Memory in Language: Language in Memory

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Although constraints of memory have long been assumed to affect sentence processing (Miller & Chomsky, 1963) and contingencies in language have long been known to affect human memory (Miller & Selfridge, 1950), the connection between models of sentence comprehension and memory remains less than clear and there is often too little dialogue between memory and language researchers. In this symposium, we aim to bring together researchers studying sentence processing that are interested in the constraints imposed by memory (Culicover, Lewis, McElree) and researchers studying memory that work on incorporating language sensitive representations into their models (Dennis, Howard).

The prima facie evidence for the potential value of a closer relationship is substantial. For instance, Fedorenko, Gibson, and Rohde (2006) found that when a working memory load is imposed during sentence comprehension, object extracted relative clauses, which are typically more difficult to process, are affected more than subject extracted relative clauses. This effect is magnified if the nouns present in the working memory set are similar to those in the sentence. In addition, when a licensor for a negative polarity item appears in an inaccessible position (such as "no" in "A man who had no beard was ever thrifty") it nonetheless impacts both the reading time and the probability of judging the string grammatical (Vasishth, Brussow, Lewis, & Drenhaus, 2008) suggesting that sentence processing is subject to the kinds of similarity phenomena that are observed ubiquitously in working memory studies.

Models of short term memory have progressed substantially since the observations of Miller and Chomsky (1963) observations. Buffer models have been replaced by direct access models and the cue dependent nature of memory is now more broadly appreciated. The importance of this change in perspective was underlined by McElree, Foraker, and Dyer (2003). Using a response signal procedure, they found that while increasing the length of a dependency impacts accuracy it does not affect the rate of formation accrual the signature pattern of a direct access memory process.

The broad implication is that the detailed nature of sentence processing emerges from the interaction of general principles of human memory with the specialized task of language comprehension. Conversely, many memory experiments involve sequences of word stimuli and the role of language is well known. For instance, Howard, Addis, Jing, and Kahana (2007) showed that semantic relatedness affects the conditional response probability of producing items in free recall. Furthermore, models of free recall performance such as the temporal context model (Howard & Kahana, 2002) can be used to construct lexical representations directly from language corpora.

The purpose of the symposium is to bring together leading researchers from both domains to discuss how memory and language models can be brought into closer alignment.

Peter Culicover: Linguists working on the syntax of natural languages conventionally categorize instances of unacceptability as 'ungrammaticality' (except for clear cases of semantic anomaly). However, there has been a recent trend (even among some linguists, e.g. Kluender, Sag, myself) in favor of taking a somewhat narrower view of what constitutes 'ungrammaticality', and to attribute some types of unacceptabilty to the processing complexity associated with particular syntactic constructions. Typically, such complexity is characterized in terms of 'memory limitations' (as in the work of scholars such as Gibson and Lewis), the most familiar cases involving nested dependency in relative clauses. I consider a

range of syntactic constructions that are candidates for such a processing account, and explore the question of how processing would have to proceed in order for a general and reasonably principled complexity account to be plausible. The main goal is to highlight the syntactic phenomena that might profit from continuing investigations into how discourse representations are constructed in the course of processing, how such representations are represented in memory, and what takes place in accessing, retrieving and otherwise manipulating their components.

Simon Dennis: In models of human episodic memory, it is common to consider retrieval to be the consequence of both item and contextual cues. However, the features of these representations are often assumed to be drawn independently from some distribution, without regard to semantic or syntactic contingencies that may have led to their formation. In this talk, I will outline a version of the syntagmatic paradigmatic model (Dennis, 2004, 2005) that builds contextual representations from exposure to a corpus. The contextual representations formed capture syntactic constituent and semantic role information that may help bridge the gap between models of memory and sentence comprehension.

Marc Howard: In recent years, mathematical models of episodic memory have increasingly utilized a gradually-changing state of temporal context as the cue for recall from episodic memory. I will describe a recent extension to the temporal context model that attempts to model the development of semantic representations from a gradually-changing state of temporal context. The model, referred to as pTCM, uses the current state of context—a weighted sum of the semantic representations of recently-presented items—as a cue to generate a prediction about what word will be presented next. The semantic representation of a word is formed by averaging the predictions that precede its presentation. The model performs comparably to LSA when trained on a corpus of naturally-occurring text. The semantic representation generated by pTCM performs best when temporal context changes gradually over time and extends across sentence boundaries.

Richard Lewis: I present a theoretical framework that construes linguistic processing and its behavioural manifestations as rational processes bounded by constraints on cognitive architecture such as short term memory, noise, and perceptual motor bottlenecks. The framework is supported by new computational modelling techniques for deriving adaptive control strategies given a specific set of cognitive constraints and some probabilistic environment. The presentation will provide summarize evidence on the nature of memory constraints in sentence comprehension, and then show how incorporating these constraints in boundedly rational control models provides a novel and detailed integration of memory based and experience based approaches to language comprehension.

Brian McElree: Understanding language routinely requires comprehenders to establish dependencies between elements that span several words, phrases, or even clauses. I will first present an overview of studies indicating that the same mechanism identified in basic research on recognition memory underlies sentence comprehension. Specifically, that a) the interpretations of expressions with various types of non-adjacent dependencies are mediated by content-addressable memory representations that are retrieved with a cue-driven, direct-access operation, and b) although this type of retrieval operation enables the rapid recovery of past analyses, it is highly susceptible to interference from other constituents in memory that match the cues used for retrieval. A second line of research explores the hypothesis that memory retrieval is required whenever a constituent needed to resolve a dependency is outside of focal attention. Although studies using a range of cognitive tasks suggest that the span of focal attention is extremely limited, research has not directly examined the effective span of focal attention in comprehension, and whether it interacts with linguistic structure and linguistic devices for focusing information. I will report initial studies that investigate the span of focal attention with time course measures of retrieval speed during on-line comprehension.

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