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## CONTEXT EFFECTS ON LEXICAL PROCESSING DURING AUDITORY SENTENCE COMPREHENSION

On the Time-Course and Neurological Bases of a Basic Comprehension  
Process

**Abstract.** This paper presents an integrated view of the effects of context upon lexical access and lexical integration during sentence comprehension. The review incorporates evidence from both standard psycholinguistic and neuro-cognitive approaches. Along with this integrated overview, new hemisphere-specific processing evidence concerning context and lexical processing is presented. The evidence is taken to support a “modes of processing” perspective in the examination of sentence comprehension.

### 1. INTRODUCTION

Understanding the nature of lexical representation and processing constitutes one of the foundational issues in the study of sentence comprehension. A vast literature, spanning decades of research, has been produced on topics and issues related to lexical issues, resulting in a number of well-established findings but an even larger set of conflicting evidence and theoretical claims. The goal of this chapter is to present an integrated view of lexical access, lexical integration, and the time-course of the effect of context upon these processes. We propose to accomplish this with the aid of two specific levers (involving relevant new data): First, an examination of the neurological underpinnings of these processes and second, consideration of the issue of “modes” of processing. Ultimately, we believe that these considerations allow for an integrated view of lexical processing in service of sentence comprehension. In what follows, we first present some parameters that limit the domain of the field to be covered in this chapter, followed then by our examination of lexical processing and context effects.

### 2. SCOPE OF REVIEW / ANALYSIS

There are three tenets which guide the approach taken and the choice of evidence examined in this exposition. The first is that language processing in general is something that can be accomplished in a number of ways. Moreover, central to any understanding of the nature of the processes underlying language is a clear, detailed definition of the “type” of language situation – the parameters of language processing – that are under focal investigation. It follows from this that lexical access and integration can potentially be accomplished via varying processes in different situations. Thus, it is absolutely critical to carefully specify the parameters and conditions focused on in any set of claims about the nature of lexical processing.

The second tenet is that any deep understanding of sentence/language comprehension can only be developed via examination of evidence which reflects moment-by-moment details of the (sub)processes involved in ongoing comprehension, evidence typically referred to as "on-line" reflections of processing. We also believe, of course, that such processes must be examined in conjunction with broader-scope (off-line) approaches in order to gain an integrated picture of all levels of processing; however, it is the on-line details that will largely differentiate among most current theoretical accounts of contextual processing and lexical access.

Finally, the third tenet guiding our approach is that it is only in the conjunction of traditional on-line behavioral processing evidence combined with relevant evidence from modern cognitive neuroscience (e.g., studies of focal brain-damaged populations, brain imaging, etc.) that the necessary leverage will be obtained to gain more definitive answers about the classic, central theoretical issues in the field.

In line with the above, this chapter will focus on the study of lexical processing during auditory comprehension. The processes underlying listening and of reading diverge and differ at numerous critical stages and detailing the differences and similarities between the two is considerably beyond the scope and length parameters of this chapter. In addition to focusing on the auditory domain, this chapter will also focus on comprehension of lexical information as examined within the context of ongoing sentence comprehension. While the processing of words outside of sentence/discourse contexts (i.e., in isolation, in pairs, etc.) holds obvious relationships to that found within standard sentence/discourse comprehension, the comprehension process is sensitive to critical processing parameters which are simply unavailable (and hence not utilized) in the processing of words outside of discourse/sentence settings. The link between the mechanisms underlying lexical processing as found in sentences and lexical processing as found in other settings awaits a far larger understanding of goals and parameters of cognitive processing in general.

### 3. THE EFFECTS OF CONTEXT ON LEXICAL ACCESS

**Basic Issues and Evidence.** The fundamental issue that has formed the basis of debate in the lexical representation / lexical processing field has concerned the manner in which lexical information is made available to the ongoing comprehension process. While this has often been framed as an issue of "Modularity vs. Interactivity" of information processing during comprehension (e.g., Fodor, 1983; Swinney, 1979; Tyler & Marslen-Wilson, 1982), each of these terms have come to "cover" for a (surprisingly varied) number of claims about processing. We will thus avoid use of these specific terms at first here, focusing instead on specifically defined issues. We will be concerned with the question of how (and when) contextual material which occurs prior to a particular word in a sentence constrains the amount or type of lexical information about that word that is made available to ongoing comprehension. This is the aspect of the modularity-interactivity debate that is concerned with whether or not prior context has the ability to limit access to information "stored with" a lexical item.<sup>1</sup> We will be concerned with the time-course of availability of (all or part of) such lexical information for further processing during ongoing comprehension. Ultimately, we

will also be concerned with the degree to which specific lexical processes are susceptible to effects of expectations and predictions based on world knowledge and prior context. Alternatively, we will explore the degree to which these certain lexical processes are fundamentally form-directed operations.

Our analysis in this chapter focuses on the processing of lexically ambiguous words, words in which the phonological form connects to more than one meaning. Such homophonic/homonymic lexical elements have traditionally constituted the major testing ground for the issues concerning context effects and lexical processing, as they provide *individuable information* (the distinct “meanings” of the ambiguity) which can be separately addressed via contextual material. This, allows for empirical tests of when and how context may come to constrain the access to such information (See, e.g., work by Foss, 1998; Foss, Starkey, & Bias, 1988).

Studies examining the processing of lexical ambiguities during auditory sentence comprehension, in the absence of a biasing prior context, have nearly uniformly, demonstrated that all meanings associated with the word form are momentarily accessed and made available for further processing (Onifer & Swinney, 1981; Picoult & Johnson, 1992; Prather & Swinney, 1977; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Simpson, 1981; Swinney, 1979; Swinney & Prather, 1989; Tanenhaus, Leiman, & Seidenberg, 1979, among others). Thus, when no prior biasing constraints from world knowledge, lexical associates, plausibility, discourse context, etc. are present, access to all information stored with a lexical entry is made available to sentence processing for a short period. Note that there is standardly the inherent effect of relative frequency which may determine the order of availability of various meanings of lexical ambiguities; however, such frequency effects are neither constraining nor precluding effects (i.e., the less frequent meanings are still made available for further processing; see more on this, below).

Studies examining the processing of lexical ambiguities during auditory sentence comprehension in the presence of prior context are slightly more varied in the interpretation of their findings. The vast majority of such work has regularly and repeatedly demonstrated, across a large range of “prior contexts”, that context does not restrict immediate or initial access to lexical information. This is nearly universally true in research which has employed temporally-sensitive tasks which have been demonstrated to have only a minimum of demand-characteristics that force interactions with the lexical access process itself. Thus, for example, unrestricted, exhaustive initial access of meanings for lexical ambiguities has been found even in the presence of prior contexts which place strong and definitive constraints on their interpretation in terms of: 1) Syntactic category (e.g., Prather and Swinney, 1977; Tanenhaus et al., 1979), 2) Semantic-associative contexts (e.g., Love & Swinney, 1996; Miyake, Just & Carpenter, 1994; Onifer & Swinney, 1981; Picoult & Johnson, 1992; Seidenberg et al., 1982; Simpson, 1981; Swinney, 1979; among others), 3) Highly restrictive semantic-associative sentential contexts (e.g., Swinney, 1991), and 4) Discourse contexts (e.g., Swinney, 1982). This effect also holds, regardless of whether the biasing context appears earlier in the same sentence as the ambiguous word, or in a prior sentence in a larger discourse (e.g., Swinney, 1979). Similarly, it has been shown that a patient population which has well-defined and well-known disabilities in utilizing context - chronic schizophrenics - demonstrates their “context problems” only at a point “downstream” from initial access of all the meanings of a lexical ambiguity, not at the point of access (Onifer,

1980). This, therefore, supports the view that the locus of “prior context” effects on lexical ambiguity is at a point following initial access of all information stored with that entry. Finally, we note that this same pattern of exhaustive, form-driven, context-independent access has also been demonstrated in on-line studies of processing in pre-school age children (Love, Swinney, Bagdasaryan, & Prather, 1999; Swinney & Prather, 1989).

This relatively large range of evidence has come from a number of different tasks – cross-modal lexical priming, auditory ERPs, immediate judgment tasks, etc. – which have examined context and ambiguity processing in normal, fluent speech. In all, then, studies of fluent auditory language processing have repeatedly demonstrated that whenever a phonetic form of a word is encountered there is immediate and unconstrained access to all information for that word, even in the face of a wide range of strongly constraining, prior-occurring, contexts. There is evidence, however, that as early as 200-300 msec following initial access, biasing contexts may begin to have constraining effects.<sup>2</sup> Our examination of the neurological underpinnings of lexical ambiguity access, resolution and context effects begins with these established findings.

In what follows immediately below we briefly present a summary of a small portion of a recent study that replicates the basic findings discussed above. We present it in some detail so as to allow for both a specific set of findings to carry through in further discussion, and a specific example to consider throughout our consideration of these effects.

Love and Swinney (1996) present an examination of effects of context and structural processes on lexical ambiguity access and processing. The following is a summary of the *methodology* employed in this study:

### 3.1 Methodology

A Cross-Modal Lexical Priming (CMLP) task was employed, using a matched-probe configuration (Swinney, Onifer, Prather, & Hirshkowitz, 1979)<sup>3</sup>. Participants in the part of the study to be described here were 51 non-neurologically-involved college students, who heard sentences such as:

*The professor insisted that the exam be completed in ink, so Jimmy used the new pen\* that his mother-in-law recently purchased because the multiple colors allowed for more creativity.*

There were 40 such experimental sentences (along with 40 structurally similar “control” sentences and 10 practice sentences). All sentences were recorded (in pseudo-random order on counterbalanced scripts) by a male speaker at the rate of approximately 5 syllables per second. The asterisk (\*) indicates position at which the experimental and control visual probes appeared during the sentence; only a single sentence and single probe at a single position was presented to any one participant; conditions were counterbalanced across a series of scripts and subject groups<sup>4</sup>. Participants “named” each probe word that appeared and RT to voice-onset of these “naming” responses was recorded. The biasing contexts in the experimental materials were created followed the criteria employed by Tabossi (1988) to establish

a bias toward a strong “aspect” of the *a priori* more frequent meaning of the ambiguity. (under these criteria, a minimum of 75% of 12 judges agreed on intended aspect of meaning of the ambiguous word in the sentence, etc.). In a separate pretest, the “related” visual probes were created by first obtaining associations to the ambiguous word. Uniformly agreed-upon associates related to each interpretation of the ambiguity were chosen as the “related” probes, and these were matched with “unrelated control” probes (based on *a-priori* reaction times taken in an isolated word “naming” task, performed with over 50 subjects from yet another pretest) Thus (to follow the above example) associated probes related to each of the meanings of the ambiguous word “PEN” were chosen (e.g., “PENCIL” and “JAIL”), along with reaction-time-matched control words. Experimental and control probes were also equated for both “goodness-of-fit” to the sentence as heard up to the point the probe appeared (this involved a rating scale ranking of goodness of fit of the probe to the “preceding” sentence fragment) and for “relatedness-of-probe-to-sentence” (again, a rating scale).<sup>5</sup>

### 3.2 Results

The critical findings were: A main effect for Probe Type (related vs. control) ( $F(1,47) = 14.844, p=.001$ ), which did not interact significantly with the Ambiguity-Meaning factor (Primary vs. Secondary). Planned *a priori* comparisons performed on the related vs. control probes for each of the Ambiguity Meanings demonstrated a significant priming effect for both the Primary Meaning - PENCIL ( $t_{50}=2.242, p=.015$ ) and for the Secondary Meaning - JAIL ( $t_{50} = 1.805, p=.038$ )

The mean reaction times for “control” and “related” probes for both primary and secondary interpretations of the lexical ambiguity) can be seen in the following:

Ambiguity Meaning :	Primary (PENCIL)	Related probe: 521 msec
		Control probe: 533 msec
	Secondary (JAIL)	Related probe: 529 msec
		Control probe: 537 msec

This study thus replicated the long established finding of contextually independent, form-driven initial access for lexical information.<sup>6,7</sup>

We now turn to considerations of the neuro-biological mechanisms that might underlie both the contextually-independent, form-driven access and subsequent “meaning resolution” evidence seen in this and many similar on-line behavioral studies of the effects of context upon the processing of lexical information during sentence comprehension.

## 4. NEUROLOGICAL BASIS OF LEXICAL PROCESSING

### 4.1 Lesion Evidence

Evidence from the processing of lexical ambiguities in patients with focal lesions provides vehicle via which an understanding of aspects of the behavioral evidence derived from non-neurologically involved populations (and discussed above) can be

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