ($p < .05$). However, this effect was absent in the *unconventional group*. This result suggests that the speaker's labeling behaviour on labeling trials influenced children's use of the situational context. This result mirrors recent research with adults and lends support to a pragmatic account of the contrast effect whereby children use information about the conventionality of the speaker to successfully resolve ambiguity.

Table 1: Difference Score (standard error) during pronoun region

Group	No Contrast Set "Big"	Contrast Set "Big"
Conventional	-0.04 (-0.008)	0.15 (.035)
Unconventional	0.06 (0.01)	-0.005 (-0.001)

Friend or confederate: Conversation and a concurrent visuomotor task

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Conversation; Dual-task; English

Recent studies have shown that conversation can impair the performance of a simultaneous visuomotor task and have attributed this to the amodal attentional demands of speech planning in language production (Almor, 2008). Therefore, under an interactive model of language production in which planning occurs concurrently with speaking, there should be no noticeable differences in this interference between speaking (which involves ongoing speech planning) and preparing to speak. In addition, if speech planning is the true attention-draining culprit, then the degree of difficulty of a conversation (and thus the degree of difficulty of planning an utterance) should impact performance on the secondary task. According to Pickering and Garrod (2004), the difficulty of conversation is related to the degree of alignment between the interlocutors at different linguistic levels, likely through ameliorating the cognitive demands of speech planning. We therefore predicted that conversation between intimate interlocutors (who are already aligned at various linguistic levels) would be less demanding than conversation between strangers (i.e., interlocutors not yet aligned) and should thus pose less interference on a concurrent visuomotor task. We further predicted that this difference mainly occurs during speech planning.

We conducted two experiments during which participants performed a smooth pursuit tracking task while conversing remotely via microphones and headsets. In Experiment 1, the conversation partner was a friend the participant had known for over a year ($M = 5.4$ yrs.). In Experiment 2, the conversation partner was a confederate the participant had never met prior to the experiment. Conversations lasted twenty minutes and were unconstrained. Conversational data were segmented in the following way: Talk (segments where the participant speaks), Listen (partner speaks), Overlap (both speaking simultaneously), Prepare (silence following a Listen segment and preceding a Talk segment), Pause (silence between Talk segments), and Control (visuomotor task only).

Performance on the smooth pursuit task during the various segments is reported in Table 1. In Experiment 1, Talk segments were more detrimental to the concurrent task than Listen segments ($t(18) = 3.5, p < .01$), and interestingly there was no significant difference between Pause and Talk segments ($t(18) < 1$). In Experiment 2, Talk segments were once again more detrimental to the visuomotor task than Listen segments ($t(20) = 5.68, p < .001$), Pause and Talk did not differ significantly ($t(20) = 1.5, p > .05$), and Prepare segments were more detrimental than Listen ($t(20) = 2.93, p < .01$). A between subject analysis of the data from both experiments showed that there was a significant Partner by Conversation interaction ($F(5, 35) = 2.39, p < .05$), characterized by worse performance during Talk and Pause segments when conversing with a stranger than when conversing with a friend.

These results point to the act of composing an utterance as the aspect causing the most interference on concurrent processes. Also, the level of intimacy between conversation partners crucially affects performance. When speaking with strangers the cognitive demands of speech planning require more attentional resources than when speaking with a friend.

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Table 1

Average distances in pixels to target by conversational condition, standard errors of the mean in parentheses.

	Talk	Listen	Overlap	Prepare	Pause	Control
E1	41.38 (3.14)	38.14 (2.62)	39.26 (3.09)	38.99 (2.85)	42.52 (3.61)	40.41 (2.87)
E2	44.34 (1.98)	37.6 (1.5)	41.91 (1.95)	40.44 (1.84)	46.13 (2.39)	40.47 (1.57)

I can tell from your voice: Adults and children use speaker identity to generate predictions during incremental sentence comprehension

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Speech comprehension; Language development; Visual world paradigm; Eye-tracking

Successful sentence comprehension requires listeners to efficiently attend to and integrate numerous cues in the speech stream while concurrently ignoring acoustic cues irrelevant to word identity. But how do listeners decide what cues are (not) relevant? Talker-related information is an interesting case where helpful and unhelpful cues occur simultaneously: talker-related acoustic variation may obfuscate cross-speaker similarities in speech, while higher-order information about talker-identity may assist in semantic interpretation. In this study, we focus on whether and how adult and child listeners use talker-identity cues to swiftly interpret speech.

Recent work has shown that adult and child listeners can rapidly activate a speaker's color preference during sentence comprehension (Creel, in press) and that adults swiftly evaluate talker-related consistency with a sentence-level message (Van Berkum et. al. 2008). Additionally, adult and child listeners can activate information about explicitly-named agents (in combination with actions) to generate predictions about upcoming sentential themes (Borovsky, et. al., in press). However, it is unclear whether listeners predictively generate inferences about a speaker's potential role in an action as a sentence unfolds.

We explore this question by asking whether voices activate role information in an eye-tracked sentence comprehension task with college-aged adults (N=50) and children (N=11, aged 3;8-7;1). The experiment consisted of six blocks of two interleaved tasks: 1) Talker familiarization, and 2) Sentence comprehension. Participants were initially introduced to two speakers' images and voices that conveyed their role (e.g. PRINCESS and PIRATE). Participants then completed a sentence comprehension task where a previously-introduced speaker named an action and object ("*I want to hold the wand,*" in the princess' voice). As the sentence was spoken, we recorded listeners' eye-movements to four objects that varied in relationship to the sentential speaker and action (Target: WAND, Speaker-Related: CARRIAGE, Action-Related: SWORD, and Unrelated: SHIP). The task was to select the named image. Each image appeared in all conditions across all versions, yielding a completely balanced within-subjects design. Importantly, in each trial two images (*wand* and *sword*) were semantically-related to the verb (*hold*), and two (*wand* and *carriage*) were semantically-related to the speaker (*princess*). Thus, listeners could only anticipate the target if they integrate both talker and action information.

Adult data and preliminary results with children suggest that listeners rapidly combined inferences about speaker with the action: they generated anticipatory fixations to the Target item in greater proportion than other objects [Adults: (F(3,47)=62.5, $p < 0.0001$), Children: (F(3,8)=9.94, $p < 0.005$)]. Within 400ms of sentential action onset, both adults (344 ms), and children (394 ms) generated anticipatory saccades to the Target item. Even though timing of initial Target saccades across age did not reach significance [$t(60)=1.627$, $p=0.11$], point-by-point analysis of the fixation timecourse indicated that adults' fixation proportions to the Target diverged from that of all other objects much earlier than it did for children, by 410 ms ($p's < 0.05$). Together, our results reveal that even very young listeners actively store and integrate real-world understanding of a speaker's role with sentential information to swiftly comprehend language, and that this ability may become more fluent with age.

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Antecedent topicality affects the processing of both NP anaphors and pronouns

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Anaphora processing; Topicality; Visual world paradigm; English

Topic continuity and grammatical subject antecedents are often claimed to be associated with the use of pronouns, while topic shifts and grammatical object antecedents are often linked with the use of fuller anaphors. Teasing apart the role of topic and subjecthood on subsequent anaphor processing is challenging because discourse topics tend to occupy the grammatical subject position. We conducted two visual-world experiments to test the unique effect of topic on processing noun and pronoun anaphors by using pre-sentential topicalizing adverbial phrases (e.g., "In his opinion, ..."), which have been shown to affect the processing of subsequent anaphors (Gordon et al., 1993).

In both experiments, participants heard three-sentence discourses in which Sentence 3 (the critical sentence) referred to a Target with either a definite NP or a pronoun (see sample items below). Both experiments used the same visual displays of four objects: Target (a woman with a purse), Interactor (a doctor), Distracter similar to the Target except in one distinctive feature (a woman with a hat but no purse), and an Unrelated item. Our main interest was in the effect of the topicalization manipulation in Sentences 1 and 2, which varied by experiment, on looks to the Target immediately after hearing the anaphor in Sentence 3, which was the same in both experiments.

Experiment 1 tested the effect of topicality on reference to grammatical subject antecedents. Sentence 1 established the Target as the topic by mentioning it in the subject position. Sentence 2 varied by condition. In the Compatible condition, the Target was both the topic and the subject. In the Incompatible condition, the topic shifted to the Interactor, but the Target appeared as the grammatical subject. A 2x2 ANOVA with factors Discourse-Condition and Reference-Form of the proportion of fixations to the Target at the 10 ms immediately after the anaphor revealed only an interaction the factors ($F(1,35)=4.17, p<0.05, F(1,24)=3.96, p<.06$): For the noun anaphors, there were more looks to the Target in the Incompatible condition than the Compatible condition. For the pronouns, there were no differences between the conditions.

Experiment 2 tested the effect of topicality on non-subject antecedents. Sentence 1 established the Interactor as the topic by mentioning it in the subject position. Sentence 2 varied by condition. In the Compatible condition, the Interactor was both the topic and the subject. In the Incompatible condition, the topic shifted to the Target, but the Interactor appeared as the grammatical subject. An ANOVA similar to Experiment 1 found only a main effect of Discourse-Condition such that for both pronoun and noun anaphors, there were more looks to the Target in the Incompatible condition than the Compatible condition, $F(1,35)=12.12, p<.002, F(1,23)=12.63, p<.002$.

Our results show that antecedent topicality: (a) affects the processing of repeated anaphors but not pronouns with a grammatical subject antecedent (Exp1), (b) facilitates both repeated noun and pronoun anaphors to a non-subject antecedent (Exp2). Overall, this study shows that topicality can affect anaphor processing independently of subjecthood but its effects on repeated noun anaphors and pronouns and are not always complementary.

Experiment 1 (E1) sample item (* - position of analysis time windows)

The woman with the purse yelled at the doctor about smoking in the hospital.

In *her/his* opinion, she should not have done that. (*Compatible/Incompatible*).

* *The woman/she* apologized to * the doctor * about the incident. (*Noun/Pronoun*).

Experiment 2 (E2) sample item (* - position of analysis time windows)

The doctor yelled at the woman with the purse about smoking in the hospital.

In *her/his* opinion, he had the right to do that. (*Incompatible/Compatible*).

* *The woman/she* apologized to * the doctor * about the incident. (*Noun/Pronoun*).

Gordon P., Grosz B., Gilliom L. (1993). Pronouns, names and the centering of attention in discourse. *Cognitive Science*, 17, 311-347.

The mechanics of causal interpretation: Explaining implicit verb causality

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Implicit causality bias; Discourse processing; Production; German

Implicit Causality (IC) plays an important role in investigations of discourse expectations ([1]a.o.). Although there is good evidence as to when IC affects comprehension ([2,3]), its exact nature is still poorly understood. Recent research suggests that discourse coherence ([4]) and verb-class semantics ([5]) are important factors. Going beyond this, we show that IC can be better understood if we consider a typology of different kinds of verb-dependent explanations. Based on three continuation experiments, we present a detailed semantic analysis of IC. Participants continued simple sentences (4a-b). Continuations were annotated for (i) whether they were explanations, (ii) the kind of explanation, and (iii) IC-bias. Following [6], we distinguished simple/direct causes (SimpCause=(1)) from externally or internally anchored reasons (ExtReason=(2);IntReason=(3)). We show below that IC-bias is semantically determined by elaboration preferences for specific verb-dependent explanations and how this property allows us to manipulate IC-bias systematically (all contrasts: loglinear models, LRCS_{1/2;p_{1/2}<.01}).

Experiment 1A+B (N=52;12+12 verbs;(4)-(5)+(6)-(7)): Encountering strong IC-verbs raises the expectation that a specific explanation will follow. To test this assumption, we explicitly provided such explanations in the prompt. 1A: In stimulus-experiencer verbs (4a-b), NP1 is a placeholder for some property causing (=SimpCause) NP2's experience. We predicted explanations to specify this property (NP1-association=NP1-bias). Crucially, in (5a-b) we stated this property explicitly using *durch*-phrases ('by'/'with'). This should impede the production of SimpCauses, shifting IC-bias towards NP2. As predicted, (i) after a full stop, explanations dropped from 58%=(4b) to 33%=(5b), (ii) in 'full stop'- and *because*-explanations SimpCauses dropped from 52%=(4a-b) to 24%=(5a-b), (iii) altering the bias from 71% to 49% NP1. 1B: Causal elaboration may also reflect a strategy of avoiding presupposition accommodation ([7]). (6a-b) presupposes a fact associated with NP2 which constitutes an ExtReason for NP1 to act. Conditions (7a-b) specified this ExtReason. Accordingly, (i) explanations dropped from 67%=(6b) to 37%=(7b). In the explanations (ii) ExtReason-continuations were reduced from 53%=(6a-b) to 23%=(7a-b), and (iii) IC-bias shifted from 20%=(6a-b) to 60%=(7a-b) NP1.

Experiment 2 (N=36;20 stimulus-experiencer+20 agent-patient verbs;(8)/(9)): Stimulus-experiencer and causative agent-patient verbs are semantically similar, allowing *durch*-phrases to specify SimpCauses (8a)/(9a). However, agent-patient verbs don't allow *because* to do so (10) – a fact overlooked by [5]. Consequently, the bias of agent-patient verbs should be more balanced. For both verb classes, *durch*-continuations were 99% SimpCauses. In *because*-continuations, stimulus-experiencer verbs (8b) triggered 83% SimpCauses (NP1-bias:92%). Agent-patient verbs (9b) prompted only 2% SimpCauses, 56% IntReasons and 42% ExtReasons (NP1-bias:50%).

Experiment 3 (N=52;24 verbs;(11a-c)): *Intentionally* turns ambiguous agent-patient/stimulus-experiencer verbs into agent-patient verbs ([8]), disallowing SimpCauses (Exp. 2). By contrast, *unintentionally* produces stimulus-experiencer interpretations triggering SimpCauses (Exp. 1). As expected, manipulation by *intentionally* (11b) blocked SimpCauses (unmanipulated:39%→*intentionally*:3%), prompting IntReasons instead (40%→75%). Bias wasn't affected (NP1-bias:67%→68%), since both SimpCauses and IntReasons are associated with NP1. *Unintentionally* (11c) led to a significant increase of SimpCauses (39%→66%) and NP1-bias (67%→85%).

The results show that IC-bias strongly depends on the availability of specific explanation types and that it can be manipulated by specifying those implicit explanations. In contrast to [5], our work shows that IC-bias depends on the semantics of the verb and of *because*. Moreover, we can account for focussing effects in processing ([2,3]): if a verb triggers a specific kind of explanation, we may expect focusing of the associated referent.

- (1) John disturbed Mary because **he** was making lots of noise. (simple cause)
- (2) John disturbed Mary because **she** had damaged his bike. (externally anchored reason)
- (3) John disturbed Mary because **he** was angry at her. (**internally anchored reason**)
- (4) Maria (NP1) beeindruckte ('impressed') Peter (NP2), a) weil ('because') / b) ('full stop') [...]
- (5) Maria beeindruckte Peter durch ihr offensives Spiel ('with her aggressive play'), a) weil ('because') / b) . [...]
- (6) Sara gratulierte ('congratulated') Martin, a) weil ('because') / b) . [...]
- (7) Sara gratulierte Martin zum glänzenden Sieg ('on the brilliant victory'), a) weil ('because') / b) . [...]
- (8) Emma bezauberte ('charmed') Paul, a) durch ('by'/'with') [...] / b) weil ('because') [...]
- (9) Emma tötete ('killed') Paul, a) durch ('by'/'with') [...] / b) weil ('because') [...]
- (10) #Sue killed Ben because she stabbed him in the back. ≠ S. killed B. by stabbing him in the back.
- (11) Maria störte ('disturbed') Peter
a) weil ('because') / b) absichtlich ('intentionally'), weil / c) unabsichtlich ('unintentionally'), weil [...]

The collective bias?

Using eye movements to examine collective vs. distributive interpretations of plural sets

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Ambiguity; Collective; Distributive; Plurals; Eye-tracking; Visual world paradigm; English

Introduction: In this study, we recorded eye movements of listeners in order to investigate the representation of collective vs. distributive interpretations of plural sets. In an eye-tracking study of reading times, Frazier et al. (1999) found evidence for increased processing load associated with distributive sentences and concluded that the processor initially pursues a collective interpretation in sentences ambiguous for collectivity/distributivity. However, increased reading time at the point of distributive (vs. collective) disambiguation does not itself provide information about when, or in fact whether, listeners commit to a distributive or collective reading. To test the hypothesis that subjects converge on one interpretation even in the absence of disambiguating information, we utilized the visual world paradigm to test whether predicates undetermined for collectivity/distributivity would nonetheless prompt listeners to converge immediately on the collective interpretation.

Method: We employed the visual world paradigm to track which representations subjects considered over the course of hearing a sentence. The eye movements of 24 participants were recorded as they listened to explicitly collective/distributive sentences and locally indeterminate sentences that resolved to either a collective or distributive reading at the end of the sentence; while listening, subjects considered collective and distributive acts depicted on a computer screen. E.g., a subject would hear sentence (1), (2), or (3) while viewing two side-by-side scenes, one of a collective action on one object ("ball"/"box"), and one of a distributive action on another object (e.g. "box"/"ball"). For a sentence like (1), the only disambiguating information is the final word of the sentence, e.g. the object "ball." Unless participants have committed to a collective or distributive reading, they should not have a preference for either of the two images until they hear the sentence-final word ("ball"). An earlier switch in gaze to one of the two images would indicate a processing preference for one interpretation over the other.

Results: Explicitly collective sentences prompted looks to the collective scenario at the point of disambiguation (i.e. at "together"), as did explicitly distributive sentences (at "each") to the distributive scenario. Crucially, the indeterminate (null) sentences patterned with the explicit "together" sentences at the predicate: the predicate immediately prompted looks to the collective.

We also compared the proportion of looks averaged across two time windows: an 800-ms interval before the predicate onset and an 800-ms interval after the predicate onset. In an ANOVA of proportion of looks to collective/distributive scenes, we found significant interactions between disambiguator ("together"/"each"/null) and time window. In a targeted analysis of disambiguator effects in each time window, we found significant differences for both "together" vs. "each" and for null vs. "each" after predicate onset but not before. The "together" sentences did not significantly differ from the null form.

Conclusion: Despite a lack of explicit disambiguating information, the indeterminate, null-disambiguator sentences prompted looks to the collective scenario almost immediately upon hearing the predicate, and this time course was reliably different from that of distributive-directed "each" sentences. This provides evidence that the listener has committed to the collective interpretation even in the absence of disambiguating information.

Examples

John and Bill are carrying a red ball. (accompanied by a distributive ball-carrying scene and a collective box-carrying scene)

John and Bill each are carrying a red ball. (accompanied by a distributive ball-carrying scene and a collective box-carrying scene)

John and Bill together are carrying a red ball. (accompanied by a collective ball-carrying scene and a distributive box-carrying scene)

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Stress matters revisited: A boundary change experiment

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Implicit prosody; Metrical stress; Eye-tracking; Reading; English

Breen and Clifton (2011) presented evidence that readers' eye movements are influenced by the stress patterns of words. In particular, eye movements were disrupted in items like (1) more than in items like (2). Both kinds of items were disrupted compared to (3) and (4), reflecting readers' initial preference to assign a noun reading to the critical word (abstract or report) and the need to revise when later material forced a verb reading. However, they reported an interaction such that disruption was greater when the shift of part of speech also required a stress shift from the strong-weak pattern of the noun to the weak-strong pattern of the verb, as is the case for abstract but not for report. However, the data contained a puzzle: The disruption appeared on the critical word (abstract) itself, although the material that forced the part of speech change did not appear until the next region. Breen and Clifton argued that parafoveal preview of the disambiguating material triggered the revision, and that the eyes did not move on until a fully-specified lexical representation of the critical word was achieved. Their evidence for this claim came from the observation that disruption on the stress-shifting critical word appeared only when the disambiguating region was skipped, which presumably indicates that the region was processed parafoveally.

The present experiment was designed to address the claim that readers resolved the ambiguity of the critical word using parafoveal preview. Specifically, we recorded eye movements of participants reading a superset of items taken from Breen and Clifton. Parafoveal preview of the disambiguating region was prevented by use of a boundary change paradigm (Rayner, 1975) in which the first few words following the critical word were replaced by random letters, but changed to the actual words when the eye crossed an invisible boundary immediately after the critical word.

The data supported the original claim that having to change the stress pattern of a word disrupted reading. Go-past time was increased in Regions 3 and 4 (indicated by / marks in (1)-(4)) in both conditions that required a change from noun to verb, but the cost of this change was greater for stress-shifting items like abstract than non-shifting items like report. This extra cost was apparent (and significant, using a linear mixed model with random slopes) in Region 4, and a similar significant cost was seen in the percentages of regressions out of the region. This pattern of results supports Breen and Clifton's claim that readers form an implicit metrical representation of text during silent reading. However, in contrast to the very early effect Breen and Clifton observed, the effect of metrical revision in the current experiment appeared only on a region following the disambiguating region, and only in a measure (go-past) that is arguably sensitive to late processes. It may be that the lack of parafoveal preview of the disambiguating region slowed its processing (as Rayner, 1975, demonstrated) enough to delay full recovery of the correct lexical form of the target word.

(1) Verb, stress alter: The brilliant/1 abstract/2 the best ideas/3 from the things they read./4

(2) Verb, non-alter: The brilliant/ report/ the best ideas/ from the things they read./

(3) Noun, stress alter: The brilliant/ abstract/ was accepted/ at the prestigious conference./

(4) Noun, non-alter: The brilliant/ report/ was accepted/ at the prestigious conference./

Table 1: Go-past Times

	Reg 1	Reg 2	Reg 3	Reg 4
(1) Verb, stress alter	270	433	918	1369
(2) Verb, non-alter	280	415	862	1234
(3) Noun, stress alter	285	413	655	862
(4) Noun, non-alter	282	378	626	987

Preceding prosody influences metrical expectations during online sentence processing

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Prosody; Spoken word recognition; Lexical stress; Expectations; Lexical competition; Visual world paradigm; English

A growing body of work indicates that expectations about the acoustic realization of the phonemes and prosody of a spoken sentence influence how listeners initially interpret incoming acoustic-phonetic cues during sentence processing. However, little is known about the types of representations that contribute to these perceptual expectations. The present study investigates whether perceived prosodic and metrical patterning across preceding portions of an utterance can influence listeners' expectations about the metrical organization of upcoming material. In particular, we examined whether expectations modulate listeners' interpretation of proximal cues to lexical stress and therefore influence the activation of potential lexical candidates.

Experiment 1 ($n=12$) used the visual world paradigm to establish that phonemically overlapping words with different initial stress patterns compete for recognition. Participants listened to spoken sentences containing a target word beginning either with a strong-weak (SW) stress pattern, like *jury*, or with a weak-strong (WS) stress pattern, like *giraffe* [1]. Their task was to correctly identify the target in a four-picture display containing images of the target, the opposite-stress competitor, and two unrelated distractors. Hearing the initial sounds of a SW target word elicited transient activation of a phonemically overlapping WS word, and vice versa. Participants were significantly more likely to fixate competitors than distractor pictures, beginning about 200ms after word onset.

Experiment 2 ($n=32$) further investigated whether metrical expectations based on preceding fundamental frequency and syllable timing patterns can influence the relative activation of competing SW and WS lexical alternatives. Target type (SW vs. WS) was crossed with two prosodic context conditions [2], which were created by employing methods used in previous work investigating effects of distal prosody on lexical processing [3,4,5]. In the **SW-biasing condition**, syllables preceding the target word were synthetically manipulated such that the initial syllable of the target word had acoustic characteristics that were similar to preceding lexically *stressed* syllables (e.g., relatively high f_0 and approximately isochronous timing). In the **WS-biasing condition**, syllables preceding the target word were instead manipulated such that the initial syllable of the target word had acoustic characteristics that were similar to preceding *unstressed* syllables. Critically, the acoustic characteristics of the rest of the utterance, starting at the syllable immediately preceding the target word, were identical across SW- and WS-biasing conditions. The main result was a significant interaction between target type and prosodic condition, starting shortly after the onset of the target word: SW words were most strongly activated in the SW-biasing condition, whereas WS words were most strongly activated in the WS-biasing condition. This interaction demonstrates that prosodic patterning in distal sentence context influences listeners' expectations about the relative metrical prominence of upcoming syllables and their interpretation of proximal cues to lexical stress.

Taken together, these findings suggest that listeners' expectations about the acoustic realization of an utterance include information about metrical organization and lexical stress, and that these expectations constrain the interpretation of acoustic-phonetic cues to lexical identity in the earliest moments of processing. These results are interpreted as support for expectation-based forward models in which acoustic information in the speech stream is interpreted based on expectations created by preceding speech.

[1] SW target word: Heidi sometimes saw that **jury** leaving the courthouse.

WS target word: Heidi sometimes saw that **giraffe** in the city zoo.

[2] SW-biasing f_0 & duration: H L H L H L H L H ...

... saw ...

WS-biasing f_0 & duration: L H L H L H L H L H ...

... saaw ...

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Utterance planning and articulatory duration

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Word lengthening; Utterance planning; Picture naming; Eye-tracking; Acoustic analysis; English

Variation in word duration can occur as a result of the speaker's communicative intentions, for example the need to emphasize or accent some words over others. At the same time, numerous findings suggest that word duration may vary as a function of the need to plan subsequent words. The timing of lexical planning can vary according to word length (Griffin, 2003). Word duration is lengthened when upcoming information is less predictable (e.g., Bell et al., 2009). These findings seem to suggest that speakers are doing at least some incremental planning. Other evidence suggests that the scope of planning is flexible (Wagner, Jescheniak, & Schriefers, 2010). We tested the hypothesis that variation in word duration is modulated by variation in the scope of planning.

Previous studies provide little evidence on this question. Ferreira & Swets (2002) argue that utterance duration is lengthened when the speaker experiences conceptual difficulty but only under time pressure to start speaking. Furthermore, on some accounts, e.g. Ferreira (2007), planning of upcoming material does not affect word duration. Our first goal was to find if individual word duration was adjusted because of planning difficulty. Our second goal was to test whether the timing of Word2 planning modulates this phenomenon.

We examined these questions in 3 two-picture naming experiments. We used an experimental paradigm that has shown evidence of a small scope of planning. Following Griffin (2003) we asked participants to name pairs of pictured objects from left to right without pausing. We manipulated the difficulty of the second word in terms of its frequency (High vs. Low). For example, the speaker would say e.g. *toaster giraffe* in the low frequency condition and *toaster chicken* in the high frequency condition. We predicted a lengthened Word1 when Word2 was low frequency. Would the extent of lengthening depend on the timing of Word2 planning?

In all experiments we measured speech initiation time and word duration; in Exps. 2 and 3 we also measured the right picture eye-voice span (e.g., Griffin & Bock, 2000). We analyzed the spoken word duration of word 1, depending on a) the frequency of the following word (word 2), and b) evidence of the extent to which word 2 was pre-planned, i.e. speech onset time and eye-voice span. In mixed effects regression models we controlled for variables that can influence word duration (sex, number of syllables, pause duration). We also excluded utterances with pauses longer than 200ms.

Results from all experiments show that Word1 is lengthened when Word2 is difficult, whereas speech onset time does not change. Experiment 2 and 3 provide evidence that the scope of planning modulates the degree of Word1 lengthening. Trials with pre-speech looks to the right object had shorter Word1 duration than those with post-speech looks. This effect was stronger in the high frequency than low frequency condition.

Our results suggest that speakers use relatively longer Word1 durations according to two scenarios: (1) when they cannot estimate Word2 planning difficulty because they never looked at the right object pre-speech, (2) when they can estimate Word2 planning difficulty because they looked at the right object pre-speech, and Word2 is difficult to plan. Both scenarios provide evidence that word duration is modulated by the scope of planning.

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Anticipation in real-world scenes: The role of visual context and visual memory

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Situated language comprehension; Anticipation; Visual context; Visual memory

When we comprehend sentences in the context of visual scenes, we generate expectations about upcoming linguistic material (Altmann and Kamide, 1998). These expectations are constrained by the current input and are incrementally revised (Knoeferle and Crocker, 2006). So, upon hearing *the man will eat the sandwich*, while the verb *eat* unfolds, anticipatory eye-movements are launched to the semantically appropriate object SANDWICH, if visually depicted.

Contextual expectations of a similar nature contribute to visual guidance during visual search in real-world scenes: when looking for MUGS, fixations are more likely on COUNTERS than on FLOORS (Torralba, et al., 2006). We therefore hypothesize that expectations extracted from the visual scene also play a role also during situated language processing. So, upon hearing the verb *eat*, we should observe anticipatory eye-movements to the object TABLE, which is contextually related to the action of eating. This should happen even if the search target (SANDWICH) is not depicted.

We test this hypothesis in Experiment 1: participants listened to sentences (e.g., *the man ate the sandwich*), while viewing scenes containing a target object (SANDWICH) and a contextually related object (TABLE), among other objects. In order to maximize contextual expectations, we used photo-realistic scenes, as these are maximally contextually coherent. In a 2x2 design, we manipulated the thematic restrictions of the verb (specific: *eat*, ambiguous: *move*) and the presence of the target object (present, absent). In a linear mixed effect analysis of the time-course of fixations from verb onset to 1000ms after it, we observed anticipatory looks to the contextually related object TABLE driven by the thematic restrictions of the verb. Crucially, this effect was found regardless of whether the target object was visually present. This demonstrates that (a) anticipatory eye-movements are generated in complex real-world scenes, not just in visual arrays or clip-art scenes (used in the prior literature); and (b) the semantic context provided by a scene can constrain the incremental interpretation of situated speech. This constraint is so strong that it operates even in the absence of the target object.

Experiment 2 aimed to establish whether the effect found in Experiment 1 is a memory effect (possible target locations are stored in memory, as in visual search, Torralba et al., 2006), or whether contextual expectations are computed on the fly, requiring the co-presence of visual and linguistic information. We used the blank-screen paradigm, which previously demonstrated anticipatory eye-movements driven by the thematic restrictions of the verb, even when the scene was no longer present (Altmann, 2004). The experimental conditions and materials were the same as in Experiment 1, but participants previewed the scene for 5000ms before it disappeared. Then after a 1000 ms pause the sentence was played.

In this setting, we failed to find anticipatory effects; the target region on the blank screen was fixated only once the post verbal NP was processed and only when the object had been depicted during preview. This suggests that (a) the blank-screen anticipation effect found by Altmann (2004) does not generalize to real-world scenes; and (b) contextual expectations are computed on the fly, i.e., they require the scene and the linguistic input to be co-present. The memory trace of a visual scene is sufficient to locate the target object, but it cannot be used to infer where the target object should have been, given the memorized visual context: (i.e., a previously seen TABLE is not enough to infer that a SANDWICH could have been there).

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Can syntax influence morphological complexity? Evidence from the gender congruency effect

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Morphological choice; Diminutives; Corpus linguistics; Dutch

When speakers have the option of using either a morphologically complex form or a synonymous simpler base form, which factors influence their choice? In this project we ask whether syntactic context is one such factor. We compare the production of Dutch noun phrases with diminutive and non-diminutive heads. Previous literature (Janssen and Caramazza, 2003) showed that naming latencies in the production of diminutive nouns are affected by syntactic information—specifically, grammatical gender and the presence of an agreeing determiner. Here, we ask whether this information affects whether the diminutive is used at all.

Janssen and Caramazza (2003), in examining the syntactic planning of Dutch NPs, take advantage of the fact that Dutch diminutives, which are always neuter, can be grammatically derived from base-words of any gender. They showed that participants responded more slowly when producing *incongruent* diminutive NPs—i.e. ones formed from non-neuter base words—than when producing *congruent* diminutives, which are formed from neuter base words. For example, participants initiated speech more slowly when producing incongruent *het beertje*, ‘the little bear (neuter)’, from *de beer*, ‘the bear (non-neuter),’ than when producing congruent *het schaapje*, ‘the little sheep (neuter),’ from *het schaap*, ‘the sheep (neuter).’ This effect is absent when forms are produced without an agreeing determiner. In other words, the morphological derivation is affected by syntactic context. We hypothesized that this effect would also be observable in the choice of wordform. If speakers are deciding between a diminutive or non-diminutive form in running speech, they might be more likely to opt for the non-diminutive form exactly in those cases where retrieval of the diminutive is delayed—i.e., in cases where the diminutive would be incongruent and follows a definite determiner.

We tested our predictions with data from the CGN corpus of spoken Dutch (Schuurman et al 2003), extracting all instances of a noun whose lemma is also associated with a diminutive counterpart. We analyzed the observations with a mixed effects logistic regression model, with lemma as a random effect. The resulting model does not support the hypothesis. Although there was a main effect of congruency such that neuter base gender increases the probability of using the corresponding congruent diminutive ($p < .001$), and a main effect of context such that diminutives are less likely immediately after a definite determiner ($p < .001$), there was no interaction between gender and context. Further, when this analysis was repeated on a subset of the data restricted only to the semantic category of animal names, the only significant effect present in both models was that of frequency: higher log frequency consistently lowers the likelihood of a diminutive ($p < .001$). Congruency and context were not significant predictors.

Although the analysis is ongoing, these preliminary results suggest that the delay in production observed by Janssen and Caramazza does not straightforwardly translate into constraints on the choice of morphological form in conversational speech.

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Referential forms in ADHD Children's Narrative

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Attention deficit and hyperactivity disorder (ADHD); Pronouns; Brazilian Portuguese

In this work, we investigated the pattern of referential form choice in Attention deficit and hyperactivity disorder (ADHD) children's narratives compared with narratives produced by normal controls. ADHD has been associated, among other symptoms, with distinct language behavior. Their language has been described as presenting errors such as "ambiguous references, disfluencies" (Tannock, 2006). Those problems have been related to inhibition disorders and a tendency to disregard the needs of others in structuring discourse. Although these are probably reasonable explanations, the underlying causes of such patterns are not well defined in current literature. This work uses a widely applied technique – narrative production – to tap into structural linguistic aspects that may lead to the mentioned difficulties. One such linguistic aspect is the choice of referential form. In discourse, there are different referential forms to choose from, ranging from full NPs to pronouns and null pronouns, the latter in pro-drop languages like Portuguese. This choice has been linked to working memory processes (Almor, 1999). Thus, conditions associated to working memory impairment are likely to be associated with an altered pattern in referential form use.

To investigate this hypothesis, we collected a corpus of narratives by 12 ADHD children and 18 normal developing controls matched by age (from 9 to 13) and schooling, all native speakers of Brazilian Portuguese. Each child produced a set of 4 (four) narratives, related to different tasks. Each referential form found in the narratives was counted and categorized. Results show that ADHD children, use significantly more pronouns and null pronouns than normal controls [$\chi^2(1)$, $p < 0.001$]. Furthermore, ADHD children introduce more new referents with pronouns than the other children. Compare the examples below (adapted to English). All referential expressions are marked in bold:

Normal developing child:

Chico Bento sees **the owner** of a **guava tree** sleeping, **he** is planning to get some **guava**, **he** goes silently, **he** jumps to get the **guava**, **he** is grabbed by a cane and can't go on and **the guy** seems to be awoken and throws **him** away with the **cane**.

ADHD child:

The boy was trying to get **some fruits** from **the tree** and **he** didn't let **him** because **he** was sleeping, because if **it** falls on his head/ **the fruit**... **He** was sleeping, **he** cut the ladder that **he** tried and then **he** tried.

We attribute this difference to the fact that referential forms are probably chosen according to their discursive saliency and accessibility. Accounts like Almor's (1999) Informational Load Hypothesis (ILH) explain anaphor processing as reflecting a balance between discourse function and processing cost. Pronouns are semantically less loaded than full nominal expressions. Therefore, pronouns are more frequently used when reference is made to entities already salient in discursive memory. When the working memory processing component is impaired, resources are scarce to activate and maintain more costly lexical-semantic information, so the lighter forms – pronouns – tend to be used when more informative nominal expressions would be preferable, leading to apparent disregard to listeners' needs.

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Naturalness of lexical alternatives predicts time course of scalar implicatures

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Scalar implicatures; Visual world paradigm; English

Speakers using a weak expression on a partially ordered scale are taken to implicate the negation of a stronger alternative. For example, (1) is standardly taken to implicate (2). Alternatives for scalar implicatures are assumed to be invariant across contexts. In real-world language use, however, salient and natural alternatives might vary with context. Considering the naturalness and availability of lexical alternatives to “some” may unify the conflicting literature on the real-time processing of scalar implicatures ([1,3,6] vs. [2,5]). We find that the availability of more natural lexical alternatives like number terms reduces the naturalness of “some” for subitizable sets (1-4 objects), but not for non-subitizable sets (Experiments 1 and 2) and reduced naturalness affects the time course of real-time implicature generation (Experiment 3).

Experiment 1 (n=120) collected naturalness ratings. Participants saw a gumball machine with an empty lower and full upper chamber (13 gumballs). After 1.5s a new display appeared in which 0-13 gumballs moved to the lower chamber. Participants heard a statement of the form “You got X of the gumballs” and on a 7-point scale rated the statement’s naturalness as a description of the scene. They clicked a FALSE button if they thought the statement did not describe the scene. We used the quantifiers “some”, “all”, and “none”. Mean ratings for “none” and “all” were almost at ceiling for 0 and 13 gumballs, respectively, but close to zero for all other set sizes. Mean ratings for “some” were 4.9 in the subitizing range, highest at 6 gumballs (mean 6.4), and gradually dropped to 3.0 as the full set was approached.

Experiment 2 (n=240), which used the same paradigm, included the number terms “one” through “twelve”. Including number decreased the naturalness of “some” only for subitizable sets.

Experiment 3 (n=37). Participants’ eye movements were monitored as they viewed displays of gumball machines that contained gumballs of contrasting colors (blue, orange). Target trials contained a contrast between a subitizable and a non-subitizable set (e.g. two orange gumballs and six blue gumballs) in the lower chamber, one of which was a partitioned. Participants heard statements of the form “You got *some/all/two/six* of the *blue/orange* gumballs”). Identifying the “some”-target required generating a scalar implicature. Subitizability of the target set for “some” and “all” was manipulated. Looks to the target set were delayed for “some” relative to “all” for the subitizable set (2 gumballs, replicating the effect found by [6]). In contrast, for the non-subitizable set there was no delay for “some” relative to “all”.

We conclude that scalar implicatures from “some” to “not all” are delayed when there are more natural alternatives that the speaker could have used to convey her intended meaning, but can be computed as rapidly as literal content when relative naturalness of “some” is high. These results reconcile the conflicting results between studies finding delayed effects of implicature computation, which have been interpreted as supporting logical/semantic-first models, and studies finding immediate effects, which have been interpreted as evidence for default implicatures.

- (1) Some of the students were at the party.
- (2) Not all of the students were at the party.

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Electrophysiological evidence of additional structure in intensional transitive constructions

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Syntax/semantics interface; Intensional transitives; Event Related Potentials (ERPs); Italian

According to a widely accepted view, intensional verbs like 'want' and 'need' select for clausal complements denoting states of affairs or propositions (e.g., Quine 1956; Larson, 2002), though they naturally and frequently combine with direct object NPs as in 'John wants a beer'. Recent psycholinguistic work (Delogu et al., 2010) has shown that intensional transitive constructions (ITs) result in longer reading times relative to control expressions (e.g., John drinks a beer), suggesting that interpretation of ITs requires complex compositional operations that interpolate additional structure to meet the selectional requirements of the verb (e.g., John wants [to have/drink a beer]). It is still an open question, however, whether such compositional operations are syntactically or semantically driven.

Some linguistic approaches (e.g., Larson et al., 1997) would attribute the complexity of ITs to the interpretation of a covert syntactic head, i.e., a silent V node (HAVE) in the syntactic structure of the sentence. Lexical semantic accounts (e.g., Pustejovsky, 1995), on the other hand, would attribute the processing cost to an independent semantic operation (called complement coercion) that shifts the semantic type of the NP object from an entity (<beer>) into an event or proposition (<drinking/having a beer>) that meets the selectional restrictions of the verb.

The present study used Event-Related Potentials (ERPs) to discriminate between these two alternative accounts of IT complexity. 20 native Italian speakers read 30 sentences in two conditions: Control Transitive (1a) and Intensional Transitive (1b).

The covert syntax account predicts that an ERP effect should be elicited already at the determiner (*una*), i.e., the earliest sentence position at which the two conditions differ in terms of the assumed underlying syntactic structure. In particular, the occurrence of a determiner is consistent with a direct-object complement as required by the verb in (1a), but inconsistent with a clausal/infinitival complement as required by the intensional verb in (1b). The complement coercion account, on the other hand, predicts that an ERP effect should be elicited at the noun (*birra*), i.e., the earliest sentence position at which the two conditions differ in terms of satisfaction of the semantic requirements of the verb. More specifically, the entity-type NP *beer* satisfies the selectional restrictions of the verb in the control condition but not in the intensional condition, where a proposition/event-denoting complement would be required (cf., for example, *John wanted an exiting life/party*).

The analyses revealed a broadly distributed negativity between 400-600 ms post onset of the determiner in the intensional transitive condition compared to the control transitive condition. The ERP modulation evoked by the noun did not differ across conditions.

In general, our result provides further evidence that intensional transitive constructions such as *John wanted a beer* are harder to process than control transitives such as *John drank a beer*. In addition, the time-course of the effect provides initial evidence in favor of the covert syntax hypothesis, according to which ITs are only apparently transitives. Our findings will be further discussed with reference both to ERP patterns associated with the processing of closed-class words and to recent ERP and MEG studies investigating other categories of linguistic expressions that are argued to require enriched compositional operations.

(1)

- a. Giorgio bevve una birra dopo la passeggiata. (**Control Transitive**)
Giorgio drank a beer after the walk.
- b. Giorgio voleva una birra dopo la passeggiata. (**Intensional Transitive**)
Giorgio wanted a beer after the walk.

Congruence effects in narrative time shifts

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Temporal shifts; Discourse expectations; Story-continuation task; Moving window; English

Previous research has shown that readers track and integrate temporal information as they construct situation models of narratives (Zwaan & Radvansky, 1998; Speer & Zacks, 2005). Explicit markers of temporal shifts (i.e., *a moment/hour/day later...*) have been claimed to increase processing times with longer shifts requiring more resources to track time in the situation model and therefore resulting in longer reading times (Zwaan, 1996; Ditman, Holcomb, & Kuperberg, 2008). In this paper, we present evidence that suggests that longer temporal shifts are not costly *per se*. Rather, upon reading about an event, readers generate expectations about *when* the next-mentioned event is likely to take place: elevated reading times arise when the size of the temporal shift is *incongruent* with readers' expectations.

In three experiments, we manipulated situation complexity (*simple/complex*), which we hypothesize to lead to different expectations about the temporal location of the next-mentioned event. Complex situations always involved plural/collective agents, had longer temporal durations, and had salient sub-events, while simple situations always involved singular agents and had shorter temporal durations. Experiment 1 involved an offline comprehension-to-production story-continuation task, where participants provided what they thought was a plausible continuation to single-sentence prompts that differed in situation complexity (*Madison spread some mayo on bread vs. The US Navy abandoned its foreign bases*). We measured proportions of responses that moved time forward, as well as responses that held time static. We found that temporally-static responses were more likely given complex events, while forward-moving responses were more likely given simple events. Experiment 2 also involved a story-continuation task. But this time, participants were constrained to continue the discourse with what they thought would happen next (*Then, ...*). Participants were then asked to estimate the size of the temporal shift between the end of the prompt event and the beginning of the event they wrote in response. We found that complex events elicited longer shifts than simple events. Experiment 3 involved an online moving-window reading task, manipulating the size of temporal shifts through the use of temporal connectives. Reading times were analyzed in a linear mixed-effects logistic regression model with temporal shift size, event complexity, and probability of moving time forward after reading the first sentence (as estimated in Experiment 1) as predictors. We predicted and confirmed a significant interaction between complexity and temporal shift size. Reading times on the region immediately after the temporal connective (the subject region of the second sentence) were observed to be elevated when simple events were paired with long temporal shift connectives and when complex events were paired with short temporal shift connectives. There was no main effect of temporal shift size as would be predicted by Zwaan (1996) and Ditman et al. (2008).

The results of our experiments suggest a more active view of discourse comprehension than is often assumed. In building situation models, readers do not just passively track time; they actively generate expectations about *when* the next-mentioned event is likely to take place. Our experiments also show that one source of these expectations is the complexity of the event readers just learned about.

Sample Stimuli

- Simple
 - *Madison spread some mayo on bread.*
 - Expt. 1: _____.
 - Expt. 2: *Then,* _____.
 - Expt. 3: *After a few seconds/weeks, she added lettuce and ham.*
- Complex
 - *The US Navy abandoned its foreign bases.*
 - Expt. 1: _____.
 - Expt. 2: *Then,* _____.
 - Expt. 3: *After a few seconds/weeks, they were re-occupied by foreign governments.*

A computational model of discourse predictions in sentence processing

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Syntax-discourse interactions; Cognitive modeling; English

Recent research in psycholinguistics has seen a growing interest in the role of prediction in sentence processing. Most attempts to computationally model predictive processing have focused on syntactic prediction. Examples include Hale (2001)'s surprisal model, which relates processing effort to the conditional probability of the current word given the previous words in the sentence. Recent work has attempted to integrate semantic and discourse prediction with models of syntactic processing. This includes Mitchell et al. (2010)'s approach, which combines an incremental parser with a vector-space model of semantics. However, this approach only provides a loose integration of the two components, and the notion of semantics is restricted to lexical meaning approximated by word co-occurrences. At the discourse level, Dubey (2010) has proposed a model that combines an incremental parser with a probabilistic logic-based model of co-reference resolution. However, this model does not explicitly model discourse effects in terms of prediction, and again only proposes a loose integration of co-reference and syntax. Furthermore, the Dubey (2010) model has not been evaluated on broad coverage data.

Here, we propose a computational model that captures discourse effects on syntax in terms of prediction. The model posits a strong link between syntax and co-reference: it comprises a co-reference component which maintains a list of previously mentioned NPs, and an hidden Markov model-based syntactic component which predicts facilitation for discourse entities which are discourse-old as opposed to discourse-new. This entails a strong interaction between parsing and reference: referential ambiguities are given probabilities and disambiguated by the parser.

Our evaluation experiments used the Dundee corpus (Kennedy et al., 2003), which has recently become the gold-standard in computational psycholinguistics (e.g. Demberg and Keller, 2008; Frank, 2009; Boston et al., 2008; Mitchell et al., 2010). For each word in the corpus, we computed total reading times, defined as the overall time participants spent looking at a word, including any re-fixations after looking away. We compared three mixed models: (i) a baseline, with only low-level eye movement variables (such as length and frequency) as predictors; (ii) the Syntax-only model, with the baseline factors plus syntactic surprisal scores; and (iii) the Co-reference model, with the baseline factors, syntactic surprisal scores, and surprisal scores based on our new co-reference model (residualized against syntactic surprisal).

We found that both the Syntax and Co-reference models provide a significantly better fit with the reading time data than the Baseline model; all three criteria agree: AIC and BIC lower than for the baseline, and log-likelihood is higher. Moreover, the Co-reference model provides a significantly better fit than the Syntax model, which demonstrates the benefit of co-reference information for modeling reading times. Again, all three measures of model fit provide the same result.

The primary finding of this work is that incorporating discourse information such as co-reference into an incremental probabilistic model of sentence processing has a beneficial effect on the ability of the model to predict broad-coverage human parsing behavior.

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Subject-verb agreement in Persian

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Subject-verb agreement; Animacy; Thematic roles; Sentence production; Persian

Like many languages, Persian exhibits subject-verb number agreement. However, Persian also has some other features that make it an especially interesting language to study agreement phenomena in. First, while most work on agreement has dealt with ungrammatical sentences (e.g. Wagers, Lau, & Phillips, 2009), Persian allows the grammatical use of either singular or plural morphology on the verb, but only when the subject is an inanimate plural noun. Second, Persian is an SOV language and thus objects are typically placed between subject and verb. Finally, there are two bound morphemes marking plurality in nouns, /-ha/ and /-an/. The suffix /-ha/ can be used for all nouns (animate and inanimate) while /-an/ is limited to only animate nouns. In this study, we investigated some of the factors that influence plural vs. singular agreement morphology in Persian, and what the effect of an intervening object attractor would be.

Experiment 1 investigated the effect of tense and the thematic role of the subject on agreement. Twenty-eight native speakers of Persian were provided a series of preambles and instructed to repeat the preambles aloud and then complete the sentences. Tense was manipulated with a counter-balanced block design in which the participants were asked in one half of the experiment to imagine that the events described in the preambles happened the day before, while in the other half they were asked to imagine them happening on the current day. The preambles consisted of an inanimate plural subject noun and the nonverbal component of an intransitive complex (light verb) predicate. Subjects were assigned agent, patient, or instrument roles.

Responses were coded for singular vs. plural morphology on the verb (e.g. *kærd do.Past.3SG* vs. *kærd-æn do.Past.3PI*). There was an effect of tense, with more singular agreement when verbs were inflected for past tense compared to present tense. Further, more singular agreement was used with patient subject nouns than either agent or instrument. Thus, both tense and thematic role appear to influence subject-verb number agreement in Persian.

In Experiment 2, the goal was to examine the effect of intervening object attractors in agreement. 45 native speakers of Persian were given a series of preambles and instructed to repeat the preambles aloud and then complete the sentences. In critical trials, the preambles consisted of an inanimate plural subject noun, an object noun, and the nonverbal component of an intransitive complex (light verb) predicate. Five types of preambles were created in which the object varied by animacy, number and suffix type (to see if the type of plural marking could have an influence). Participants were told to imagine that all the events of the preambles happened the day before.

An analysis of singular vs. plural verb morphology revealed that both animate and inanimate singular objects (ASO/ISO) caused a higher degree of attraction than the comparison plural conditions (APN/APH and IPH respectively). Further, /-ha/ conditions showed higher degrees of singular use than the /-an/ condition. These results show attraction effects based on both the number and morphological marking of the object.

Experiment 1

Sample	<i>ketab xune-ha ronæq</i>	Possible	<i>ketab xune-ha ronæq gereft</i>
Preamble	<i>library-PI flourishing</i>	Response	<i>library-PI flourishing take.Past.3sg</i>
	<i>'the libraries flourishing</i>		<i>'The libraries flourished.'</i>

Experiment 2

Sample	<i>wagon-ha æsb-an ra hæml</i>	Possible	<i>wagon-ha æsb-an ra hæml kærd-æn</i>
Preamble	<i>wagon-PI horse-PI Acc carrying</i>	Response	<i>wagon-PI horse-PI Acc carrying do.Past-3PI</i>
	<i>'the wagons carrying</i>		<i>'the wagons carried the horses.'</i>

Objects types in Experiment 2: APN: animate plural with /-an/ (e.g. *æsb-an*, *horse-PI*, 'horses')

APH: animate plural with /-ha/ (e.g. *æsb-ha*, *horse-PI*, 'horses')

ASO: animate singular with no suffix (e.g. *æsb*, *horse*, 'horse')

IPH: inanim. plural with /-ha/ (e.g. *mojæseme-ha*, *statue-PL*, 'statues')

ISO: inanim. singular with no suffix (e.g. *mojæseme*, *statue*, 'statue')

Task-constraints (but not semantic association) facilitate perspective use during discourse interpretation

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Perspective taking; Discourse comprehension; Eye-tracking; English

Interpreting descriptions about other peoples' actions relies on an understanding of their current mental state. Psycholinguistic research on this topic has focused on the comprehension of referentially ambiguous expressions (e.g. "the cup"), and has revealed a different time-course of anticipation across tasks that either require participants to engage in an interactive question-answer discourse[4], follow a speaker's instructions[1,2,3], or attend to a passive narrative scenario[5,6]. Indeed, it has been suggested that understanding privileged information is subject to an egocentric bias, perhaps caused by low-level associations between spoken descriptions and visually available referents [7].

We report a visual-world study, where two groups of participants watched short videos. Passive observers (N=40) were simply told to 'look and listen', while active participants (N=40) were instructed to 'click on the container that will complete the sentence'. Experimental videos depicted transfer events, which began with an actress ('Sarah') moving an object (e.g. a chocolate) into one of three boxes while another actress ('Jane') looked on. In the second part of the video, Sarah moved the object into one of the other boxes- either while Jane was watching or after she had left the scene. Additionally, on half the trials the first container used in the transfer event (i.e. the 'belief' box) predictably matched properties of the object (e.g. a chocolate box), thus providing an additional low-level cue to facilitate the belief inference in some conditions. Thus, the experiment crossed task (passive vs. active), belief (true vs. false) and predictability of the belief box (predictable vs. unpredictable). We tracked participants' eye-movements around the final visual scene, time-locked to related auditory descriptions (See example).

Eye-tracking analyses on word-onset-locked time-windows revealed significantly different patterns of anticipation in true vs. false belief conditions throughout the auditory input ($F_s > 35.7$, $p_s < .001$). This reflected a general bias to predict the reality box when Jane witnessed the second transfer event ($t_s > 6.2$), and a bias to the belief box (from [objects] onwards) when Jane was ignorant to the second transfer event ($t_s > 2.2$). Prior to [objects] participants also showed a predictability bias ($F_s > 3.75$, $p_s < .05$), reflecting a stronger bias to the belief box when low-level cues predicted this container. Moreover, task emerged as a main effect during "[object] in the container" ($F_s > 3.91$, $p_s < .05$) and interacted with belief throughout ($F_s > 4.39$, $p_s < .04$). These effects reflect a weaker bias to the belief box in the passive task compared to the active task. While active participants correctly anticipated reference to the belief box from "look" onwards ($t_s > 2.4$), passive observers did not significantly predict the belief box until location information became auditorily available (t_s prior to location < 1.3). Both groups showed appropriate reality biases on TB trials ($t_s > 2.3$).

These results provide further online evidence that comprehenders are spontaneously sensitive to others' perspectives. However, they also demonstrate that active engagement in a task leads to earlier and stronger anticipation of perspective-appropriate discourse interpretations, compared to passive observers who are susceptible to egocentric influences. Finally, this study shows that low-level language cues guide early visual biases to objects, but are not sufficient to overcome a 'pull-of-reality'. We consider the role of task-constraints, relative to previous studies of perspective use in language comprehension.

Example: Jane will look for the [objects] in the container on the [left/ middle/ right].

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Language experience accounts for individual differences in syntactic processing: Evidence from multi-level modeling

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Syntax; Comprehension; Individual differences; Language experience; Moving window; American English

Individual differences in online syntactic processing [1,2] and offline comprehension [3] have been reported, but their existence and source remain debated [4,5]. Theories have alternately attributed such differences to language experience [4,6], working memory [1], phonological processing [4], and executive conflict resolution [2]. Teasing apart these influences has been challenging for several reasons. First, these abilities frequently correlate. If only one construct is tested, it is possible its apparent effects actually reflect another construct with which it correlates. Second, many studies used only one measure of each construct, which likely introduced variance unrelated to the construct of interest: e.g., a Stroop task might reflect differences in executive attention but also in lexical access. Finally, the failure of a construct to predict syntactic processing cannot be easily interpreted if it is unknown whether the construct was reliably measured to begin with.

We investigated individual differences in syntactic processing using multi-level models, which can test how participant-level variables (e.g., language experience) interact with trial-level variables (syntax). To better assess which abilities affect syntactic processing, we (a) investigated multiple constructs, (b) measured each using multiple tasks, and (c) assessed measurement reliability through intra- and inter-task correlations.

English monolinguals ($N=63$) completed self-paced reading and a battery of tasks measuring language experience (vocabulary and self-reported reading frequency), phonological processing (two pseudoword repetition tasks), executive attention (antisaccade and Stroop tasks), and working memory (reading, listening, and operation spans). Tasks within each construct were z-scored and combined. We tested whether these factors predicted three measures of online and offline syntactic processing.

Resolution of direct object/sentential complement ambiguities was predicted exclusively by language experience: language experience increased sensitivity to verb bias statistics in online reading ($t=2.60$, $p<.01$).

Preference for low versus high attachments of ambiguous relative clauses, assessed by comprehension questions, was predicted by two variables. Higher working memory predicted low attachment preference ($z=4.60$, $p<.0001$), consistent with past results [3], but so did language experience, independently of working memory ($z=4.70$, $p<.0001$). We suggest this experience effect reflects learning of the English low-attachment preference.

Reading of object-extracted relative clauses (ORCs) was slower than reading of subject-extracted relative clauses (SRCs), $t=2.48$, $pMCMC<.01$, but no individual differences modulated this difference. Correlations between even- and odd-numbered items revealed little consistency ($r=.09$, $p=.47$) in which participants showed greater ORC minus SRC differences. Either individuals differ little in their difficulty with ORCs, or the reading-time measure was insufficiently reliable to detect such differences.

These results suggest language experience plays a critical role in online and offline syntactic processing. No other construct predicted online syntactic processing, and only one (working memory) predicted offline comprehension. Crucially, the null effect of other constructs cannot be attributed to a failure to reliably assess them. The tasks within each construct correlated (all $ps<.05$), suggesting stable measures; they just did not predict syntactic processing. These results are congruent with findings that lab-provided distributional experience alters syntactic processing [7,8] and demonstrate that *a priori* individual differences in syntactic processing may reflect differential exposure to language input.

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Case-neutralized NPs in Tagalog and the nature of heavy shift

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Heavy shift; Acceptability rating; Tagalog

The existence of heaviness preferences is well-documented for Tagalog: as in English, heavier NPs tend to follow lighter ones in Tagalog [1,2]. In the Recent Perfective (RP) form, the case morphology of the arguments of some verbs is neutralized with the genitive form. From the perspectives of sentence processing, in such sentences, explicit morphological cues to distinguish verbal arguments from one another and from possessors are not available for the parser. Thus, if three NPs follow the verb, there is an ambiguity between the following two structures: $[[NP_1, NP_2]NP_3]$ and $[NP_1, [NP_2NP_3]]$. Here, one of the three NPs, either NP2 or NP3, must be a possessor of the preceding NP. How Tagalog speakers deal with such ambiguous sentences can distinguish two hypothesis on Tagalog's heaviness preference: (i) heavy elements are located to the right in order to satisfy working memory or planning constraints [3,4,5]; or (ii) heaviness is a licensing condition on dislocation and thus only affects the acceptability of sentences which deviate from base Agent >> Patient order.

73 native Tagalog speakers rated the acceptability of sentences like (1). In (1), Case Form of NPs (Neutralized vs. Non-Neutralized) and placement of possessor (in first vs. second argument) are manipulated as independent factors (not all conditions shown). In the non-case-neutralizing normal perfective, 3-NP sequences are unambiguous provided the argument marked with "ang" is dislocated after the argument marked with "ng". So in (1a-d) only a single unambiguous parse (equivalent to the translation provided) is possible, because the arguments of the verb are distinctly case-marked. In (1a,b), the heavier NP comes second, while in (1c,d), it come first. The additional factor of Plausibility (Possessed-Possessor sequence is plausible vs. implausible) was also varied in the non-case-neutralizing conditions. In (1a,d), the complex NP (possessed and possessor) is semantically plausible, while in (1b,c) it is implausible. Due to the absence of case cues, Plausibility is indistinguishable from Heaviness for the RP conditions. In RP conditions, NP2 can be parsed either as the possessor of NP1 or an argument of the verb and the possessed of NP3, with Plausibility serving to bias the parse to one constituency or the other. In (1e), the former parse is more plausible, while in (1f), the latter is. If Tagalog's heaviness preference is a general parsing effect (hypothesis i), it should be equally operative in case-neutralized and non-case-neutralized sentences. If it is dislocation-specific (hypothesis ii), it may be absent in the RP because the case-neutralization allows either NP (heavy or light) to be construed as subject or object: the examples can be parsed as not including dislocated NPs because the neutralized case-marking allows a base-position parse. For example, when the plausible heavy NP is first (1e), it can be parsed as the subject, eliminating dislocation from base order from the structure.

In this experiment, location of the [Possessed-Possessor] sequence had a significant effect on the unambiguous normal perfective sentences. Participants significantly preferred $[NP1[NP2NP3]]$ over $[[NP1NP2]NP3]$. (Mean rating 2.8 vs. 2.5, 5 pt. Likert scale, $p < 0.001$) In the RP, however, the conditions were statistically indistinguishable (Mean rating 2.3 and 2.2, $p > 0.5$). The heaviness preference affects overall acceptability of unambiguous sentences, but does not in case-neutralized RP contexts. This suggests that Tagalog's heaviness preference is a constraint over only NPs dislocated from base order that need not apply in RP sentences.

(1)a. Pumili ng rantsero ang narses ng pasyente.
chose CASE1 cowboy CASE2 nurse CASE1 patient.
The patient's nurse chose the cowboy.

(1)c. Pumili ng rantsero ng narses ang pasyente.
chose CASE1 cowboy CASE1 nurse CASE2 patient.
The patient chose the nurse's cowboy.

(1)e. Kapipili lang ng narses ng pasyente ng rantsero.
RP.chose just CASE1 nurse CASE1 patient CASE1 cowboy
~The cowboy just chose the patient's nurse.

b. Pumili ng narses ang pasyente ng rantsero.
chose CASE1 nurse CASE2 patient CASE1 cowboy
The cowboy's patient chose the nurse.

d. Pumili ng narses ng pasyente ang rantsero.
chose CASE1 nurse CASE1 patient CASE2 cowboy
The cowboy chose the patient's nurse.

f. Kapipili lang ng rantsero ng narses ng pasyente.
RP.chose just CASE1 cowboy CASE1 nurse CASE1 patient
~The patient's nurse just chose the cowboy.

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Error attraction and syntactic priming in subject-verb agreement production

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Agreement; Sentence completion; English

A canonical finding in agreement production research is local noun interference; subjects produce more agreement violations (e.g. “the key to the cabinets *are...”) when a local noun of mismatched number (cabinets) appears between the head noun (key) and its verb than when the local noun and head noun share the same number (e.g., “the key to the cabinet,” Bock & Miller, 1991). Previous work has suggested that this error attraction is less frequent with local nouns embedded in relative clauses (NP[RC] structures, e.g. “the key that opened the cabinets”) than in prepositional phrases (NP[PP]) (Bock & Cutting, 1992), but there has been relatively little work on agreement in NP[RC] structures in English (see Hartsuiker et al., 2001, for Dutch NP[RC] agreement results).

Effects of local nouns on agreement are often interpreted as purely structural, but we investigate whether one putative non-structural effect extends to the NP[RC] construction. Haskell, Thornton, and MacDonald (2010) found that participants exposed to collective NP[PP]s with plural agreement (e.g., “a trio of violinists are...”) produced more plural agreement than those who were primed with singular agreement with collective NP[PP]s. Haskell et al. (2010) investigated priming only from NP[PP]s to other PP constructions, so it remains unclear whether priming effects could extend to agreement production in NP[RC]s. We address this question.

Participants (n=40) read either the singular-prime or the plural-prime version of the Haskell et al. (2010) priming story, which contained a number of collective NP[PP] expressions paired with either singular or plural verbs. Immediately after reading the story, participants completed sentence fragments, including filler items, additional collective NP[PP] primes, and NP[RC] items. These contained a collective head noun modified by a subject relative clause ending with either a singular or plural noun, as in “the class that escaped the chaperone(s)”. The singular/plural local noun was always the direct object of the RC verb, which was always past tense and unmarked for number. The singular and plural variants were matched for plausibility, as established by prior norming with different participants. Priming was manipulated between subjects, local noun plurality within.

Participants' completions were coded as singular, plural, and other (typically containing a non-explicitly number-marked verb, e.g. “ran away”). Results showed significant effects of the local noun plurality (plural completions 15.8% with singular local noun vs. 35.0% with plural local noun). This strong local noun effect is notable given that local nouns took the role of RC direct object (intrinsically not an agreement controller), extending findings from Dutch (Hartsuiker et al., 2001). However, there was no significant effect of priming; plural completions did not differ significantly across priming conditions (21.5% with singular agreement primes vs. 29.2% with plural agreement primes, averaged over local noun type). This result suggests that the priming effects for NP[PP] conditions observed in Haskell et al. (2010) do not extend to relative clauses. We will discuss these results in terms of other syntactic priming effects and other agreement results in production.

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The rational integration of noise and prior semantic expectation: Evidence for a noisy-channel model of sentence interpretation

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Sentence comprehension; Noisy-channel models; Mechanical Turk

According to noisy-channel theories of sentence comprehension (e.g., Levy et al., 2009), listeners attempt to infer the most likely meaning from an utterance which may have been corrupted by noise such as deletions or insertions of words. These accounts therefore predict that the ultimate interpretation of a sentence should depend on the *proximity of plausible alternatives* under the noise model. In particular, if there is no plausible interpretation for an input string, then the closer a semantically plausible alternative is, the more comprehenders should rely on semantic cues for interpretation. Because previous models do not consider possible corruption of the linguistic signal by noise, they predict that the final interpretation is determined by syntax (e.g., Tanenhaus et al., 1995).

We investigated five English syntactic alternations (Levin, 1993): two “major-change” alternations – the active/passive and locative-inversion alternations – and three “minor-change” alternations: the transitive-intransitive alternation, the double-object (DO) / prepositional phrase object (PO) alternation for goals (“to” phrases), and the DO/PO alternation for benefactives (“for” phrases) (Table 1). If comprehenders rationally integrate the likelihood of noise with their prior semantic expectations, then semantic cues will have strongest influence on the interpretation of minor-change alternations. Thus, implausible DO structures like “The mother gave the candle the daughter” – which require only one deletion from the plausible PO (see 4b) – should be more likely to be interpreted according to semantics than implausible active structures like “The ball kicked the girl” – which require two deletions from the passive (see 1a).

We evaluated this prediction using a paradigm where participants answered a comprehension question about a sentence, whose answer indicated whether syntactic or semantic cues governed the interpretation (five experiments, 60 participants each; 20 items each). E.g., if the target sentence was “The ball kicked the girl”, then participants might be asked “Did the ball kick something/someone?”; “yes” indicates reliance on syntax; “no” – on semantics.

The noisy-channel prediction was borne out across the five alternations (Table 1). In particular, people relied on syntax more in the major-change alternations (93.4% (1)-(2)) than in minor-change alternations (56.1% (3)-(5); $p < .0001$). Furthermore, analysis of the minor-change alternations revealed that people rely on syntax more for structures requiring an insertion (66.1%) than those requiring a deletion (46.0%; $p < .0001$). This asymmetry is predicted by the Bayesian size principle (MacKay, 2003; Tenenbaum & Xu, 2007) because a deletion only requires a particular word to be randomly selected from a sentence, while an insertion requires its selection from (a subset of) the speaker’s vocabulary; the insertion of a specific word therefore has smaller likelihood.

Five follow-up experiments validated the assumptions of the noise model for each alternation. Participants were asked how likely a speaker would be to accidentally produce an implausible target sentence when intending to produce a plausible alternation. The results were as predicted: deletions were most expected, with insertions less expected, and multiple insertions/deletions still less expected.

In summary, we have demonstrated that comprehenders rationally integrate the likelihood of noise with prior expectations, and we have provided evidence for a particular noise model where deletions are more expected than insertions.

Construction/alternation	Example sentence	Plaus→Implaus changes	%Syntactic reliance
1a. Passive → Active:	The ball was/∅ kicked by/∅ the girl.	2 deletions	0.986
1b. Active → Passive:	The girl ∅/was kicked ∅/by the ball.	2 insertions	0.968
2a. Subj-loc → Obj-loc:	Onto/∅ the table jumped ∅/onto a cat.	1 deletion, 1 insertion	0.856
2b. Obj-loc → Subj-loc :	∅/Onto The cat jumped onto/∅ a table.	1 insertion, 1 deletion	0.933
3a. Intrans → Trans:	The tax law benefited ∅/from the businessman.	1 insertion	0.796
3b. Trans → Intrans:	The businessman benefited from/∅ the tax law.	1 deletion	0.625
4a. DO → PO-goal:	The mother gave the daughter ∅/to the candle.	1 insertion	0.620
4b. PO → DO-goal:	The mother gave the candle to/∅ the daughter.	1 deletion	0.478
5a. DO → PO-benef:	The cook baked Lucy ∅/for a cake.	1 insertion	0.568
5b. PO → DO-benef:	The cook baked a cake for/∅ Lucy.	1 deletion	0.276

Table 1: % syntactic reliance for the interpretation of implausible syntactic constructions, and the number of insertions & deletions that are needed to form a plausible alternation from the implausible version. E.g., 2 deletions are needed to form the implausible sentence “the ball kicked the girl” from the plausible “the ball was kicked by the girl”. Plausible (control) versions of these materials were also run in the experiment, and people always interpreted them according to their syntax & semantics (99%).

The parsing of Spanish object clitics by 4-year-olds

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Clitics; Syntax; Looking-while-listening; Eye-tracking; Spanish; Children; Production-comprehension

Learners' difficulties with object clitics (1) are well-documented in the acquisition literature, with supporting evidence coming primarily from production data (e.g., Castilla & Pérez-Leroux, 2010; Clark, 1985)). Recent work has added evidence from offline receptive tasks, but little is known about the parsing of object clitics in real-time (Grüter, 2006; Pérez-Leroux et al., 2008). Here we present findings from an eye-tracking experiment with 4-year-old (n=24) and adult (n=12) native speakers of Spanish, designed to address this gap. Specifically, we ask:

Q1) Do children's difficulties with clitics in production extend to online comprehension?

Q2) Are preverbal clitics (1a) more difficult to parse than postverbal clitics (1b)?

Building on Ferreira (2000), Grüter and Crago (2011) presented an account for learners' illicit clitic omissions (1c) in terms of processing limitations affecting the syntactic encoding stage in production. This suggests learners' difficulties are limited to production, thus predicting 'no' in answer to Q1. Within their account, the non-canonical word order – Subject-Object(clitic)-Verb – in sentences with *preverbal* clitics plays an important role, implicating that sentences with *postverbal* clitics may cause less difficulty (potentially 'yes' to Q2).

In an experiment using the looking-while-listening procedure (Fernald et al., 2008), participants listened to sentences like (1a/b) while looking at two pictures, both showing the same agent and action (*Dora touching*) but a different object. Only one of the objects was mentioned in the previous trial and matched the clitic for gender, thus constituting an appropriate referent for the clitic. **Adults** started orienting towards the target picture shortly after the onset of the clitic in both preverbal-clitic and postverbal-clitic conditions, i.e., significantly earlier in the pre-compared to the postverbal condition. **Four-year-olds** were divided into two groups based on frequency of clitic omission in an elicited production task (G1: ≤10%, G2: >10% omissions). The eye-movement data from G1 indicate a similar pattern to that observed in adults, with increased looks to the target after the onset of the clitic in both conditions, i.e., earlier in the CLITIC-PRE compared to the CLITIC-POST condition. In G2, however, no significant increase in looks to the target is observed following the clitic in either CLITIC-PRE or CLITIC-POST condition. This between-group difference is underscored by the observation that both subgroups performed comparably when the object was named with a full noun phrase (2), suggesting that the difference is specific to the parsing of clitic constructions.

The observation that children whose production of clitics is variable (G2; mean omissions: 41%, mean clitics: 52%; 31% preverbal, 21% postverbal) also have difficulty parsing clitic constructions in real-time ('yes' to Q1) indicates that the problem is not limited to syntactic *encoding* (contra Grüter and Crago, 2011), but affects a processing mechanism common to production and comprehension. Interestingly, postverbal clitics did not appear to be easier to process than preverbal ones ('no' to Q2). This indicates that syntactic complexity beyond surface word order, such as verb movement to the left periphery in both pre- and postverbal clitic constructions but not in clauses with lexical objects (e.g., Uriagereka, 1995), may be a critical contributor to learners' processing difficulties, suggesting that 'linguistic' grammars may indeed articulate closely with processing.

Examples

- (1) a. Dora **lo** está tocando.
Dora *it-SG-MASC* is touching
- b. Dora está tocando**lo**.
Dora is touching-*it-SG-MASC*
- c. *Dora está tocando.
'Dora is touching it.'
- (2) Dora está tocando el zapato.
'Dora is touching the shoe.'

Grounding of anaphora in pointing gestures: Order of mention and prominence

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Anaphor resolution; Embodied language processing; Plausibility judgment times; French

Anaphor resolution involves linking an anaphoric expression to a referent residing in the mental representation of the current discourse. Following the mental models approach (Johnson-Laird, 1983), such a mental representation includes a spatial dimension such that discourse entities occupy a more or less specified spatial position in the respective model, possibly from left to right following the order of mention.

Konieczny et al. (2010) demonstrated that resolving a pronominal reference is grounded in a simulated pointing gesture to a discourse entity. In an experiment using the action sentence compatibility paradigm (Glenberg & Kaschak, 2002), participants had to judge the plausibility of sentences, using a keyboard that consisted of three buttons located in a line with a distance of about 15 cm between them. Participants had to keep the center button pressed to display sentences word by word. The stimuli consisted of a main clause with two full noun phrases and a following subordinate clause containing a pronoun. Half of the target sentences involved pronouns referring to the subject of the main clause; the remaining target sentences contained pronouns referring to the object. Plausibility was evaluated by pressing the left or right button, respectively (with button assignments reversed after half of the trials). As predicted, compatible responses were performed faster, implying that interpreting a pronoun which refers back to the subject (1) was faster when the sentence required pressing the left button, while interpreting a pronoun referring to the object (2) was faster for sentences requiring the participants to press the button on the right. Beyond the compatibility effect, a subject preference as it is generally found in German was established.

A problem with the German data is that linear order and prominence are fully confounded as the first mentioned referent usually is also the most prominent one. We can thus not know whether the left to right ordering of subject and object is due to order of mention or to prominence. This problem can be solved in investigating a language such as French where the most prominent referent in within sentence pronoun resolution is usually mentioned later in the sentence (Hemforth et al, 2010). We thus ran a French version of the experiment with a highly similar experimental set-up.

A linear mixed-effects model with participants and items as random factors showed a main effect for the fixed factor pointing compatibility. Numerically but not reliably, responses to object resolutions were faster. As in the German experiment, hand movements were faster when the forced response direction was compatible with the canonical location of the discourse referent in the mental virtual space (subject-left and object-right). These cross-linguistic data strongly confirm the grounding of pronoun resolution in pointing gestures with order of mention as a major factor for positioning referents in the virtual space.

Examples

- (1) *The opera singer saw the scavenger, when she performed the difficult aria.*
- (2) *The scavenger saw the opera singer, when she performed the difficult aria.*

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Cumulative semantic interference persists even in highly constraining sentences

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Cumulative semantic interference; Cloze; Error-based learning; Picture naming; English

When speakers engage in conversation, they often talk about multiple members of the same semantic category (e.g., “Lions, and tigers, and bears – oh my!”; Baum, 1900). Given this, it seems inefficient that subjects name pictures (e.g., *cow*) slower when they have previously named other (and more) members of the same semantic category (*horse*, *pig*; Howard et al., 2006). Of course, in normal speech, words are typically produced in rich semantic contexts. The present study investigated whether the *cumulative semantic interference effect* (CSIE) persists even when pictures are presented in such a context; i.e., after high-cloze sentences.

In Experiment 1, 80 subjects named 94 pictures (60 critical) in each of two blocks. The critical pictures constituted 12 semantic categories of five pictures each. Half of the pictures in each block were presented in isolation; the other half were preceded by high-cloze sentences presented via RSVP with the last word omitted (e.g., “On the class field trip, the students got to milk a ____”). Results showed that although pictures were named 194 ms faster in the sentence condition relative to the bare condition, CSIEs of equivalent size were observed within both conditions. Furthermore, this interference fully transferred between conditions: Naming *cow* slowed the subsequent naming of *horse* equally regardless of whether *cow* or *horse* were named in isolation or after a sentence.

This finding cannot be explained straightforwardly by Howard et al.’s (2006) model of CSIE since it incorrectly predicts that trials with faster naming latencies will show less interference. However, it could potentially be explained by Oppenheim et al. (2010), whose error-based learning account claims that higher target activation and lower non-target activation constitute less error and thus reweight semantic-lexical connections to a smaller degree. These lead to decreased repetition priming and decreased interference on subsequent trials, respectively. Thus, to explain why bare and sentence conditions elicit same-sized CSIEs, Oppenheim et al.’s model must claim that a high-cloze sentence increases the target’s activation level while leaving its competitors’ activation levels unchanged. If so, we should observe less repetition priming for pictures previously named in sentence conditions than bare conditions.

Experiment 2 tested this hypothesis. As before, 80 subjects named 94 pictures (60 critical) in each of two blocks. In Block 1, half of the pictures were presented in isolation and half were presented after high-cloze sentences. However, in Block 2, every picture was presented in isolation. As in Experiment 1, CSIEs of equivalent size were observed in Block 1 for the bare and sentence conditions. Critically, Block 2 pictures were named 16 ms slower when they were previously named after a sentence than when they were previously named in isolation, confirming the prediction of Oppenheim et al. (2010).

In sum, our results confirm that cumulative semantic interference is undiminished even in richer semantic contexts and provide evidence for Oppenheim et al.’s (2010) error-based learning account of the CSIE. Furthermore, they shed light on how high-cloze sentences facilitate production, suggesting such sentences increase activation levels of targets while leaving the activation levels of their competitors unchanged.

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Evaluation of a Bayesian belief-updating model for the time course of linguistic adaptation

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Speech perception; Phonetic adaptation; Computational modeling; Mechanical Turk; English

Language understanding requires inference over noisy input. There is broad agreement that comprehenders make use of a variety of acoustic, syntactic, and discourse cues. Comprehenders also seem to rapidly adapt to situation- or speaker-specific changes in these statistical regularities [1-5]. These findings are compatible with experience-based accounts of language processing, which hold that individual experience affects language processing. What is missing, however, is a *theory* of such adaptation, an account that makes predictions about when and in what form adaptation should be observed. One theoretical framework with the potential to provide a unified account of the flexibility of language comprehension across linguistic levels is belief-updating, quantified as Bayesian inference. Bayesian belief-updating models have successfully been employed to model syntactic adaptation [6] as well as phonetic adaptation [7-9]. Here, we test the quantitative predictions of our Bayesian belief-updating model of phonetic adaptation, which we have previously evaluated *post hoc* against Dutch [8]. We used simulations over this model to derive predictions for English, which were then evaluated against human perception data, including several previously untested adaptation conditions.

Vroomen et al. [5] induced phonetic adaptation using AV /aba/ and /ada/ stimuli, where videos of a speaker producing either /aba/ or /ada/ were dubbed with synthetic audio which was either an unambiguous rendition of the video category, or was ambiguous. Unambiguous AV adaptors exhibited selective adaptation, where fewer (audio-only) test stimuli were categorized as /b/ after /b/-exposure, while ambiguous adaptors exhibited recalibration--more /b/ responses at test. Interestingly, selective adaptation strengthened with further exposure, while recalibration peaked after about 30 repetitions and then declined.

Experiment 1 replicates [5] on English, using a novel web-based approach (audio quality assessed in an initial calibration phase; only participants with sufficient category sensitivity finish). All effects of ambiguity found by [5] are present (logistic mixed-effects regression, $p < 0.05$), and as in [8] the belief-updating model fits well ($r^2 = 0.67$).

Experiment 2: Our model predicts that selective adaptation and recalibration are not, as previously claimed, distinct, but arise from listeners matching their expectations to the statistics of recent experience. That is, selective adaptation and recalibration are two points on a continuum, and intermediate adaptors should produce intermediate effects. Examining such an intermediate adaptor that is not fully ambiguous (auditory stimulus classified with 86% consistency), the adaptation effect is indeed intermediate between those in Experiment 1 (logistic mixed-effects regression, $p < 0.05$ for both main effects and one interaction). Furthermore, the model fits from Experiment 1 provide as good a fit for Experiment 2 ($r^2 = 0.66$) as for Experiment 1.

Experiment 3 tests our model's prediction that exposure to a high-variance distribution of ambiguous adaptors, would produce longer-lasting recalibration than the standard design using repetitions of exactly the same adaptor with no variability. Indeed, at the end of such high-variance exposure, recalibration was stronger compared to the original, low-variance condition (paired Wilcoxon $V(42) = 627$, $p = 0.028$).

Together, these results strongly support a unified Bayesian belief-updating model of selective adaptation and recalibration. Crucially, this framework is broadly applicable to linguistic prediction and inference, and in fact makes predictions about syntactic adaptation that are consistent with recent experiments [1,3].

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Online use of relational structural information in processing bound-variable pronouns

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Binding; Cue-based retrieval; C-command, Parsing

Recent findings in psycholinguistics motivate a parser that relies on parallel access mechanisms in content addressable memory [1]. In such an architecture non-local syntactic relations are not easily encoded. Evidence for this architecture comes from interference of grammatically-illicit licensors [2,3] and non-effects of syntactic dependency length [4,5]. On the other hand, some studies have shown that antecedent-retrieval procedures for reflexives are immune to interference [6-10], which suggests the need for a structure-sensitive access mechanism, and therefore, explicit encoding of syntactic relations in memory. The reflexive findings, while important, do not conclusively show retrieval's general sensitivity to relational information, since they involve local retrievals that could be computed heuristically (e.g., through a clause-mate feature). What is needed is a non-local relation that unambiguously obeys c-command constraints. Bound variable anaphora (1) provide such a test case. In two experiments (one self-paced reading, one eye-tracking) we show the parser's immediate sensitivity to structural constraints on bound variables. These results imply a structure-guided access mechanism that can implement such constraints.

Both experiments investigated reaction times at a critical pronoun (*he*, in 2). A feature-matching NP (*janitor*) served as a potential antecedent. The potential antecedent's ability to c-command the pronoun was manipulated by varying the attachment height of the pronoun's embedding clause. In *Command* conditions, the pronoun was embedded in a *when*-clause, in *NoCommand* conditions a *but*-clause was used. In addition to c-command relations, the potential antecedent's quantificational status was manipulated by changing its determiner: *any* in *Quant* conditions, *the* in *Referential* conditions. This allowed for comparison between binding of the pronoun and coreference. Coreference is insensitive to c-command restrictions, so *the janitor* could serve as antecedent for the pronoun equally well in both *Ref* conditions. However, the quantificational *any janitor* could only bind *he* in the *Command-Quant* condition, because c-command between *any janitor* and *he* obtains. Thus, the only condition in which the pronoun does not have an intra-sentential antecedent is *NoCommand-Quant*.

In Experiment 1 (self-paced reading, n=24) immediate sensitivity to the constraint on bound variable pronouns was demonstrated in a significant slowdown at the pronoun, in the *NoCommand-Quant* condition relative to all others ($p < .05$ - data were fit to linear mixed-effect models with subject and item as random effects [11]). In Experiment 2 (eye-tracking, n=32), like in Experiment 1, we found that the *Command* manipulation affected reading times following the pronoun in the quantificational conditions but not in the referential conditions, confirming that the clause-type effects are specifically associated with bound variable anaphora, and indicating immediate sensitivity to c-command constraints. However, the clause-type manipulation affected the different eye-tracking measures in different ways. Probability of regression mirrored the self-paced reading results, showing more regressions in the *NoCommand-Quant* condition. While the overall interaction effect was marginal ($p < .10$), pair-wise comparisons within *Quant* conditions showed a significant effect of increased regressions in *NoCommand-Quant* compared to *Command-Quant* ($p < .01$). Interestingly, second pass showed the opposite pattern, with elevated times in only the *Command-Quant* condition ($p < .01$). That is, only the condition where binding was available showed elevated reading times. This suggests that the impact of c-command constraints is not adequately captured in terms of more/less difficulty. Failure of licensing leads to regressive eye-movements, whereas successful variable-binding leads to longer dwell time on the pronoun region itself (see, e.g. [12]).

In sum, these findings show that the parser exhibits immediate sensitivity to relational structural constraints during on-line comprehension, and hence call for models of memory access in which relational structural information is readily available.

(1) *No man* said that Mary likes *his* mother.

(2) Kathy didn't think [*any janitor*] liked performing custodial duties, **but** *he* had to . . . [NOCOMMAND-QUANT]

Kathy didn't think [*any janitor*] liked performing custodial duties, **when** *he* had to . . . [COMMAND-QUANT]

Kathy didn't think [*the janitor*] liked performing custodial duties, **but** *he* had to . . . [NOCOMMAND-REF]

Kathy didn't think [*the janitor*] liked performing custodial duties, **when** *he* had to . . . [COMMAND-REF]

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Dissociating influences on prosodic prominence: Repetition shortens words but predictability lengthens words in Korean

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Predictability; Repetition; Prominence; Prosody; Speech production; Korean

In an object naming study, Lam & Watson (2010) found that predictability and repetition have independent effects on how prominently a word is produced in a discourse. Repeated words are produced with shorter duration whereas words with low predictability are produced with greater intensity. Lam & Watson (2010) argue that different cognitive processes underlie the two effects. Reduction is the result of lexical priming while increased intensity results from marking information status. These findings are consistent with Watson's (2010) multiple source theory: acoustic prominence is best understood as the product of multiple cognitive processes. This theory makes a strong prediction about the nature of prominence across languages: prominence linked to planning (e.g. repetition reduction) should be universal while prominence linked to marking information status may vary more freely.

In this study, we attempt to replicate Lam & Watson's (2010) finding in Korean. It has been argued that F0 is the most important acoustic correlate to prominence in Korean, whereas in English, intensity, F0, and duration are important (Jun, 1993). Despite these differences, repetition should still lead to shorter durations in Korean. In contrast, effects of predictability on the acoustic signal may vary across the two languages.

We used the same methodology as Lam & Watson (2010) with native Korean speakers. There were two factors: repetition and predictability. On each trial, participants were shown a 3x4 array of 12 images. Their task was to describe a shrinking and a flashing event that occurred in succession in each trial. The critical word for acoustic analysis was the noun in the second utterance. On repeated noun trials, the same object shrank and then flashed. On non-repeated trials, one object shrank and then another object flashed (See Example 1). To manipulate predictability, a circle cued the noun of the second event before it flashed. Exactly 11/12ths of the time, the cue correctly signaled the object involved in the second target. The rest of the time a different object flashed. This resulted in four conditions: repeated/expected, repeated/unexpected, non-repeated/expected, non-repeated/unexpected.

We analyzed duration, intensity, and F0. All analyses were conducted using multilevel linear regression. As in Lam & Watson (2010) repeated mention led to reduced duration ($p < 0.001$). Additionally, repeated mention led to reduced maximum F0 ($p < 0.05$). However, unlike Lam & Watson, predictability did not lead to reduced intensity. Instead predictable words were produced with longer duration than less predictable words ($p < 0.01$).

As in English, repetition led to shorter durations in Korean, suggesting that repetition reduction is the result of priming. However, predictable words were produced with longer durations, perhaps revealing a cross-linguistic difference in how discourse status is realized within the two languages. Nonetheless, this data supports Lam & Watson's (2010) claim that reduction is the result of priming processes (not predictability), and that multiple factors independently contribute to acoustic prominence.

Example 1:

Non-repeated: 참새가 작아진다 ... 의자가 깜빡인다
(bird is shrinking ... chair is flashing)

Repeated: 의자가 작아진다 ... 의자가 깜빡인다
(chair is shrinking ... chair is flashing)

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Syntactic parsing reduced to its core

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Specifier-Head-Complement analysis; Click-detection paradigm; Spanish

Chomsky (2007) proposes that language is a system designed for thought and only subsidiarily connected to the perception. If so, this would suggest that the grammar and the perceptual systems are two different realities of the mind that may have to come to be connected serendipitously. The aim of the psycholinguist would then be to work out how the perceptual systems deal with producing and processing language, a labour for which they were plausibly not designed. An “analysis-by-synthesis” approach might be a sensible way to relate grammar and perception, as it accommodates the fact that language comprehension is primarily a perceptual phenomenon (by postulating a first stage in which a ‘preliminary analysis’ is undertaken) with the observation that the representations the parser builds are structured, and hence generatively constructed (by grammatical rules stored in memory). Townsend & Bever (2001) suggest that the preliminary analysis involves imposing a NVN template onto the input, which we reformulate here as a (Specifier)-Head-Complement(s) (SHC) one in order to probe the cognitive load of complex Ns (SHCs embedded into other SHCs). We used the click-detection paradigm, an online technique that has been shown to be sensitive to the different memory loads between and within-clauses in complex sentences. 60 pairs of mono-clausal Spanish sentences composed of high frequency words and 20-syllables long were employed. These pairs were constructed from subject-verb-object sentences, resulting in two experimental conditions: extension of the verb to the left or to the right (Type A or Type B). Three click positions (1-2-3) were controlled for length and every sentence had one click only. Subjects listened to 72 sentences (12 practice, 60 experimental) and were instructed to press a button as soon as they heard the superimposed, 1000Hz tone, which had a peak amplitude similar to the most intense sound of the materials and a length of 25 ms. Responses were longer at the beginning of sentences, and there was a linear decrease in RTs between positions within sentence type. An analysis of variance showed that the Position factor was significant for both subjects and items analyses ($p < .01$), while the Type factor was only significant for the subjects analysis ($p < .05$; $p = .120$ for items). There was no interaction effect between factors in either analysis ($p = .534$, $p = .860$). Nevertheless, we compared pairs within same sentence type (A1 vs. A2, etc.) and across sentence type (A1 vs. B1, etc.) with a two-tailed t-test and found that all comparisons within sentence type were statistically significant for subjects and items, while the A2-B2 pair proved to be significant in the subjects analysis ($p < .05$). The data point to an uncertainty factor (similar to other monitoring tasks), a position effect, and to a lesser degree, a “verb search” effect. The latter two have not been reported in the literature, but may be taken to suggest that at a very early stage of processing the parser is (a) sensitive to the macro SHC structure and (b) trying to conjoin phrases as soon as possible (i.e., there is no “wrap-up” effect).

Materials

Experimental items (the click positions are marked by the | symbol):

Type A: La apertura | del hospital | se demoró | por diversos motivos.
‘The opening of the hospital was delayed for various reasons’

Type B: La apertura | se demoró | por motivos | aún desconocidos.
‘The opening was delayed for as yet unknown reasons’

Results: Subjects analysis, N=80: A1=257.22 ms; A2=222.51; A3=206.78
B1=252.40; B2=217.33; B3=205.26

Items analysis, N=60: A1=257.04; A2=222.78; A3=207.05
B1=253.23; B2=217.32; B3=205.00

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Grammatical or notional number?**3-year-olds' production and comprehension of verb agreement**

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Language acquisition; Syntax acquisition; Agreement; Production; Looking-while-listening; English

Three-year-olds show substantial command of subject-verb agreement in production and comprehension [1,2], and use agreeing verbs to anticipate the number of an upcoming noun in online sentence processing [3]; see example (1). But what representations support early sensitivity to subject-verb agreement? Referential and grammatical number typically concur: plural count nouns refer to multiple objects, are grammatically plural, and control plural verb agreement. Thus, sensitivity to verb agreement could rely on representations of number as a semantic property (the subject's number of referents), as a grammatical property (the subject's syntactic features), or both. For adults, verb agreement depends primarily on grammatical number [4]. Do toddlers also privilege number syntax, or do they rely more heavily on number meaning in computing verb agreement? The answer to such questions bears on classic debates regarding the centrality of semantic analysis in syntax acquisition [5,6].

We examined 3-year-olds' production and comprehension of verb agreement when grammatical and notional number mismatched. Mass nouns (e.g., *toast*) are grammatically singular even when referring to multiple objects [7,8]; invariant plurals (e.g., *pants*) are grammatically plural even when referring to one object.

Experiment 1 tested 3-year-olds' production of verb agreement. On each trial, a picture eliciting a count (e.g., *shirt*), mass (*bread*), or invariant-plural noun (*pants*) appeared, and then moved onto one of two shapes. Children described this scenario (e.g., *The shirt(s) is(are) on the star*). For count nouns, children's marking of noun number and verb agreement was strongly influenced by the number of objects. In contrast, for mass nouns and invariant plurals, marking of noun number and verb agreement honored grammatical features: Children treated mass nouns as singular (*corn is*), and invariant plurals as plural (*glasses are*), largely ignoring the number of referents.

Experiment 2 explored whether 3-year-olds' could use grammatical number in online comprehension of verb agreement in a looking-while-listening procedure. On each trial, children saw two pictures, each showing one or two identical objects, and heard a sentence with an agreeing verb (examples 2-3). The number of objects in the two pictures always matched. We paired count nouns with mass nouns (*banana(s)*, *toast*) or invariant-plural nouns (*phone(s)*, *glasses*), to create trials in which verb agreement yielded information about the grammatical but not the notional number of the target. Three-year-olds used agreeing verbs (*is*, *are*) to predict the grammatical number of the upcoming noun. Children were reliably faster to switch from the distractor to the target picture in number-informative than in uninformative trials. Children were also reliably more likely to make this switch in a brief interval after the verb and before the onset of the noun, in informative than in uninformative trials.

Thus 3-year-olds, like adults, privilege number syntax over number meaning in deriving and interpreting verb agreement. In production and comprehension, they linked plural-marked verbs with grammatically plural subjects regardless of the number of real-world entities the subject noun referred to. This suggests that formal grammatical categories, not reducible to semantic categories, provide the foundation for the acquisition of grammar.

Examples

	<i>Experimental</i>	<i>Control</i>
Informative: "Where <u>are</u> the good cookies?"	[1 apple, 2 cookies]	[2 apples, 2 cookies]
Uninformative: "Can you find the good cookies?"	[1 apple, 2 cookies]	[2 apples, 2 cookies]
<u>Mass Trials</u>		
Informative: "Where is the good toast/are the good bananas?"		[2 bananas, 2 pc. toast]
Uninformative: "Where is the good toast/banana?"		[1 banana, 1 pc. toast]
<u>Inv.Pl. Trials</u>		
Informative: "Where are the pretty glasses/is the pretty phone?"		[1 phone, 1 pair glasses]
Uninformative: "Where are the pretty glasses/phones?"		[2 phones, 2 pairs glasses]

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Info/information theory: Speakers actively choose shorter word in predictable contexts

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Uniform information density; Word length; Corpus analysis; Behavioral study; Efficiency; Surprisal

Piantadosi, Tily & Gibson (2011, henceforth PTG) demonstrated that the average information conveyed by a word is a significant predictor of its length. However, PTG did not examine length effects within part of speech categories nor attempt to control for meaning. Here, we show that language users actively choose short forms of synonym pairs (e.g., math/mathematics, exam/examination) in predictive contexts, a result consistent with uniform-information density (UID) accounts of language production (Genzel & Charniak 2002, van Son & Pols 2003, Aylett & Turk 2004, Jaeger 2006, Frank & Jaeger 2008, and Jaeger 2010). The use of near-synonyms that vary in length ensures that the observed effects hold for content words of the same part of speech and meaning. This work extends previous work on UID by showing that information rate can be manipulated not just through phonetic reduction (as in Bell, et al. 2003), syntactic factors (such as *that* omission, as in Levy & Jaeger, 2007), and choice of contractions (Frank & Jaeger 2008), but through active selection of noun word forms.

In a corpus study, we first used the data from PTG (a three-gram model from the Google corpus) to obtain average surprisal estimates for 22 long/short word pairs. Replicating PTG with this paired sample, the mean surprisal for long forms (9.21) was significantly higher than the mean surprisal for short forms (6.90) ($P = .004$ by Wilcoxon signed rank test). Of the 22 pairs, 18 showed higher average surprisal for the long form than for its short counterpart. A linear regression revealed that this difference held even while controlling for frequency: an intercept of 1.45 ($t = 2.76$, $P = 0.01$) indicated that, when there is no difference in frequency between the forms, the mean surprisal of long forms is 1.45 higher than of short forms.

To test whether participants actively choose short forms in predictive contexts, we presented participants with forced-choice sentence completions in which they had to choose between the short and long form of a word pair (exam/examination) based on which sounded more natural. The manipulation of interest was whether the context provided by the sentence was predictive of the missing final word (supportive-context condition) or was non-predictive (neutral-context condition), as in the sample item below. The order of the answer choices (i.e., whether the short form or long form was listed first) was balanced across participants and items.

- (1) **supportive-context:** Susan was very bad at algebra, so she hated...
1. math 2. mathematics
neutral-context: Susan introduced herself to me as someone who loved...
1. math 2. mathematics

In supportive-context sentences, the short form was chosen significantly more often (67%) than in neutral-context sentences (56%). The effect was significant by a mixed-effect logistic regression with both item and participant slopes and intercepts ($P < .01$).

These results indicate that speakers use content words to manipulate information rate, choosing words that optimize communicative efficiency. Moreover, these results suggest that the correlation between word length and informativeness is likely influenced by language production phenomena, where users actively prefer to convey meanings with short forms when the meanings are contextually predictable. We thus conclude that information-theoretic considerations are part of a speaker's knowledge and likely a causal factor in language change.

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Cue-based retrieval interference during ellipsis: ERP evidence

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Retrieval interference; Ellipsis; Event Related Potentials (ERPs); Spanish

Ongoing comprehension requires access to products of past processing. Consequently, understanding how the 'right' representations are retrieved from memory and what variables affect this process is fundamental for any theory of language. Under cue-based retrieval accounts, retrieval is subject to interference because it occurs by content – that of the antecedent *and* the retrieval cues [1-3]. But how does “other information,” especially between the words that form the dependency, modulate processing of the retrieval cues themselves? One way to test this is to manipulate how *diagnostic* a cue is to a unique antecedent in memory, or *cue-diagnosticsity* – the relative degree of match between cues and the antecedent versus other items in memory [2,4].

We asked if the syntactic structure of information in memory at the point of retrieval affects measures of retrieval interference (RI) in a gender-agreement attractor paradigm. We observed the online processing of noun-phrase ellipsis (NPE; see Table), where antecedents must be retrieved and interpreted in a new sentence position. In Spanish, the determiner *otro/a* can head elided NPs and must agree with the NP [5]. We recorded ERPs while participants ($n=29$) read NPE sentences (see Table; 120 items, 60 unelided fillers); between the antecedent and the retrieval site was an object-extracted relative clause (RC) (cf.[4]). The determiner ('otra'/'otro') correctly or incorrectly agreed with the antecedent ('la camiseta') and occurred in the context of a matching/mismatching local agreement attractor ('la falda'/'el vestido'). The attractor was never a licit antecedent. Importantly, and in contrast to [4], antecedent had the same syntactic role in every clause - that of object.

Critical words (CW) elicited a sustained anterior negativity (Incorrect–Correct) between 100-500msec that was modulated by the attractor. A repeated-measures ANOVA showed a Cue (correct, incorrect) x Attractor (same, different) x Anteriority (anterior, posterior) 3-way interaction. Follow-up analysis on CW Anterior channels revealed an interaction between Cue and Attractor ($F(1,28) = 4.63, p < .05$) in this time window, whereby the Correct conditions differed (A more negative than B) and the Attractor-different conditions differed (D more negative than B). The following word (FW) elicited a posterior positivity between 700-900msec (Incorrect-Correct; P600-like effect), also modulated by the attractor. Another Cue x Attractor x Anteriority interaction was found. Follow-up analysis on FW Posterior channels showed an interaction between Cue and Attractor ($F(1,28) = 4.81, p < .05$) and a main effect of Cue ($F(1,28) = 23.08, p < .001$) in this time window; the Correct conditions differed (B more positive than A), and the Attractor-same conditions differed (C more positive than A).

This pattern provides further evidence that RI occurs under grammatical circumstances and that gender-agreement and structural information form a composite retrieval cue, affecting how diagnostic a cue is to its target. In contrast to [4], where the antecedent had different syntactic roles in the RC and elided clause, RI from decreased cue-diagnosticsity manifested as interactions on the CW and FW. We take this to suggest that structural aspects of the current contents of memory determine what 'counts' as diagnostic and therefore modulate the ERP signature of RI.

Condition	Sentence
A. Correct cue, Attractor-same / C.*Incorrect cue, Attractor-same	Marta se compró la camiseta con la que la <u>falda</u> iba bien _y Miren cogió otra/*otro [...] para salir de fiesta. <i>Marta bought the t-shirt that the skirt went well with and Miren took another to go to the party.</i>
B. Correct cue, Attractor-different / D.*Incorrect cue, Attractor-different	Marta se compró la camiseta con la que el <u>jersey</u> iba bien _y Miren cogió otra/*otro [...] para salir de fiesta. <i>Marta bought the t-shirt that the sweater went well with and Miren took another to go to the party.</i>

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Syntactic probability influences duration

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Duration; Phonetic reduction; Structural probabilities; Training

Spoken words reduce more the more predictable, or redundant, they are given their context (Aylett and Turk, 2004; Jaeger, 2010). Because of this, knowledge of predictability must have a place in the production system. This paper demonstrates, more particularly, that the production system must have access to information about the probability of syntactic structures which is not retrievable from the lexicon.

This study builds on work by Gahl and colleagues, which demonstrates that the predictability of the syntactic structure of a verb's complement given the verb's subcategorization bias affects the duration of words in that structure in a production task (Gahl and Garnsey, 2004) and in a spoken corpus (Tily et al., 2009). This work demonstrates that speakers use the probability of a structure given its context in the production process. This work does not address the question of where these probabilities are stored. Because they examine probabilities of complement structures which are conditioned on the identity of the verb, one option is that the probabilities of complement structures are affiliated with each verb's lexical entry.

In the current study, I aim to demonstrate that speakers know and use online probabilities over syntactic structures which are not conditioned by a particular lexical item, and cannot be affiliated with a particular lexical entry. I will separate the probability of a structure from its inherent complexity by manipulating the probabilities of structures within the experiment. The results of this show the need for some extra storage mechanism for probabilities over structures, which must be accessible to the production system.

For animate extracted constituents, subject extraction is much more common in corpora than object extraction (Roland et al., 2007). The present study measured the duration of the clefted constituent, not including pauses, in experimentally-induced pronunciations of subject- and object-extraction clefts in English.

Object extraction (OE) is more difficult to process than subject extraction (SE) (e.g. Gibson, 1998). In order to disentangle the probability of OE structures from their inherent difficulty, the probability of each structure was manipulated within the experiment. Two groups of participants each saw: First, two of each type of cleft; second, eight of either SE or OE clefts; and finally, another two of each type of cleft.

Before training, the clefted constituent was longer in OE clefts (mean 407ms) than in SE clefts (370ms, $t=2.4$, $p=.02$). After OE training, this difference was no longer present (OE: 385ms, SE: 397ms), but it was still present after SE training (OE: 448ms, SE: 388ms). A linear mixed effects regression model was fitted to the duration data from the two training conditions, with extraction type and training condition and their interaction as the fixed effects, and subject and item as random effects. A significant effect ($p=.04$) was found for the interaction of extraction type and training condition.

These results demonstrate that speakers track probabilities over different types of clefts, and thus know probabilities over syntactic structures not affiliated with any particular lexical entry, and use them in production.

(1)**Subject-extraction:** It was Edward who (t) scammed Melvin out of some money.

(2)**Object-extraction:** It was Edward who Melvin scammed (t) out of some money.

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Filling and revising a gap in Chinese: What does it tell us about semantic and syntactic processing?

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Gap-filler dependency; Self-paced reading; Sentence completion; Chinese

In processing a gap-filler dependency, the gap is received before its filler. Gaps are structural positions that have little semantic content until linked to fillers. Thus, gap-filler processing may involve the dual goals of building a phrase and completing its meaning. This could cause conflicts of following structural rules or supplying semantic content for the gap. Will the parser violate structural principles to provide a filler for an identified gap? How high is the cost of gap reinterpretation? The present study investigated processing of ambiguous Chinese constructions containing a subject gap, as in (1). The fragment can be analyzed as a right-branching subject clause (SC), where the gap is not filled, or a noun phrase containing a pre-nominal relative clause (RC), where *friend* is the filler. The right-branching structure is overwhelmingly preferred when the clause-initial verb *wait* is received (Ng & Fodor, 2011). Here we determined if Chinese speakers adopt the RC analysis at *friend*. This revision would violate several structural principles (e.g., Minimal Attachment and Minimal Revisions), and would show a preference for filling the gap early despite the greater structural complexity of the RC.

Native Mandarin speakers were tested on a sentence completion task and two self-paced reading tasks. Sentence completion results (n=20) confirm that SC is preferred up to the first noun, i.e., *guest* in (1). However, fragments like (1) were equally likely to be continued as SC or RC. The word-by-word reading (n=36) employed sentences like (2a,b), which differ only in the second noun (*friend* vs. *reply*). At that point, an animate noun makes both analyses possible but an inanimate noun allows only the right-branching analysis. Crucially, if the RC analysis is adopted with *friend* as the head noun, the appearance of the second *de* would force structural revision and *host* would become the head noun. Results showed that the second *de* and *host* in (2a) were read significantly slower than those in (2b), suggesting that at *friend* in (2a), the RC analysis was adopted and the subsequent appearance of *de* caused reanalysis. The second reading task (n=36) employed sentences like (1) and (3). (3) is ambiguous between a noun-complement clause (NCC) and a SC. NCCs have a structure like regular RCs, but the noun after *de* cannot be the filler for any gap in the clause. Each sentence was divided into two parts. The first part could be ambiguous; the second part disambiguated the structure. Reanalysis cost was derived from the reading-time difference of the second part between the ambiguous conditions like (1) and (3) and their unambiguous counterparts. Results showed that the reanalysis cost for (1) was significantly larger than that for (3). This suggests that revising a construction with gap reinterpretation (RC and SC) is more costly than revising one without gap reinterpretation (NCC and SC).

Overall, the parser will sacrifice structural economy for gap-filler completion. Moreover, gap reinterpretation is costly. Further implications are that the parser may take priority in completing the meaning of a phrase, and revising the established semantic relations among arguments is difficult.

- (1) e Dengdai keren de pengyou... (*de*: adnominal marker)
 wait guest de friend
 a. SC: 'Waiting for the guest's friend...' ([S [S [NP e][VP wait [NP guest de friend]]] [VP ...]])
 b. RC: 'The friend who waited for the guest...' ([S [NP [CP [S [NP e][VP wait guest]]] [C de]] [N friend;]] [VP...]])
- (2) a. [[e; Dengdai keren de pengyou] de zhuren;] hen jiaoji.
 wait guest de friend de host very anxious ([RC [e; wait guest de friend]] de host;)
 'The host who waited for the guest's friend was very anxious.'
 b. [[e; Dengdai keren de dafu] de zhuren;] hen jiaoji.
 wait guest de reply de host very anxious ([RC [e; wait guest de reply]] de host;)
 'The host who waited for the guest's reply was very anxious.'
- (3) Part I: e Fucong WangTao de zhishi...
 obey WangTao de instruction
 a. NCC: 'The instruction that (someone) obey WangTao...'
 ([S [NP [CP [S [NP e][VP obey WangTao]]] [C de]] [N instruction]] [VP...]])
 b. SC: 'To obey WangTao's instruction ...' ([S [S [NP e][VP obey [NP WangTao de instruction]]] [VP ...]])
 Part II: NCC: ...was already dispatched. / SC: ... can reduce your mistake.

Retrieval interference in the resolution of anaphoric PRO

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Anaphor resolution; Memory retrieval; Self-paced reading; Acceptability judgments; English

Recent research on the memory mechanisms used in real-time language comprehension has revealed a selective profile for retrieval interference effects. Subject-verb agreement shows facilitatory interference, predicted by cue-based (mis-)retrieval in a content-addressable architecture [1,2]. By contrast, reflexive anaphors do not show facilitation effects: previous studies have either found (i) no effects of structurally inaccessible antecedents [3,4,5], or (ii) inhibition effects [3,6,7], which are not predicted by the cue-based model. The reasons for this contrast remain unresolved. The contrast may reflect the interpretive status of agreement vs. anaphora, or differential use of non-structural features as retrieval cues. Licensing PRO provides a good test of the candidate retrieval mechanisms because it shares properties with both agreement and reflexive binding. Results from three studies confirm the structural constraints on licensing PRO, but show an on-line interference profile similar to agreement, suggesting the use of non-structural cues for PRO retrieval. These results provide the first case of facilitatory interference in anaphora resolution.

Licensing PRO in adjunct clauses is subject to structural constraints. The controller must be the subject of the next higher clause (1). This constraint suggests that retrieval might consider only structurally appropriate controllers, similar to reflexive licensing. However, PRO shares two properties with subject-verb agreement: the search for a controller is triggered by a verb rather than an independent anaphoric element, and selectional restrictions from the gerundive verb (e.g. [+animate] subject bias) might provide additional retrieval cues. Given that agreement shows strong facilitatory interference, if PRO behaves like agreement, then facilitatory interference from structurally inaccessible antecedents should occur.

We compared agreement and adjunct control sentences (8 conditions, 48 sets, (2)). Both cases contained a grammatical subject (underlined) and a structurally inappropriate subject ("attractor", in {}). In the agreement conditions (2a-d) we manipulated the number of the attractor such that it either agreed or disagreed with the highlighted verb, testing for "illusions of grammaticality". In the adjunct control conditions (2e-h), the animacy of the attractor was independently manipulated. An emphatic reflexive requiring an animate, gender matching NP antecedent as the local subject (PRO) served as a probe to determine whether an animate NP had been retrieved as the subject of the adjunct clause.

Experiment 1 (off-line acceptability ratings, n=24) confirmed the structural requirements on PRO licensing. Experiment 2 used the ACT-R parser to establish predictions from a cue-based retrieval theory [8,9]. Simulations predict facilitatory interference for both agreement and adjunct control. Experiment 3 (self-paced reading, n=32) tested the predictions of the model. Linear mixed-effects modeling revealed facilitatory interference effects for both agreement and adjunct control, due to reduced disruptions for ungrammatical conditions in the presence of a plural attractor (agreement) and interfering animate NP (adjunct control) at the post-verbal and post-reflexive regions respectively.

These results indicate that the contrasting interference profiles seen in previous studies cannot be due to the interpretive status of anaphora vs. agreement. We propose instead that susceptibility to interference is a consequence of the use of specific content cues (such as animacy) in retrieval.

1a. John_i read the report after PRO_i drinking his coffee. 1b. *The report confused John_i after PRO_i drinking his coffee.
2a/b: The doctor that the {researcher/reports} evaluated extensively was commended [after PRO disproving the controversial theory at the research institute in Europe].
2c/d: The experiment that the {researchers/report} evaluated extensively were commended [after PRO disproving the controversial theory at the research institute in Europe].
2e/f: The doctor that the {researcher/report} evaluated extensively was commended [after PRO disproving the controversial theory himself at the research institute in Europe].
2g/h: The experiment that the {researcher/report} evaluated extensively was commended [after PRO disproving the controversial theory himself at the research institute in Europe].

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The mental representation of plurals

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Plurals; Picture-matching paradigm; English

Evidence suggests that comprehenders represent both morphological and conceptual number on-line (e.g. Berent et al., 2005; Patson & Warren, 2010), but few studies have investigated the mental representations comprehenders construct for plurals (cf. Kaup et al., 2002; Patson & Ferreira, 2009). We used the NP/picture matching paradigm used by Zwaan and colleagues (e.g. Stanfield & Zwaan, 2001) to test the hypothesis that plurals are represented indistinctly, as non-individuated sets (e.g., Patson & Ferreira, 2009; Patson & Warren, 2011).

In Experiment 1, participants read sentences that ended with either a singular or plural NP (*The farmer picked the apple/apples*) and then saw a picture that either matched or mismatched the number of items mentioned. For example, for the singular NP example above, the picture was either a single apple (match condition) or multiple apples (mismatch condition). Participants judged whether the pictured item(s) was/were mentioned in the sentence, and were instructed to ignore the number of items pictured. Judgment times showed an interaction between NP plurality and match condition, $F(1,47)=8.10, p=.007$; $F(1,27)=3.38, p=.077$, such that when the NP was plural, the effect of the number of pictured items was not reliable. However, when the NP was singular, participants were reliably faster to respond “yes” to a singular picture compared to a plural picture. Importantly, picture naming times from a norming study did not predict judgment times in this task, consistent with the assumption that the judgment time effects reflect the interaction of the sentences and pictures.

Experiment 2 extended this finding to conceptual plurals. Participants read sentences biased toward either a collective (*Together the men carried a box*) or distributed (*Each of the men carried a box*) reading. Under a collective reading, the plural subject is treated as a single group and it is their combined effort that carries a single box. However, under a distributed reading, the most common reading is one in which each man has an associated box (Kurtzman & MacDonald, 1993). Therefore, *box* becomes conceptually plural. Experiment 2 showed an interaction between NP conceptual plurality and match condition, $F(1,47)=7.49, p=.01$; $F(1,33)=7.59, p=.01$, with the same pattern of means found in Experiment 1.

These results suggest that our mental representations for plurals cannot be characterized as containing multiple copies of singular exemplars. If they could, we should have found a main effect of match. The observed interactions, such that participants were slower to respond to a plural picture than to a singular picture following singular NPs, but did not show a reliable difference in picture judgment times following plural NPs, are consistent with the hypothesis that plurals are represented indistinctly. Specifically, an indistinct group representation might focus on different features than a singular representation; for example, a mental representation for “The farmer picked the apples” might highlight their amount or weight, rather than their redness or roundness, etc. In this case, neither a plural nor a singular picture would be a good match for the mental representation of a plural NP, leading to the observed interaction.

Experience-dependent predictive processes in learning novel verb bias: An ERP study

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Verb bias; Syntactic learning; Event Related Potentials (ERPs); English

Frequency-based accessibility of structural alternatives for particular verbs, also known as verb bias, plays an important role in comprehenders' predictions about upcoming sentence structure [1, 2]. The current study investigated electrophysiological dynamics underlying learning new verb biases by asking two questions: 1) Do readers use newly learned verb biases to predict upcoming words in sentences?, and 2) How does ambiguity resolution contribute to learning?

Twenty-four participants completed four training blocks and were then tested in a forced-choice picture-matching task. EEG was recorded while participants read training sentences containing novel verbs. Training sentences provided strong context promoting either modifier or instrument attachment of a prepositional phrase, as in (1) and (2). In instrument-training sentences (1), *tractor* is clearly an instrument for an unknown action *dakking*, while in modifier-training sentences (2), *stalks* is clearly a property of the *corn*. For each participant, two novel verbs were trained in ambiguous sentences containing *with*-phrases, while another two verbs were trained in sentences disambiguated by substituting *using* or *that has* in place of *with*. Each novel verb was presented in only one of the four training structures. Pictures of the direct object (corn) and the potential instrument (tractor) were presented before each trial, to allow specific predictions about upcoming words. The instrument noun (e.g., *tractor*) appeared in all sentences, but in later non-critical positions in modifier-training sentences. We predicted that instrument training would lead to a highly predicted PP-object noun, while modifier training would not generate such specific expectations. At the behavioral test afterwards, each participant read 24 sentences containing the 4 trained verbs and another 2 untrained verbs in globally ambiguous sentences including *with*-phrases, such as (3). The task was to choose which of 2 pictures was more consistent with the ambiguous sentence.

Behavioral data suggested participants tended to learn instrument bias only from structurally ambiguous sentences using *with*-phrases. This effect was mainly carried by right-handers without left-handed relatives ($n=13$), who made reliably more instrument attachment choices for instrument-trained than modifier-trained verbs and untrained control verbs. No such difference was observed for verbs trained in unambiguous structures. The higher learning efficacy of ambiguous training was also reflected in reduced P600 amplitude across training blocks for ambiguous-trained novel verbs only. At the disambiguating noun, mean N400 amplitude elicited by instrument nouns (e.g., *tractor*) was reduced compared to modifier nouns (e.g., *stalks*) during the first training block, suggesting confirmation of readers' semantic predictions about an upcoming instrument. Starting from the second training block, the effect changed to a reduced P600 elicited by instrument nouns compared to modifier nouns. The N400-to-P600 transition was observed mainly in ambiguous conditions containing *with*-phrases, suggesting that resolving ambiguity might be crucial for verb bias learning.

The results suggest experience-dependent plasticity in the language system, which continuously collects statistical patterns from linguistic input, particularly when input is ambiguous. Participants quickly apply newly-learned distributional information to guide predictions about upcoming sentence structure. Future analyses will further address effects of individual differences in familial sinistrality on verb bias learning.

Sentence Examples

- (1) Instrument Ambig. / Unambig.: *The suntanned farmer dakked the corn with / using the big tractor...*
- (2) Modifier Ambig. / Unambig.: *The suntanned farmer dakked the corn with / that has the high stalks...*
- (3) Globally Ambiguous test sentence: *The angry teacher dakked the student with the low score.*

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Communication breakdown induces audience design strategies

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Audience design; Miscommunication; Pseudo-confederate interaction; Production; English

Several studies have tried to get speakers to produce unambiguous syntactic structures for listeners, but only with mixed success (e.g., Ferreira & Dell, 2000; Kraljic & Brennan, 2005; Snedeker & Trueswell, 2003). Most of these designs lack the context that necessitates disambiguation, and the responses obtained from participants has often been interpreted as being an egocentric default (i.e., it is cognitively easier to take one's own perspective). In most contexts, visual ambiguity is inconsequential to the success of the interaction and miscommunication is unlikely. In the current work, we seek to induce participants to use an instruction-giving strategy that clarifies a visual ambiguity (e.g., "Put the banana that's in the box on the circle"; similar to Haywood, Pickering & Branigan, 2005). In the Haywood et al. study, relatively mixed or weak hints of audience design were found. We attempt here to make visual ambiguity more salient in the form of visual communication breakdown, in order to explore its effect on disambiguation.

Experiment 1 implemented a visual mistake (pre-recorded video with a mistake), during an ambiguous two-referent instruction task with a pseudo-confederate (pre-recorded video and audio responses). The mistake was intended to draw the participant's attention towards the visual ambiguity. The presence of a mistake had a significant effect on disambiguated statements (e.g., a statement that grouped the two-referents as one object) for participants who believed the pseudo-confederate was real. Subsequent analysis revealed that as the experiment progressed, two-referent statements decreased in duration relative to the one-referent statements. The visual mistake was clearly a successful cue, which may have promoted faster productions that required fewer resources for future productions in an automatic way.

Experiment 2 tested the role of cognitive load, via an imposed time pressure, during disambiguation strategy formation. The results revealed that increased time pressure or induced cognitive load, reduced syntactic disambiguation. This suggests that planning an utterance is affected by cognitive load and if resources are taxed then an interlocutor will resort to an ease of production strategy.

Subsequently, Experiment 3 evaluated the effect of varying time pressure on syntactic disambiguation to further explore memory's role on strategy formation. The results suggested that participants strategically formulate syntactic disambiguation if they have time, and these strategies will persist when they are eventually pressured for time. In contrast, when pressured early on interlocutors have difficulty formulating a strategy to disambiguate resulting in ambiguous utterances. However, as soon as the time pressure is removed, they quickly disambiguate. Until a disambiguation strategy is established, cognitive load seems to have a substantial impact on an interlocutor's ability to plan syntactic disambiguation, but not the talker's ability to take the other's perspective.

When participants are able to integrate the communication breakdown, they make use of it successfully. Here we show that disambiguation can happen as a wholesale strategy, but that it requires cognitive resources to succeed. We advocate that audience design is adaptive and does not anchor itself to concepts of an "egocentric default" as a fixed aspect of production processes during interaction.

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An ERP study of semantic processing in Austrian sign language (ÖGS): The case of antonyms and classifiers

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Sign language; Semantic processing; Prediction; Event Related Potentials (ERPs); Austrian Sign Language

One of the main issues in human sentence processing is the question to what degree language processing strategies can be regarded as universal strategies applicable to all languages or whether processing strategies are guided by language-specific information. Despite this typological approach almost all experimental studies are based on spoken languages and moreover to an overwhelming degree on English. In contrast, investigation of sign language is still in its very infancy. Indeed, there are only few studies investigating online processing with event-related potentials (ERPs) and only recently researchers started to use videos for stimulus presentation to assure a natural rate of signing (Capek et al., 2009; Hoseman et al., 2011).

Starting from earlier findings that lexical-semantic N400 effects in sign language are similar to spoken language (cf. Capek et al. 2009) the aim of our study was to investigate whether one can also find similarities with respect to ERP correlates of predictive processing strategies. Roehm et al. (2007) showed that distinct parsing strategies due to task demands and/or semantically restrictive contexts influenced semantic processing. In a sentential context involving antinomies (e.g. The opposite of black is ...) participants showed a P300 for the sentence-final word in the antonym condition ("white"), in contrast to graded N400s for the related ("yellow") and non-related ("nice") conditions. The authors suggested that the P300 reflects the match between the parsers' prediction of an incoming element (pre-activated representation) and the target stimulus.

In this experiment we tried to replicate these findings in Austrian Sign Language (ÖGS). To this effect, three antonym conditions in which the final sign either fulfilled the semantic expectation (A1=antonyms), or violated the expectation (A2=related; A3=unrelated signs) were presented to 15 deaf native ÖGS signers in real time videos. In addition, we presented two conditions in which the sentence final classifier sign either was correct (B1) or incorrect (B2). In order to detect the exact point in time of lexical access we defined several triggers reflecting different parameters in sign production: (i) offset of the pre-critical sign, (ii) handshape, i.e. the first frame where the handshape information of the critical sign was clearly visible, (iii) frame where an additional parameter (e.g. correct position, mouth shape) was added, and (iv) frame where the intended sign was uniquely identifiable.

Similar to previous ERP studies (Capek et al., 2009) semantically deviant structures elicited an N400-effect that showed the most typical peak latency distribution with respect to trigger (ii) and (iii). For the antonym conditions the N400 was more pronounced for the non-related (A3) in comparison to the related (A2) condition. More interestingly, in the same time window antonyms (A1) showed a P300 for semantically congruent words, thereby indicating a prediction-based parsing strategy. Yet, unlike spoken language, an N400 for antonyms (A1) can be observed even before stimulus onset (handshape information), thus indicating lexical access before the critical sign is uniquely identifiable. By contrast, incorrect compared to correct classifiers elicited an LAN / P600 pattern which typically shows up for morphosyntactic violations in spoken language.

A) BLACK OPPOSITE+PART WHAT WHITE / *YELLOW / *NICE.
*The opposite of black is (1) white / (2) *yellow / (3) *nice.*

B) * MOTORBIKE B-CL OPPOSITE+PART WHAT MOTORBIKE B-CL.
upward-movement palm vertical downward-movement (1) palm vertical / (2) *pronated
A motorbike goes uphill is the opposite of a motorbike goes downhill.

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The effects of addressee attention on prosodic prominence

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Prosodic prominence; Attention; Audience design; Instruction-giving task; English

How do speakers accommodate distracted listeners? Specifically, how does prosody change when speakers know that their addressees are multitasking? Two conflicting possibilities are considered. First, speakers might produce more acoustic prominence for distracted addressees, to ensure that important information is communicated. Prominence, as expressed by pitch and duration, among other prosodic features, is used to signal important or new information (Brown 1983, Sityaev 2000). The second possibility is that speakers might disengage from the task and use less acoustic prominence. This possibility is suggested by findings that speakers produce less detailed stories when speaking to inattentive listeners (Kuhlen & Brennan 2010, Pasupathi et al. 1998). Task demands may also influence prosodic choices. Previous studies have used narrative tasks, in which there are few consequences if information is not correctly conveyed. Perhaps speakers would use more acoustic prominence to communicate important information to distracted listeners if this information were necessary for task completion. Such questions are relevant to models of language production because they examine how prosody is influenced by audience design. Speaker internal constraints on planning and production are known to influence prosody (Bell et al. 2003, Lam & Watson 2010), but whether prosody is influenced by addressees' attention remains underspecified.

We studied the effects of addressees' attention on speakers' prosody with two instruction-giving experiments. Each experiment included 10 participants. Speakers (task participants) instructed listeners (confederates) to move objects to locations on a board. Objects were put on the table in pairs. Speakers viewed a computer screen that was out of sight of the listeners, which showed the object to be moved and its intended location. In Experiment 1 the target item was the second of two items, and therefore predictable. In Experiment 2 the target word was the first of two items and therefore relatively unpredictable. Target words were normed for length and frequency. In the distraction condition, addressees were also completing a demanding secondary computer task; in the attentive condition they paid full attention. The speakers were told that the addressees had to complete this task and it was visually apparent that the addressees were distracted. The distraction conditions were blocked, each speaker experienced both conditions, and the order of the conditions was counterbalanced.

Speakers used more acoustically prominent (longer) pronunciations for distracted listeners. Moreover, this effect was localized to the most task-relevant information, i.e. the object that the addressee needed to move. This effect was found for predictable targets (Experiment 1 items). This finding suggests that speakers are more likely to reduce predictable targets with attentive than distracted addressees. Speakers provided more, rather than less, prosodic prominence to distracted listeners, when task demands placed a high value on information being conveyed correctly.

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What can the brain tell us about *some*?

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Scalar implicatures; fMRI; Semantics; Pragmatics; Quantifiers

We often have to make inferences beyond the literal meaning of what we hear. Weak scalar elements like “some” typically give rise to the inference *some but not all* in adults. This inference is part of the enriched meaning of *some* which is assumed to have a single lexical meaning of “all amounts greater than none”. The enriched meaning is achieved by the derivation of a scalar implicature. This aspect of language processing has been extensively tested with behavioral methods, showing that adults do indeed derive the implicatures with different types of weak quantifiers and scalar terms (such as *some* and *or*). However, the means by which this derivation occurs are still unclear. Some attribute this process to grammatical-semantic components whereas others suggest a pragmatic mechanism involving theory of mind. The present study utilized fMRI to identify the neural network associated with the enriched meaning of *some* and the derivation of scalar implicatures. Thirteen adults performed a sentence-picture matching task in which they listened to sentences with weak (*some*) or strong (*every*) quantifiers (e.g., “some elephants are dancing”) and had to match them to pictures in which all (*all context*), some (*some context*) or none (*none context*) of the individuals performed the relevant action. We focused on the neural processing differences between sentences with weak versus strong quantifiers. We also compared successful implicatures (where sentences with *some* were presented in the *some context*) and failed implicatures (where sentences with *some* were presented with the *all context*). First, we examined brain areas that were more activated for sentences with strong quantifiers compared with sentences with weak quantifiers (*every* > *some*) and no difference was observed. The opposite comparisons which investigated areas that were more activated for weak quantifiers compared to strong quantifiers (*some* > *every*) showed activations in several areas, including the left inferior frontal gyrus (Brodmann (BA) area 47). BA 47 was activated for both successful (*some* sentence in *some* context) and failed implicatures (*some* sentences in *all* context). Other areas, including bilateral superior and middle frontal gyri and the anterior cingulate, were activated instead only when implicatures failed. BA 47 has been consistently linked to semantic processing (as shown in meta-analyses and reviews of several neuroimaging studies [1-3]), but not to pragmatic processing (which is linked mainly to the right hemisphere). It has been suggested that this area is involved in integration of semantic information in ways that are different from simple lexical-semantic processes of single word meaning ([4-5]). Thus, our study has three main consequences: (1) the processing of weak quantifiers (where weak means ‘weak element of a scale’, and possibly also ‘non-partitive’) generates a greater processing load with respect to that of strong quantifiers. (2) The increased activation in BA 47 for sentences with weak quantifiers vs. strong quantifiers further suggests that the scalar implicature derivation is performed by a semantic, rather than pragmatic, network. (3) The situation in which implicatures fail induce extra cognitive cost. Our results have interesting implications for the debate regarding the nature of the derivation of scalar implicatures.

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Processing temporality: Syntactic position determines interpretation

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Processing temporal adverbials; Acceptability rating; Aparaphrase rating; Self-paced reading; German

The present study addresses whether the syntactic position of a temporal adverbial affects the temporal interpretation of a sentence. In the semantics literature it has been noted that time-frame adverbials in German, e.g., *in dreißig Minuten* (“in thirty minutes”), are ambiguous (Zybatow, 2001). With one reading, which we shall call *egressive*, given in (1a), the event takes place in the time interval specified by the adverbial. With the other *ingressive* reading, given in (1b), the event will start after this time interval; note that the German present tense can express future tense as well. It has also been noted that the position of the adverbial might trigger one of the two readings (Engelberg, 1994; Trautwein, 2005). There seems to be a preference for the egressive reading with a late adverb, as in (2a), and for the ingressive reading with an early adverb, as in (2c). If the ingressive reading is triggered by the early adverb, it should not be compatible with past tense in (2d), because the event expressed by the verb and its complements must be located in the future. Therefore, an interaction between the factors adverb position (early/late) and tense (present/past) is predicted.

This prediction was tested in two experiments. With an acceptability rating task on a five-point scale, Experiment 1 found the predicted interaction. Sentences with an early adverb and past tense were rated lower than the ones with present tense (2.3 vs. 3.3). No difference was found for sentences with late adverb (4.1 vs. 4.2). The overall low ratings for sentences with an early adverb reflect the markedness of this position. In a further experiment, we are currently testing the adverb preceding and following the object. With a self-paced reading task in Experiment 2, again an interaction of adverb position and tense was found: Longer reading times on the verb were found for sentences with an early adverb and past tense compared to those with present tense (768 vs. 712 ms). No significant difference was found for sentences with a late adverb (750 vs. 773 ms). In a third experiment, participants had to rate sentence paraphrase pairs (scale 1–5). We used sentences like (2a) and (2c) in combination with paraphrases like (1a) or (1b). The results revealed an interaction of adverb position and paraphrase. With an early adverb, the ingressive reading was rated higher than the egressive reading (3.1 vs. 2.3). In contrast, with a late adverb the ingressive reading was rated lower (2.4 vs. 3.3). Surprisingly, an interaction was also found for sentences with punctual verbs like *abschalten* (“to switch off”) for which the egressive reading is implausible. This means that syntactic position influences interpretation even in unambiguous sentences.

To sum up, the results of all three experiments show that the syntactic position of a temporal adverbial influences interpretation. The results can be explained within a *scope approach* that assumes one (underspecified) semantic representation for time-frame adverbials. The two interpretations arise from a difference in the syntax-semantics-mapping, i.e., the mapping from different modifier positions to different semantic domains. The early adverb has scope over the *event-external* domain whereas the late adverb composes with the *process* domain (e.g., Haider, 2000; Ernst, 2002; Rawlins, 2008).

Examples

- | | | |
|-----|--|-------------------------------|
| (1) | Der Chefkoch bereitet die Tomatensuppe in dreissig Minuten zu.
<i>The chef prepares the tomato soup in thirty minutes.</i> | |
| | a. Preparing the tomato soup takes thirty minutes. | <i>Egressive reading</i> |
| | b. Preparing the tomato soup will start in thirty minutes. | <i>Ingressive reading</i> |
| (2) | Maria sagt, dass
“Mary says (that)” | |
| | a. der Chefkoch die Tomatensuppe in dreissig Minuten zubereitet. | <i>Adverb late / Present</i> |
| | b. der Chefkoch die Tomatensuppe in dreissig Minuten zubereitete. | <i>Adverb late / Past</i> |
| | c. in dreissig Minuten der Chefkoch die Tomatensuppe zubereitet. | <i>Adverb early / Present</i> |
| | d. in dreissig Minuten der Chefkoch die Tomatensuppe zubereitete.
<i>(in thirty minutes) the chef the tomato soup (in thirty minutes) prepares / prepared</i> | <i>Adverb early / Past</i> |
| | “(in thirty minutes) the chef will prepare/prepared the tomato soup (in thirty minutes).” | |

Mirror recursion learning in the Box Prediction artificial grammar paradigm

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Recursion learning; Mirror recursion; Syntactic gestures; Box prediction paradigm, Artificial language

Recursion is widely regarded as a core feature of human language processing [1][2] although there is debate about whether it is universal [3], and whether a symbolic or a recurrent connectionist encoding [4] underlies this feature. Because forms of recursion vary across languages, learners must discover specific recursive structures via experience. We explore recursion learning in an artificial grammar paradigm, and offer evidence that (a) a small percentage of undergraduate students can discover mirror recursion, not merely counting recursion, in the laboratory and (b) the learning process involves mastering the timing of syntactic gestures, in line with the connectionist view.

Counting recursion (e.g. ab, aabb, aaabbb,...) can be identified by a mechanism that merely counts symbols. *Mirror recursion* (e.g., Grammar 1) requires keeping track of symbol order, not merely counting. Most natural language recursion is mirror recursion [5]. Although several artificial grammar studies demonstrate recursion learning by both humans (e.g., [6]) and animals ([7]), these have been criticized as not relevant to natural language because the evidence only supports counting recursion (e.g., [8]). We extend [9]'s new evidence for artificial mirror recursion learning with a "Box Prediction" paradigm, permitting detailed monitoring of the emergence of recursive structure.

Sentences were generated by Grammar 1 and strung end to end in a sequence of 553 words. Early in the sequence, Level 1 sentences (abp, xyp) were most common, but over the first 410 words (the "Training Phase"), Level 2 sentences (aabbp, axybp, xaby, xyyp) became increasingly common. The last 143 trials (the "Test Phase") included 4 Level 3 types (aaabbbp, axyybp, aaxybbp, xaabyp). Grammar learning was operationalized via five black boxes on a computer screen. When the participant clicked a box, one box changed color, specified by the sequence just described. The participant had to predict (by clicking on it) the unique box that would change color at each time step. Predictions: (a) We expected some participants to generalize to Level 3 sentences on the basis of exposure to Levels 1 and 2 only. (b) We expected temporal variability to decrease as learning progressed.

Results: Of 71 undergraduates, 12 scored over 80% in the last 100 training trials, suggesting that they were approximating at least a Level 1-2 finite state grammar. Of these 12, the two top scorers generalized perfectly to each first instance of the four Level 3 types at test. If, contrary to hypothesis (a), all 12 were using finite state encodings, and they guessed randomly on novel transitions, the chances of observing 2 or more perfect scorers would be 0.9% ($p = .009$). We infer that these two discovered mirror recursion. Fitting a temporal variability parameter to a model of each participant who significantly improved indicated that the temporal variability of predictions decreased in the later stages of learning, supporting the gestural timing claim (b). We conclude that mirror recursion can occur in the laboratory, that our method gives helpfully detailed information about the learning process, and that variability in the timing of syntactic gestures deserves further attention.

Grammar 1: $R \rightarrow S p$, $S \rightarrow a S b$, $S \rightarrow x S y$, $S \rightarrow 0$. E.g., abp, xyp, aabbp, axybp,...

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Priming during real-time comprehension of code-switched utterances

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Bilingualism; Syntactic priming; Eye-tracking; English; Spanish

Syntactic priming refers to facilitation in processing a syntactic structure after recent exposure to the same structure. In bilinguals, this priming occurs between sentences/phrases in one language and sentences/phrases in another, suggesting that syntactic representations (e.g., SVO structure) might be shared between languages [1, 2]. However, the full capability of the bilingual processing system remains to be explored. Can similar effects be found during bilingual comprehension as in production? Can multilingual structures, not found in either of the constituent languages, show facilitation from prior exposure? The current study addresses this question by examining the online priming of code-switched structures using the visual world paradigm.

Participants were fluent Spanish-English bilinguals (N=24). On each trial, they saw 4 objects on a computer screen. An auditory instruction directed them to click on one of the objects. The instructions consisted of the English carrier phrase "Click on the", which continued with either an English adjective-noun phrase (E) or code-switched into a Spanish noun-adjective phrase (CS) (1a-b). On critical trials, the word following the carrier phrase was temporarily ambiguous: it was roughly phonetically compatible with either an English adjective or a Spanish noun (2). Each target trial was preceded by two prime trials. Each participant received all 4 possible combinations of primes and targets (3a-d) in a pseudorandom order. The assignment of target items to conditions was counterbalanced across 4 lists. We predicted that for each target type, processing of the instruction would be facilitated by a prime of the same type compared to when the prime was a different type (3a vs. 3b, 3d vs. 3c). Participants listened to a total of 64 instructions (16 targets, 32 primes, 16 fillers).

The dependent variable was the ratio of looking time to the correct match divided by the sum of looking time to the two possible matches, in the 200-400 ms time window following the temporarily ambiguous word. For code-switched targets (3c-d), as predicted, the ratio was larger following a code-switched prime (0.52) than an English prime (0.36) ($F(1,23)=11.12, p<.01$; $F(1,15)=12.41, p<.01$). This effect appears to be driven by both a significant increase in looking to the correct match ($F(1,23)$ and $F(1,15)$ p 's $<.02$) and a marginally significant decrease in looking to the incorrect match (one-tailed p 's $<.1$) when the target instruction was preceded by a structurally similar prime. For English targets, there was no significant difference in ratio score between the English prime (0.5) and code-switched prime (0.55) conditions (p 's $>.2$). This null result could be due to a ceiling effect. Our participants, all of whom reside in the United States, may have been highly proficient in processing English sentences, independent of priming. Alternatively, it could be that code-switched utterances always benefit more from priming than single language utterances. Future work can distinguish these alternatives by employing Spanish carrier phrases.

These results show that the priming of multilingual structures can influence bilingual online comprehension. They extend previous syntactic priming effects to novel structures presumably composed "on the fly" from phrases in different languages. As such, they constrain theories of the mechanisms underlying syntactic priming. Future studies could investigate the constraints on such prime-able cross-language combinations.

Example stimuli

- 1 (a). English (E) instruction: Click on the yellow box
- 1 (b). Code-switched (CS) instruction: Click on the vaso pequeño (Translation: glass small i.e., small glass)
2. "Click on the big..."
Visual display: **big** cookie (English match), small cookie (contrast),
long mustache (Spanish match: **bigote** largo), red sweater (distractor)
- 3 (a). E prime E target Click on the yellow box; Click on the big cookie
- 3 (b). CS prime E target Click on the vaso pequeño; Click on the big cookie.
- 3 (c). E prime CS target Click on the yellow box; Click on the bigote largo.
- 3 (d). CS prime CS target Click on the vaso pequeño; Click on the bigote largo.

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Contextual effects on figurative language processing: Activation vs. suppression

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Figurative language; Lexical pragmatics; Mouse-tracking

Early psycholinguistic studies initially showed that processing figurative language takes longer than literal speech. Recent research has shown that this may be due to limitations of standard reaction time methodology, such as speed accuracy trade-off issues [3]. More importantly, including strong contextual manipulations also diminishes processing differences between literal and figurative meanings. However, the lack of reaction time differences in rich contexts supplies little direct evidence about how context alters the psychological mechanisms involved in figurative language comprehension.

In this paper, we test between two accounts of metaphor processing using a novel metaphor interference paradigm using mouse-tracking to better understand how context modulates how and when salient features of a concept are used in online-processing. Active suppression accounts hold that listeners first access the most salient or probable feature of a concept regardless of the context, and if the figurative meaning is not the most salient, then listeners must suppress this feature and retrieve a less salient feature to understand the metaphor [2][4]. Another account suggests that context can have a more direct effect on the salience of a feature and effectively eliminates the stage of processing where features must be evaluated in the order of “resting” salience [1]. In three mouse-tracking experiments, we examine how context affects the availability of low vs. high salience features during online metaphor processing.

A metaphor interference paradigm was created, in which participants read sentences such as “the goalie is a spider” and had to click on the picture that best corresponds to the figurative state of the metaphorical topic, e.g. a diving goalie. In the first experiment, listeners either read sentences with a non-sense competitor (an apple) or a literal meaning competitor (a spider) in the opposing corner of the screen as the target. In a second experiment, listeners first saw pictures that either had a feature of the topic that was relevant for the metaphor (a spider web) or an irrelevant one (spider fangs). This allowed us to separate features for a given metaphorical vehicle in terms of salience and relevance. Participants then went through the same procedure as Experiment 1 with 4 different types of competitors. The active suppression account predicts that low salience relevant features should interfere during later processing in both zero-context and full context conditions. The direct access view, however, predicts that low salience relevant features should interfere during later processing in zero-context, however during early processing the full context condition.

Results from the first experiment show a clear interference effect of literal meaning pictures. Results from the second experiment found that high salience features for the vehicle that were not relevant for understanding the metaphor interfered earlier on in processing, whereas low salience features that were relevant for the metaphor interfered later in processing. This is evidence for the active suppression account, however a third experiment is now being conducted to test whether this affect occurs in richer contexts. If context diminishes the interference effect found in Experiment 2, then this would support the direct access view.

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Syntactic priming in noun vs. verb attachment ambiguities: Evidence from ERPs and eye-tracking

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Syntactic priming; Event Related Potentials (ERPs); Eye-tracking; English

In comprehension, syntactic priming involves facilitation of sentence processing when a sentence of a particular structure follows a sentence containing some of the same structural elements (Pickering & Ferreira, 2009; Tooley & Traxler, 2010). In eye-tracking, syntactic priming effects manifest as reduced reading times for the repeated structure, while ERP studies typically reveal a reduced P600 (Ledoux et al., 2007; Tooley et al., 2009). To date, studies of syntactic priming in comprehension have focused on reduced relatives (Traxler & Tooley, 2008), datives (Arai et al., 2007), and modifier-goal ambiguities (Traxler, 2008). It is unknown whether priming extends to other sentence types, and, if so, whether it would reflect the same kinds of underlying mental operations.

In this study, participants read sentences containing verb/noun attachment ambiguities, such as (1) and (2) below. In isolation, sentences like (1) are easier to process than (2), because readers attach the prepositional phrase *with the stick* to the preceding verb (*hit*), as opposed to the preceding noun (*boy*). The prepositional phrase in sentences like (2) can only be plausibly attached to the noun (*man*). Accounts differ as to whether the greater difficulty of (2) reflects syntactic structure preferences (e.g., Rayner et al., 1982) or referential constraints (e.g., Altmann & Steedman, 1988). Our main research question is whether the difficulty associated with noun-attachment can be reduced when a noun-attached target sentence follows a noun-attached prime sentence.

In Experiment 1 (eye-tracking), 44 participants read noun-attached targets that appeared after either a noun-attached (e.g., 2) or verb-attached (e.g., 1) prime sentence. Noun-attached targets following verb-attached primes evoked a greater number of regressions than noun-attached targets following noun-attached primes. In addition, total reading time for noun-attached targets in the noun-phrase (e.g., *the man*) and prepositional-phrase regions (e.g., *with the mustache*) was lower than for noun-attached primes (NP: $t_1 p=0.01$, $t_2 p=0.01$; PP: $t_1 p=0.07$, $t_2 p=0.05$).

In Experiment 2 (ERPs), 20 participants read noun- and verb-attached sentences like (1) and (2) below, in order to determine the ERP correlates of the difficulty associated with noun- compared to verb-attachment outside of a priming paradigm. We found a reduction in N400 amplitude for verb-attached critical words (e.g. *stick*) compared to noun-attached critical words (e.g. *mustache*) ($p<0.05$).

In Experiment 3 (ERPs), 23 participants read noun-attached target sentences that appeared after noun-attached primes, such as (2). We found reduced positivities (P600s) during processing of the words following the disambiguating noun phrase in target sentences after noun-attached primes (e.g. *earlier today* in (2)) ($p<0.05$).

These results show, for the first time, that priming effects in comprehension extend to sentences containing noun-attached prepositional phrases. In addition, the ERP findings from Experiment 2 suggest that, unlike reduced relatives, facilitated processing of verb- vs. noun-attachment may primarily reflect semantic processes. We interpret these results with respect to the referential theory of modifier processing (Altmann & Steedman, 1988; Ni, Crain, & Shankweiler, 1996).

Examples:

- (1) The girl hit the boy with the stick last night. (verb-attached/ambiguous)
(2) The officer hit the man with the mustache earlier today. (noun-attached)

Contrastive and non-contrastive Poset-licensing of German marked word order

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Word order; Information structure; Acceptability judgments; Self-paced reading; German

Word order is one of the best studied aspects of German syntax. There is abundant psycholinguistic evidence that, taken out of context, sentences with marked word order---i.e., sentences, where the order of subject and object is reversed---are judged as less acceptable and show an increase in processing difficulty in online experiments relative to their unmarked counterparts (s. Hemforth, 1993).

Many studies have tried to modulate that processing difference for marked word order by embedding sentences with marked word order into contexts inducing a specific information structure for the marked word order sentences. The reasoning behind is that, given the right kind of context, a sentence with marked word order should be just as easy to process as its unmarked counterpart (what we call *weak contextual licensing*), or even easier (*strong licensing*). The most important information structural factor being manipulated in these studies was the discourse status of the subject and the object in the target sentences (s. Bayer & Marslen-Wilson, 1992; Bader, 1999; Keller, 2000; Weskott, 2003; Bornkessel & Schlesewsky, 2006). Most studies tried to manipulate the information structure of target sentences by inducing some kind of contrast between the object referent and some referent in the context. However, these studies found no online evidence for strong licensing in these contrastive contexts.

In an acceptability and a self-paced reading study (wordwise non-cumulative moving window), we presented marked vs. unmarked word orders like the ones in (1) with and without the preceding context. In the conditions with context, a whole-part relation holds between the subject referent of the context sentence (the car) and the object referent of the target sentence (the rear-view mirror). In addition to the factor context (present vs. absent) and the WORD ORDER of the target sentence (SVO vs. OVS), we also manipulated whether the target sentence expressed a CONTRAST relation relative to the context, (cf. (1.b) vs. (1.c)).

We predicted that whole-part, being a paradigmatic case of a Poset relation (s. Prince, 1998), should yield a strong licensing effect. That is, OVS word orders should be less acceptable and harder to process than SVO in the null context, but the reverse should hold true in the whole-part context (interaction of CONTEXT and WORD ORDER). In addition, we were interested in the effect of the factor CONTRAST on the licensing effect.

Our results show the predicted interaction of WORD ORDER and CONTEXT. We interpret this as evidence that whole-part one type of Poset relation is indeed a strong licensor of marked word order.

In addition, and this is surprising given previous studies, we found no effect of the CONTRAST factor: the licensing effect was not affected by whether the target sentence expressed a contrast to the context (1.b), or rather some kind of a specification (1.c).

We conclude that marked word order in German is licensed in contexts which provide a Poset-related antecedent for the object referent, and that this holds true irrespective of the contrastivity of the contextual relation.

(1) .a [Context: Peter hat den Wagen gewaschen. (*Peter has washed the car.*)]

(1) .b Er hat den Außenspiegel ausgelassen./Den Außenspiegel hat er ausgelassen.

(*He_{nom} has the_{acc} rear view mirror omitted./The_{acc} rear view mirror has he_{nom} omitted.*)

(1) .c Er hat den Außenspiegel besonders gründlich gewienert./Den Außenspiegel hat er besonders gründlich gewienert.

(*He_{nom} has the_{acc} rear view mirror particularly diligently polished./The_{acc} rear view mirror has he_{nom} particularly diligently polished.*)

Is children's reading "good-enough"?

Linking real-time processing and comprehension in children's reading

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Children's reading; Children's sentence processing; Good-enough processing; Eye-tracking during reading; English

Much research has focused on the resolution of misleading temporary ambiguities ("garden paths") in sentence processing. For example, it is well-documented that adult readers show increased reading times and regressive eye-movements when they encounter the disambiguating word in a garden-path sentence (Rayner et al, 1983). Temporary ambiguities can also affect offline measures of sentence comprehension. Christianson et al. (2001,2006) asked adults to read sentences such as "*While Anna dressed the baby played in its crib*", followed by a comprehension question probing the "temporary" misinterpretation e.g. "*Did Anna dress the baby?*". Participants incorrectly answered "YES" the majority of the time, suggesting that temporary ambiguities are not necessarily fully resolved during processing and that alternative interpretations may linger. However little is currently known about how comprehension is related to the earlier processing of the sentence. These questions are of particular interest for children since their reading comprehension is characterized by significant individual differences (Nation, 2005) and to date research with children has used non-reading paradigms Trueswell et al (1999). In the current study, children read garden-path sentences while we monitored their eye-movements, and then answered questions, allowing us to investigate the relationship between online processing and offline comprehension.

86 children (mean: 9yr;6) read sentences and responded to YES/NO questions after each, see Table 1 for examples. Each *garden-path* sentence had two control sentences: a *comma* counterpart (the control for real-time processing) and a "reversed" counterpart (a strong control for offline comprehension: errors on the YES/NO question cannot be due to garden path syntax). The design was fully crossed; filler trials ensured a balance of structures and YES/NO responses.

Results

Offline Comprehension: Significantly more errors on questions following garden-path sentences than either type of control (garden-path 58% errors; comma 43%; reversed 40%).

Online processing: Effects were apparent not at the disambiguating word but instead on the subsequent region (e.g. at "*in its*" rather than "*played*" in "*While Anna was dressing the baby played in its cot*"), corroborating previous child reading studies (Joseph et al., 2008). Specifically: we observed more regressions out of this region, and longer *go-past* times (the sum of all temporally contiguous fixations, including regressive eye-movements to the left of the region, until the point of fixation progressed to the region to the right), for *garden-path* sentences compared to *comma* sentences.

Predicting comprehension performance: Overall go-past times were *not* associated with differences in comprehension. indicating that that long go-past times may not be a good signature of the reanalysis process in children's reading. On-going work is exploring the role of regressions to specific regions and relating comprehension scores to various measures of reading and verbal working memory, with a view to further elucidating the nature of individual differences in reading comprehension.

Sentence Types	Example sentences	Example questions. Correct answer is always "NO".
Garden_P ./ Comma	1. While Anna was dressing(,) the baby played in its cot. 2. While the boy was eating(,) the biscuits baked in the oven.	Did Anna dress the baby? Did the boy eat the biscuits?
Reversed	1. The baby played in its cot while Anna was dressing. 2. The biscuits baked in the oven while the boy was eating.	

Table 1. Examples of *garden-path* sentences and their *reversed* and *comma* counterparts. Half of the sentences are *optional transitive* (e.g. eat) and half *reflexive absolute transitive* (e.g. dress) verbs (following Christianson et al. 2001).

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